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# The <br> Transistor and Diode Data Book for Design Engineers 

First Edition



# Texas Instruments <br> INCORPORATED 

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## THE TRANSISTOR AND DIODE DATA BOOK

Since 1954, when Texas Instruments introduced the first silicon transistor to the marketplace, and later with the invention of the integrated circuit, TI has been pre-eminent in the semiconductor industry.

New semiconductor products are introduced almost daily; new applications for semiconductor products are being found or comtemplated at an ever-increasing rate, especially in the consumer and automotive fields. It is a difficult task for the equipment design engineer to stay abreast of all of the discrete and integrated-circuit products available to him in his efforts to choose the best device at the optimum cost effectiveness. It is the aim of Texas Instruments to provide the design engineer with the maximum amount of accurate product data organized in such a manner that the pertinent data may be located in the least amount of time.

Due to the amount of data involved, it would be inconvenient to present TI 's complete line of standard discrete products in a single volume. TI's broad line of power products are described in The Power Semiconductor Data Book for Design Engineers, First Edition (CC-404); optoelectronic products are presented in The Optoelectronics Data Book for Design Engineers, First Edition (CC-405). For ease of reference, all current devices listed in those two volumes are contained in the Type Number Index (Section O) herein. This 1248 -page volume is designed to complement those two volumes and essentially complete the current description of TI's line of discrete semiconductors by adding all low-power silicon transistors and diodes. (Generally, "low-power" denotes free-air power dissipation of one watt or less.)

This volume contains over 800 silicon transistor types (grown-junction, multijunction, unijunction, and fieldeffect transistors) and over 500 silicon diode types (switching, rectifying, voltage-regulating, voltage-variable-capacitance, and general purpose diodes as well as multielement diode arrays and matrices), over 150 of which are being announced for the first time.

Although this volume offers specification and interchangeability data only for low-power silicon transistors and diodes, complete technical information for all TI semiconductor products is available from your nearest TI field-sales office, local authorized TI distributor, or by writing direct to: Marketing and Information Services, Texas Instruments Incorporated, P.O. Box 5012, Dallas, Texas 75222.

We hope that you will find The Transistor and Diode Data Book for Design Engineers a useful addition to your technical library.

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OPTO-Refer to The Optoelectronics Data Book for Design Engineers, First Edition (CC-405).
POWER-Refer to The Power Semiconductor Data Book for Design Enginears, First Edition (CC-404).

## Glossary

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## GLOSSARY

## Introduction

This glossary contains letter symbols, abbreviations, terms, and definitions commonly used with semiconductor devices. Most of the information was obtained from JEDEC Publication No. 77. That document has over-riding authority where any conflict may occur.

## GENERAL

## Terms and Definitions

anode . . . . . . . . . . . . . . . . .
The electrode from which the forward current flows within the
device.

reverse bias . . . . . . . . . . . . . . . | The bias which tends to produce current flow in the reverse |
| :--- |
| direction. |

reverse direction . . . . . . . . . . . . .

## Letter Symbols, Terms, and Definitions

| Symbol | Term |
| :---: | :---: |
| $\overline{\mathrm{F}}$ or $\overline{N F}^{*}$ | average noise figure ${ }^{\dagger}$ |
|  | or |
|  | average noise factor ${ }^{\dagger}$ |


| For NF* | spot noise figure ${ }^{\dagger}$ or spot noise factor ${ }^{\dagger}$ |
| :---: | :---: |
| 'F | forward current, dc |
| $1 n$ | noise current, equivalent input |
| $I_{R}$ | reverse current, dc |
| $\mathrm{R}_{\theta}$ (formerly $\boldsymbol{\theta}$ ) | thermal resistance |
| $\mathrm{R}_{\theta \mathrm{CA}}$ | thermal resistance, case-to-ambient |
| $R_{\boldsymbol{\theta J A}}$ (formerly $\theta$ J-A) | thermal resistance, junction-to-ambient |
| $R_{\theta J C}$ (formerly $\boldsymbol{\theta}_{\mathrm{J}-\mathrm{C} \text { ) }}$ | thermal resistance, junction-to-case |
|  | forward transmission coefficient |

## Definition

The ratio of (1) the total output noise power within a designated output frequency band when the noise temperature of the input termination(s) is at the reference noise temperature, $T_{0}$, at all frequencies to (2) that part of (1) caused by the noise temperature of the designated signal-input termination within a designated signal-input frequency band.

The ratio of (1) the total output noise power per unit bandwidth (spectral density) at a designated output frequency when the noise temperature of the input termination(s) is at the reference noise temperature, To. at all frequencies to (2) that part of (1) caused by the noise temperature of the designated signal-input termination at a designated signal-input frequency.

The dc current that flows through a semiconductor junction in the forward direction.

The noise current of an ideal current source (having a source impedance equal to infinity) in parallel with the input terminals of the device that, together with the equivalent input noise voltage, represents the noise of the device.

The dc current that flows through a semiconductor junction in the reverse direction.

Refer to thermal resistance (steady-state), page 1-2.
The thermal resistance (steady-state) from the device case to the ambient.

The thermal resistance (steady-state) from the semiconductor junction (s) to the ambient.

The thermal resistance (steady-state) from the semiconductor junction(s) to a stated location on the case.

The ratio of the voltage at the output port to the voltage incident on the input port with the output port terminated in a purely resistive reference impedance equal to the impedance of the source of the incident voltage.

| Symbol | Term | Definition |
| :---: | :---: | :---: |
| $\mathrm{s}_{\mathrm{i}}$ or s $\mathrm{s}_{11}$ | input reflection coefficient | The ratio of the voltage reflected from the input port to the voltage incident on the input port with the output port terminated in a purely resistive reference impedance equal to the impedance of the source of the incident voltage. |
| so or s22 | output reflection coefficient | The ratio of the voltage reflected from the output port to the voltage incident on the output port with the input port terminated in a purely resistive reference impedance equal to the impedance of the source of the incident voltage. |
| sfors12 | reverse transmission coefficient | The ratio of the voltage at the input port to the voltage incident on the output port with the input port terminated in a purely resistive reference impedance equal to the impedance of the source of the incident voltage. |
| TA | free-air temperature <br> or ambient temperature | The air temperature measured below a device, in an environment of substantially uniform temperature, cooled only by natural air convection and not materially affected by reflective and radiant surfaces. (Ref MIL-S-19500D Par. 20.20.1) |
| $\mathrm{T}_{\mathrm{C}}$ | case temperature | The temperature measured at a specified location on the case of a device. (Ref MIL-S-19500D Par. 20.20.2) |
| TJ | virtual junction temperature | A temperature representing the temperature of the junction(s) calculated on the basis of a simplified model of the thermal and electrical behavior of the semiconductor device. |
|  |  | NOTE: This term "virtual junction temperature" is taken from IEC standards. It is particularly applicable to multijunction semiconductors and is used in this publication to denote the temperature of the active semiconductor element when required in specifications and test methods. The term "virtual junction temperature" is used interchangeably with the term "junction temperature" in this publication. |
| $\mathrm{T}_{\text {stg }}$ | storage temperature | The temperature at which the device, without any power applied, is stored. (Ref MIL-S-19500D Par. 20.20.3) |


| Symbol | Term | Definition |
| :---: | :---: | :---: |
| $T_{n}$ | noise temperature | The uniform physical absolute temperature (kelvin) at which a network (and all its sources, if a multiport) would have to be maintained if it (and its sources) were passive in order to make available (or deliver) the same random noise power per unit bandwidth (spectral density) at a given frequency as is actually available (or delivered) from the network. |
| $\mathrm{T}_{0}$ | reference noise temperature | A specified absolute temperature (kelvin) to be assumed as a noise temperature at the input ports of a network when calculating certain noise parameters, and for normalizing purposes. When the reference noise temperature is 290 K , it is considered to be the standard reference noise temperature. |
| $t_{d}$ | delay time | The time interval from the point at which the leading edge of the input pulse has reached 10 percent of its maximum amplitude to the point at which the leading edge of the output pulse has reached 10 percent of its maximum amplitude. (Ref MIL-S-195000 Par. 20.11) |
| $\mathbf{t f}^{\text {f }}$ | fall time | The time duration during which the trailing edge of a pulse is decreasing from 90 to 10 percent of its maximum amplitude. (Ref MIL-S-19500D Par. 20.12) |
| $t_{\text {off }}$ | turn-off time | The sum of $\mathrm{t}_{\mathbf{s}}+\mathrm{t}_{\mathbf{f}}$. |
| ton | tum-on time | The sum of $t_{d}+t_{r}$. |
| $t_{\text {p }}$ | pulse time | The time duration from the point on the leading edge which is 90 percent of the maximum amplitude to the point on the trailing edge which is 90 percent of the maximum amplitude. (Ref MIL-S-19500D Par. 20.15) |
| $t_{r}$ | rise time | The time duration during which the leading edge of a pulse is increasing from 10 to 90 percent of its maximum amplitude. (Ref MIL-S-19500 Par. 20.13) |
| $t_{s}$ | storage time | The time interval from a point 90 percent of the maximum amplitude on the trailing edge of the input pulse to a point 90 percent of the maximum amplitude on the trailing edge of the output pulse. (Ref MIL-S-19500D Par. 20.14) |

## glossary

general

| Symbol | Term |
| :--- | ---: |
| $\mathbf{t}_{w}$ | pulse average time |

## Definition

The time duration from the point on the leading edge which is 50 percent of the maximum amplitude to a point on the trailing edge which is $\mathbf{5 0}$ percent of the maximum amplitude. (Ref MIL-S-19500D Par. 20.10)

dIAGRAM ILLUSTRATING PULSE TIME SYMBOLOGY

| $V_{F}$ | forward voltage, dc |
| :--- | :--- |
| $V_{n}$ | The dc voltage across a semiconductor junction <br> associated with the flow of forward current. |
| equivalent input |  | | The noise voltage of an ideal voltage source (having a |
| :--- |
| source impedance equal to zero) in series with the |
| input terminals of the device that, together with the |
| equivalent input noise current, represents the noise of |
| the device. |

## GLOSSARY <br> SIGNAL DIODES AND RECTIFIERS

## SIGNAL DIODES AND RECTIFIERS

## Terms and Definitions



Letter Symbols, Terms, and Definitions
(For illustration of the following currents refer to diagrams on page 1-10)

| Symbol | Term | Definition |
| :---: | :---: | :---: |
|  | forward current (see table, page 1-11) | The respective value of current that flows through a semiconductor diode or rectifier diode in the forward direction. |
| Ifrm | forward current, repetitive peak | The peak value of the forward current including all repetitive transient currents. |
| IFSM | forward current, surge peak | The maximum (peak) surge forward current having a specified waveform and a short specified time interval. |
| 10 | average rectified forward current | The value of the forward current averaged over a full cycle of hatf-sine-wave operation at 60 Hz with a conduction angle of $180^{\circ}$. |
| $I_{\text {R(RMS })} I_{r}$. <br> $I_{R}, I_{R(A V)}$. <br> $i_{R}, I_{R M}$ | reverse current (see table, page 1-11) | The respective value of current that flows through a semiconductor diode or rectifier diode in the reverse direction. |
| íR(REC). IRM(REC) | reverse recovery current (see table, page 1-11) | The transient component of reverse current associated with a change from forward conduction to reverse voltage. |
| IRRM | reverse current, repetitive peak | The maximum (peak) repetitive instantaneous reverse current. |
| IRSM | reverse current. surge peak | The maximum (peak) surge reverse current having a specified waveform and a short specified time interval. |

## GLOSSARY

## SIGNAL DIODES AND RECTIFIERS

| $\begin{aligned} & \text { Symbol } \\ & \text { PF, } P_{F}(A V) . \\ & \text { PF, PFM } \end{aligned}$ | Term <br> forward power dissipation (see table, page 1-11) | Definition <br> The power dissipation resulting from the flow of the respective forward current. |
| :---: | :---: | :---: |
| $\begin{aligned} & P_{R}, P_{R}(A V), \\ & P_{R}, P_{R M} \end{aligned}$ | reverse power dissipation (see table, page 1-11) | The power dissipation resulting from the flow of the respective reverse current. |
| Qs | stored charge | The total amount of charge recovered from a diode minus the capacitive component of that charge when the diode is switched from a specified conductive condition to a specified non-conductive condition with other circuit conditions (as described in EIAJEDEC Suggested Standard No. 1) optimized to recover the largest possible amount of charge. |
| $\mathbf{R}_{\boldsymbol{\theta}}$ | thermal resistance | See pages 1-2 and 1-3. |
| TJ | junction temperature | See page 1-4. |
| tfr | forward recovery time | The time required for the current or voltage to recover to a specified value after instantaneous switching from a stated reverse voltage condition to a stated forward current or voltage condition in a given circuit. |
|  |  |  |
|  |  |  |
| $t_{p}$ | pulse time | See pages 1-5 and 1-6. |
| $t_{r}$ | rise time | See pages 1-5 and 1-6. |
| $t_{\text {rr }}$ | reverse recovery time | The time required for the current or voltage to recover to a specified value after instantaneous switching from a stated forward current condition to a stated reverse voltage or current condition in a given circuit. |
|  |  |  |


| Symbol | Term |
| :--- | :--- | :--- |
| $t_{w}$ | pulse average time |$\quad$| See page 1-6. |
| :--- |

## gLOSSARY <br> SIGNAL DIODES AND RECTIFIERS

## DIAGRAMS ILLUSTRATING SYMBOLS FOR DIODE CURRENTS AND VOLTAGES

## I. FORWARD CURRENT AND VOLTAGE:

## II. REVERSE CURRENT AND VOLTAGE:



TABLE OF SYMBOLS FOR CURRENT, POWER, AND VOLTAGE

|  | Total RMS Value | RMS Value of Altarnating Component | DC Value, No Alternating Component | DC Value, With Alternating Component | Instantaneous <br> Total <br> Value | Maximum (Peak) Total Value |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Forward Current | IF(RMS) | ${ }_{\text {If }}$ | If | ${ }^{\text {IF }}$ (AV) | ${ }^{\text {if }}$ | IFM |
| Forward Current, <br> Average, $180^{\circ}$ |  |  |  |  |  |  |
| Conduction Angle, | - | - | - | '0 | - | - |
| $60-\mathrm{Hz}$, Half Sine Wave |  |  |  |  |  |  |
| Forward Current, |  |  |  |  |  |  |
| Repetitive Peak | - | - | - | - | - | Ifrm |
| Forward Current, Surge Peak | - | - | - | - | - | IFSM |
| Reverse Current | IR(RMS) | Ir | $I_{\text {R }}$ | IR(AV) | $i_{\text {R }}$ | IRM |
| Reverse Recovery Current | - | - | - | - | iR(REC) | IRM(REC) |
| Forward Power Dissipation | - | - | PF | $\left.\mathrm{P}_{\mathrm{F}(\mathrm{AV}}\right)$ | PF | PFM |
| Reverse Power Dissipation | - | - | $\mathrm{P}_{\mathrm{R}}$ | $\mathrm{P}_{\mathrm{R}}(\mathrm{AV})$ | PR | PRM |
| Forward Voltage | $\mathrm{V}_{\text {F (RMS }}$ | $v_{f}$ | $V_{F}$ | $\mathrm{V}_{\mathrm{F}(\mathrm{AV})}$ | vF | VFM |
| Reverse Voltage | $V_{\text {R(RMS }}$ | $v_{r}$ | $v_{\text {R }}$ | $V_{\text {R }}(\mathrm{AV})$ | vR | VRM |
| Reverse Voltage, Working Peak | - | - | - | - | - | $V_{\text {RWM }}$ |
| Reverse Voltage, Repetitive Peak | - | - | - | - | - | VRRM |
| Reverse Voltage, Nonrepetitive Peak | - | - | - | - | - | VRSM |
| Breakdown Voltage | - | - | $V_{\text {(BR) }}$ | - | v (BR) | - |

## glossary <br> voltage-regulator and voltage-reference diodes

## VOLTAGE-REGULATOR AND VOLTAGE-REFERENCE DIODES

Terms and Definitions
anode . . . . . . . . . . . . . . . . .
cathode . . . . . . . . . . . . . . . .
device when it is biased to operate in its breakdown region.

Letter Symbols, Terms, and Definitions
(For illustration of the following currents and voltages refer to diagrams on page 1-13)

| If Symbol | Term forward current, dc | Definition <br> The value of dc current that flows through the diode in the forward direction. |
| :---: | :---: | :---: |
| $I_{R}$ | reverse current, dc | The value of dc current that flows through the diode in the reverse direction. |
| Iz, <br> IZK, <br> IZM | regulator current, reference current (dc, dc near breakdown knee. dc maximum-rated current) | The value of dc reverse current that flows through the diode when it is biased to operate in its breakdown region and at a point on its voltage-current characteristic as follows: <br> $I_{Z}$ : a specified operating point between IZK and IZM <br> IZK: a specified point near the breakdown knee <br> $I Z M$ : a specified point based on the maximum-rated power. |
| TJ | junction temperature | See page 1-4. |

## GLOSSARY <br> VOLTAGE-REGULATOR AND VOLTAGE-REFERENCE DIODES

| Symbol | Term | Definition |
| :---: | :---: | :---: |
| $V_{F}$ | forward voltage, dc | The voltage drop in the diade, resulting from the dc forward current. |
| $V_{R}$ | reverse voltage, dc | The voltage applied to the diode which causes the dc current to flow in the reverse direction. |
| $\begin{aligned} & v_{Z} \\ & v_{\mathrm{ZM}} \end{aligned}$ | regulator voltage, reference voltage (dc, dc at maximumrated current) | The value of dc voltage across the diode when it is biased to operate in its breakdown region and at a specified point in its voltage-current characteristic as follows: <br> $\mathbf{V}_{\mathbf{Z}}$ : at IZ (see previous page) <br> $V_{Z M}$ : at IZM (see previous page) |
| $\begin{aligned} & \mathbf{z}_{z_{1}} \\ & \mathbf{z}_{\mathbf{z k}} \\ & \mathbf{z z m}^{2} \end{aligned}$ | regulator impedance, reference impedance, (small-signal, at IZ. at IZK, at IZM) | The small-signal impedance of the diode when it is biased to operate in its breakdown region and at a specified point in its voltage-current characteristic as follows: <br> $\mathbf{z}_{\mathbf{z}}$ : at IZ (see previous page) <br> $\mathbf{z z k}_{\mathbf{z}}$ : at IZK (see previous page) <br> $\mathbf{z z m}_{\text {: }}$ at IZM (see previous page) |



## VOLTAGE-VARIABLE-CAPACITANCE DIODES

## Terms and Definitions

## Term

voltage-variable-
capacitance diode
(varactor diode)
tuning diode

## Definition

A two-terminal semiconductor device in which use is made of the property that its capacitance varies with the applied voltage.

A voltage-variable-capacitance diode used for if tuning. This includes functions such as automatic frequency control (AFC) and automatic fine tuning (AFT).

Letter Symbols, Terms, and Definitions

| Symbol $\alpha_{C}$ | Term temperature coefficient of capacitance |
| :---: | :---: |
| $\mathrm{C}_{\mathrm{c}}$ | case capacitance |
| $\mathrm{c}_{\mathrm{j}}$ | junction capacitance |
| $\mathrm{C}_{t}$ | total capacitance |
| $\frac{c_{t 1}}{c_{t 2}}$ | capacitance ratio |
| $\mathrm{f}_{\mathrm{co}}$ | cut-off frequency |
| $L_{s}$ | series inductance |
| $\eta$ | efficiency |
| 0 | figure of merit |
| $\mathrm{r}_{\text {s }}$ | series resistance, small-signal |
| TJ | junction temperature |

## Definition

The ratio of the change in capacitance to the change in temperature. The ratio is an average value for the total temperature change. (For symbol: Ref USAS Y10.5-1968 Par. 3.6)

The capacitance between the diode terminals of the case with the semiconductor chip not installed or with the semiconductor chip instalied but not connected.

The small-signal capacitance between the contacts of an uninstalied semiconductor chip.

The total small-signal capacitance between the diode terminals of a complete device. ( $\left.\mathrm{C}_{\mathbf{t}} \approx \mathrm{C}_{\mathbf{c}}+\mathrm{C}_{\mathrm{j}}\right)$.

The ratio of total capacitance at one voltage to total capacitance at another voltage.

The frequency at which the figure of merit $\mathbf{Q}$ is equal to 1 .

The inductance between specified points on the diode terminals.

The ratio of output power to input power.
Two pi ( $2 \pi$ ) times the ratio of the energy stored per cycle to the energy dissipated per cycle.

The total small-signal resistance between the diode terminals.

See page 1-4.

## GLOSSARY <br> MULTLUUNCTION TRANSISTORS

## MULTIJUNCTION TRANSISTORS

## Terms and Definitions

base (B, b)* . . . . . . . . . . . . . . . | A region which lies between an emitter and a collector of a |
| :--- |
| transistor and into which minority carriers are injected. (Ref. 60 |

NOTE: In the graphic symbols, the envelope is optional if no element is connected to the envelope.

N-P-N TRIODE P-N-P TRIODE


N-P.N, DOUBLE-BASE
P-NP DOUBLE-EMITTER

*References to bese, collector and amitter symbolism (B, b, C, C, E, and e) refer to the device terminals connected to those regions.

## Term

## Definition

transistor, programmable unijunction

A P-N-P-N thyristor that, together with two external resistors, can generate a current-voltage characteristic similar to that of a unijunction transistor. The unijunction parameters $\eta, r_{B B}, I_{P}$, and IV (see pages 1-27 and 1-28) can be varied by selection of the values of the two resistors.


PROGRAMMABLE UNIJUNCTION CIRCUIT


DIAGRAM ILLUSTRATING CURRENT-VOLTAGE CHARACTERISTIC OF THE PROGRAMMABLE UNIJUNCTION CIRCUIT

# GLOSSARY MULTLUUNCTION TRANSISTORS 

Letter Symbols, Terms, and Definitions

| Symbol | Term |
| :--- | :--- |
| $\mathrm{C}_{\mathrm{cb}}$. | interterminal |
| $\mathrm{C}_{\text {ce }}$, | capacitance <br> (collector-to-base, <br> $\mathrm{C}_{\mathrm{eb}}$ |
|  | collector-to-emitter, <br> emitter-to-base) |


| Cibo, $C_{i e o}$ | open-circuit input capacitance (common-base, common-emitter) |
| :---: | :---: |
| Cibs, Cies | short-circuit input capacitance (common-base, common-emitter) |
| Cobo, Coeo | open-circuit output capacitance (common-base, common-emitter) |
| $\mathrm{C}_{\text {obs }}$. <br> Coes | short-circuit output capacitance (common-base, commonemitter) |
| Crbs, <br> Cres | short-circuit reverse transfer capacitance (common-base, common-emitter) |
| $\begin{aligned} & \mathrm{C}_{\mathrm{tc}} \\ & \mathrm{c}_{\mathrm{te}} \end{aligned}$ | depletion-layer capacitance (collector, emitter) |

## Definition

The direct interterminal capacitance between the terminal indicated by the first subscript and the reference terminal indicated by the second subscript, with the respective junction (collector-base, collectoremitter, emitter-base) reverse-biased and with the remaining terminal (emitter, base, collector) opencircuited to dc, but ac-connected to the guard terminal of a three-terminal bridge.
This capacitance includes the interelement capacitances plus capacitance to the shield where the shield is connected to one of the terminals under measurement.

The capacitance measured across the input terminals (emitter and base, base and emitter) with the collector open-circuited for ac. (Ref IEEE 255)

The capacitance measured across the input terminals (emitter and base, base and emitter) with the collector short-circuited to the reference terminal for ac. (Ref IEEE 255)

The capacitance measured across the output terminals (collector and base, collector and emitter) with the input open-circuited to ac. (Ref IEEE 255)

The capacitance measured across the output terminals (collector and base, collector and emitter) with the third terminal short-circuited to the reference terminal for ac. (Ref IEEE 255)

The capacitance measured from the output terminal to the input terminal with the respective reference terminal (base or emitter) and the case, (unless connected internally to another terminal) connected to the guard terminal of a three-terminal bridge and with the device biased into the active region.

The part of the capacitance across the (collector-base, emitter-base) junction that is associated with its depletion layer.

NOTE: This capacitance is a function of the total potential difference across the depletion layer. (Ref IEC 147-0 Par. II-4.8, 4.9)

| Symbol $\bar{F}$ or $F$ | Term noise figure, average or spot |
| :---: | :---: |
| finfb, <br> fhfe | small-signal short- <br> circuit forward current transfer ratio cutoff frequency (common-base, common-emitter) |
| $f_{\text {max }}$ | maximum frequency of oscillation |
| ${ }^{\mathbf{f}} \boldsymbol{T}$ | transition frequency or <br> frequency at which small-signal forward current transfer ratio (common-emitter) extrapolates to unity |
| f1 | frequency of unity current transfer ratio |
| GPB, <br> Gpe | large-signal insertion power gain (commonbase, common-emitter) |
| Gpb. Gpe | small-signal insertion power gain (commonbase, common-emitter) |
| GTB, GTE | large-signal transducer power gain (common-base, common-emitter) |
| $\mathbf{G}_{\mathrm{tb}}$. <br> $G_{\text {te }}$ | small-signal transducer power gain (common-base, common-emitter) |
| hFB, <br> hFE | static forward current transfer ratio (commonbase, commonemitter) |

## Definition

See page 1-3.
The lowest frequency at which the modulus (magnitude) of the small-signal short-circuit forward current transfer ratio is 0.707 of its value at a specified low frequency (usually $1 \mathbf{k H z}$ or less). (Ref IEEE 255)

The maximum frequency at which a transistor can be made to oscillate under specified conditions.

NOTE: This approximates to the frequency at which the maximum available power gain has decreased to unity. (Ref IEC 147.0 Par. II-4.17)

The product of the modulus (magnitude) of the common-emitter small-signal short-circuit forward current transfer ratio, $\mathrm{h}_{\mathrm{fe}} \mid$, and the frequency of measurement when this frequency is sufficiently high so that $\left|h_{f e}\right|$ is decreasing with a slope of approximately 6 dB per octave. (Ref IEEE 255)

The frequency at which the modulus (magnitude) of the common-emitter small-signal short-circuit forward current transfer ratio, Mfel, has decreased to unity. (Ref IEC 147-0 Par. 11-4.19)

The ratio, usually expressed in $d B$, of the signal power delivered to the load to the large-signal power delivered to the input.

The ratio, usually expressed in dB, of the signal power delivered to the load to the small-signal power delivered to the input.

The ratio, usually expressed in dB , of the signal power delivered to the load to the maximum largesignal power available from the source.

The ratio, usually expressed in dB , of the signal power delivered to the load to the maximum smallsignal power available from the source.

The ratio of the dc output current to the dc input current. (Ref MIL-S-19500D Par. 30.28)

# glossary <br> MULTIJUNCTION TRANSISTORS 

| Symbod | Term |
| :---: | :---: |
| $h_{f b}$. $h_{f e}$ | small-signal short- |
|  | circuit forward |
|  | current transfer |
|  | ratio (common-base, |
|  | common-emitter) |
| $h_{i b}$, | small-signal short- |
| $h_{\text {ie }}$ | circuit input impedance |
|  | (common-base, |
|  | common emitter) |
| $\begin{gathered} h_{\text {ie (imag }} \text { or } \\ \operatorname{lm}\left(h_{i e}\right) \end{gathered}$ | imaginary part of the |
|  | small-signal short- |
|  | circuit input impedance, |
|  | (common-emitter) |
| $h_{i e}$ (real) or Re(hie) | real part of the small- |
|  | signal short-circuit |
|  | input impedance, |
|  | (common-emitter) |
| hob, $h_{\text {oe }}$ | small-signal open- |
|  | circuit output |
|  | admittance |
|  | (common-base, |
|  | common-mitter) |
| $\begin{gathered} \left.h_{\text {oe (imag }}\right) \\ \text { or } \\ \operatorname{lm}\left(h_{\text {oe }}\right) \end{gathered}$ | imaginary part of the |
|  | small-signal open-circuit |
|  | output admittance, |
|  | (common-emitter) |
| hoe(real) or Re(hoe) | real part of the small- |
|  | signal open-circuit |
|  | output admittance, |
|  | (common-emitter) |
| $\begin{aligned} & h_{r b}, \\ & h_{r e} \end{aligned}$ | small-signal open- |
|  | circuit reverse voltage |
|  | transfer ratio |
|  | (common-base, |
|  | common-emitter) |
| $I_{B}$, <br> IC. <br> IE | current, dc |
|  | (base-terminal, |
|  | collector-terminal, |
|  | emitter-terminal) |
| ${ }^{\prime} b$ $I_{c}$ $\mathrm{I}_{\mathrm{e}}$ | current, rms value of alternating component (base-terminal, collector-terminal, emitter-terminal) |
|  |  |
|  |  |
|  |  |
|  |  |

## Definition

The ratio of the ac output current to the small-signal ac input current with the output short-circuited to ac. (Ref MIL-S-19500D Par. 30.20)

The ratio of the small-signal ac input voltage to the ac input current with the output short-circuited to ac. (Ref MIL-S-19500D Par. 30.24)

The ratio of the out-of-phase (imaginary) component of the small-signal ac base-emitter voltage to the ac base current with the collector terminal shortcircuited to the emitter terminal for ac.

The ratio of the in-phase (real) component of the small-signal ac base-emitter voltage to the ac base current with the collector terminal short-circuited to the emitter terminal for ac.

The ratio of the ac output current to the small-signal ac output voltage applied to the output terminal. with the input open-circuited to ac. (Ref MIL-S-19500D Par. 30.15)

The ratio of the ac collector current to the out-ofphase (imaginary) component of the small-signal collector-emitter voltage with the base terminal opencircuited to ac.

The ratio of the ac collector current to the in-phase (real) component of the small-signal collector-emitter voltage with the base terminal open-circuited to ac.

The ratio of the ac input voltage to the small-signal ac output voltage with the input open-circuited to ac. (Ref MIL-S-19500D Par. 30.18)

The value of the dc current into the terminal indicated by the subscript.

The root-mean-square value of alternating current into the terminal indicated by the subscript.



DIAGRAM ILLUSTRATING SYMBOLS AND TERMS FOR CURRENTS (Ref IEEE 255)

| IBEV | base cutoff <br> current, dc |
| :--- | :--- |
| ICBO | collector cutoff <br> current, dc, <br> emitter open |

The dc current into the base terminal when it is biased in the reverse direction with respect to the emitter terminal and there is a specified voltage between the collector and emitter terminals.

The de current into the collector terminal when it is biased in the reverse direction with respect to the base terminal and the emitter terminal is opencircuited. (Ref IEEE 255)

## GLOSSARY MULTLUNCTION TRANSISTORS

| Symbol | Term | Dafinition |
| :---: | :---: | :---: |
| ICEO, | collector cutoff current, dc, with (base open, | The dc current into the collector terminal when it is biased in the reverse direction* with respect to the emitter terminal and the base terminal is (as indicated by the last subscript letter as follows): |
| ICER, | resistance between base and emitter, | $0=$ open-circuited. <br> R = returned to the emitter terminal through a specified resistance. |
| ICES | base short-circuited to emitter, | $S=$ short-circuited to the emitter terminal. <br> $\mathbf{V}=$ returned to the emitter terminal through a specified voltage. |
| ICEV. | voitage between base and emitter, | $X=$ returned to the emitter terminal through a specified circuit. |
| ICEX |  | (Ref IEEE 255) |
|  | base and emitter) | *For these parameters, the collector terminal is considered to be biased in the reverse direction when it is made positive for N-P-N transistors or negative for P-N-P transistors with respect to the emitter terminal. |
| IE1E2(off) | emitter cutoff current | The current into the emitter- 1 terminal of a doubleemitter transistor when the emitter-1 terminal is biased with respect to the emitter-2 terminal and the transistor is in the off state (the collector-base diode is not forward-biased) with specified termination of the collector and base terminals. |
| IEBO | emitter cutoff current, dc, collector open | The dc current into the emitter terminal when it is biased in the reverse direction with respect to the base terminal and the collector terminal is opencircuited. (Ref IEEE 255) |
| IEC(ofs) | emitter-collector offset current | The external short-circuit current between the emitter and collector when the base-collector diode is reverse biased. |
| IECS | emitter cutoff current, dc, base short-circuited to collector | The dc current into the emitter terminal when it is biased in the reverse direction* with respect to the collector terminal and the base terminal is shortcircuited to the collector terminal. (Ref IEEE 255) |
|  |  | *For this parameter the emitter terminal is considered to be biased in the reverse direction when it is made positive for N-P-N transistors or negative for P-N-P transistors with respect to the collector terminal. |
| Im(Yie) |  | See preferred symbol yie(imag) |

MULTIJUNCTION TRANSISTORS

| $\begin{gathered} \text { Symbol } \\ \operatorname{Im}\left(y_{\text {oe }}\right) \end{gathered}$ | Term | Definition See preferred symbol Yoe(imag) |
| :---: | :---: | :---: |
| $I_{n}$ | noise current, equivalent input | See page 1-3. |
| $\overline{N F}$ or $\mathrm{NF}^{*}$ | noise figure, average or spot | See page 1-3. |
| $\begin{aligned} & P_{\text {IB }} \\ & P_{\text {IE }} \end{aligned}$ | large-signal input power (common-base, commonemitter) | The product of the large-signal ac input current and voltage with the common reference terminal circuit configuration. |
| $\begin{aligned} & \mathbf{P}_{i b}, \\ & P_{i e} \end{aligned}$ | small-signal input power (common-base, common-emitter) | The product of the small-signal ac input current and voltage with the common reference terminal circuit configuration. |
| POB, Poe | large-signal output power (common-base, common-emitter) | The product of the large-signal ac output current and voltage with the common reference terminal circuit configuration. |
| $\begin{aligned} & P_{o b}, \\ & P_{o e} \end{aligned}$ | small-signal output power (common-base, common-emitter) | The product of the small-signal ac output current and voltage with the common reference terminal circuit configuration. |
| $\mathrm{P}_{\mathbf{T}}$ | total nonreactive power input to all terminals | The sum of the products of the dc input currents and voltages, i.e., $\begin{aligned} & v_{B E} \cdot I_{B}+v_{C E} \cdot I_{C} \text { or } \\ & v_{B E} \cdot I_{E}+v_{C B} \cdot I_{C} \end{aligned}$ |
| $\mathrm{rb}^{\prime} \mathrm{C}_{\mathrm{c}}$ | collector-base time constant | The product of the intrinsic base resistance and collector capacitance under specified small-signal conditions. |
| ${ }^{\text {r C E }}$ (sat) | saturation resistance, collector-to-emitter | The resistance between the collector and emitter terminals for the saturation conditions specified. (Ref IEEE 255) |
| Re( $\mathrm{y}_{\text {ie }}$ ) |  | See preferred symbol Yie(real) |
| Re (Yoe) |  | See preferred symbol yoe(real) |
| re1e2(on) | small-signal emitter- <br> emitter on-state <br> resistance | The small-signal resistance between the emitter terminals of a double-emitter transistor when the base-collector diode is forward-biased. |
| $\mathrm{R}_{\boldsymbol{\theta}}$ | thermal resistance | See pages 1-2 and 1-3. |
| sfb or s21b. <br> Sfe or s21e <br> Srb or s 12 b . <br> Sre or s12e | forward transmission coefficient (common-base, common-emitter) <br> reverse transmission coefficient (common-base, common-emitter) | The respective forward or reverse transmission coefficient with the transistor in the indicated configuration. See pages 1-3 and 1-4. |

## GLOSSABY <br> MULTLUUNCTION TRANSISTORS



[^3]$\quad$ Symbol
$V_{(B R) C E O}$
(formerly $B V_{\text {CEO }}$
$V_{(B R) C E R}$ (formerly BVCER)
$V_{\text {(BR)CES }}$
(fromerly $\mathrm{BV}_{\text {CES }}$ )
$V_{\text {(BR)CEV }}$
(formerly $\mathrm{BV}_{\mathrm{CEV}}$ )
$V_{\text {(BR)CEX }}$ (formerly BVCEX)
$V_{\text {(BR)E1E2 }}$

V(BR)EBO
(formerly $\mathrm{BV}_{\mathrm{EBO}}$ )
$V_{\text {(BR) }}$ ECO
(formerly $\mathrm{BV}_{\mathrm{ECO}}$ )

| $V_{C B}(f I)$, | dc open-circuit valtage |
| :--- | :--- |
| $V_{C E}(f)$. | (floating potential) |
| $V_{E B(f)}$ | (collector-to-base, |
| $V_{E C}(f)$ | collector-to-emitter, |
|  | emitter-to-base. |
|  | emitter-to-coliector) |

$\mathrm{V}_{\mathrm{CB}}$ (fi),
$V_{C E}(f)$.
$V_{E B(f)}$.
$V_{E C}(f)$

Term
breakdown voltage, collector-to-emitter with (base open,
resistance between base and emitter,
base short-circuited to emitter,
voltage between base and emitter,
circuit between base and emitter)
emitter-emitter breakdown voltage
breakdown voltage, emitter-to-base, collector open
breakdown voltage, emitter-to-collector, base open
dc open-circuit valtage
(floating potential)
collector-to-base emitter-to-base. emitter-to-collector)

## Definition

The breakdown voltage between the collector terminal and the emitter terminal when the collector terminal is biased in the reverse direction* with respect to the emitter terminal and the base terminal is (as indicated by the last subscript letter as follows):
$\mathrm{O}=$ open-circuited.
$R=$ returned to the emitter terminal through a specified resistance.
$\mathrm{S}=$ short-circuited to the emitter terminal.
$V=$ returned to the emitter terminal through a specified voltage.
X $=$ returned to the emitter terminal through a specified circuit.

## (Ref IEEE 255)

*For these parameters, the collector terminal is considered to be biased in the reverse direction when it is made positive for N-P-N transistors or negative for P-N-P transistors with respect to the emitter terminal.

The breakdown voltage between the emitter terminals, of a double-mitter transistor, with specified termination between collector and base.

The breakdown voltage between the emitter and base terminals when the emitter terminal is biased in the reverse direction with respect to the base terminal and the collector terminal is open-circuited. (Ref IEEE 255)

The breakdown voltage between the emitter and collector terminals when the emitter terminal is biased in the reverse direction* with respect to the collector terminal and the base terminal is opencircuited.
*For this parameter the emitter terminal is considered to be biased in the reverse direction when it is made positive for N-P-N transistors or negative for P-N-P transistors with respect to the collector terminal.

The dc open-circuit voltage (floating potential) between the terminal indicated by the first subscript and the reference terminal when the remaining terminal is biased in the reverse direction with respect to the reference terminal. (Ref IEEE 255)

## GLOSSARY <br> MULTLUNCTION TRANSISTORS

| Symbol | Term | Definition |
| :---: | :---: | :---: |
| $V_{\text {CBO }}$ | collector-to-base voltage, dc, emitter open | The dc voltage between the collector terminal and the base terminal when the emitter terminal is opencircuited. |
| VCE(ofs) | collector emitter offset voltage | The open-circuit voltage between the collector and emitter terminals when the base-emitter diode is forward-biased. |
| $V_{C E}$ (sat) | saturation voltage, collector-to-emitter | The dc voltage between the collector and the emitter terminals for specified saturation conditions. (Ref IEEE 255) |
| VCEO. | collector-to-emitter voltage, dc, with (base open, | The dc voltage between the collector terminal and the emitter terminal when the base terminal is (as indicated by the last subscript letter as follows): |
| VCER, | resistance between base and emitter, | $\mathrm{O}=$ open circuited. <br> $R=$ returned to the emitter terminal through a specified resistance. |
| VCES, | base short-circuited to emitter, | $\mathbf{S}=$ short-circuited to the emitter terminal. <br> $V=$ returned to the emitter terminal through a specified voltage. |
| VCEV, | voltage between base and emitter, | $X=$ returned to the emitter terminal through a specified circuit. |
| $V_{\text {cex }}$ | circuit between base and emitter) |  |
| Vebo | emitter-to-base voltage, dc. coliector open | The dc voltage between the emitter terminal and the base terminal with the collector terminal opencircuited. |
| VEC(ofs) | emitter-collector offset voltage | The open-circuit voltage between the emitter and collector when the base-collector diode is forwardbiased. |
| $\mid V_{\text {e1e2 }}$ (ofs) $\mid$ | magnitude of the emitter-emitter offset voltage | The absolute value of the open-circuit voltage between the two emitters of a double-emitter transistor when the base-collector diode is forwardbiased. |
| $\mid\left.\Delta V_{E 1 E 2}($ ofs $)\right\|_{\Delta I_{B}}$ | magnitude of the change in offset voltage with base current | The absolute value of the algebraic difference between the emitter-emitter offset voltages of a double-emitter transistor at two specified base currents. |
| $\mid\left.\Delta V_{E 1 E 2}($ ofs $)\right\|_{\Delta T_{A}}$ | magnitude of the change in offset voltage with temperature | The absolute value of the algebraic difference between the emitter emitter offset voltages of a double-emitter transistor at two specified ambient temperatures. |
| $V_{n}$ | noise voltage, equivalent input | See page 1-6. |


| Yfb, Yfe | small-signal shortcircuit forwardtransfer admittance (common-base, common-emitter) |
| :---: | :---: |
| Yib, Yie | small-signal shortcircuit input admittance (common-base, common-emitter) |
| Yie(imag) or Im( $\mathrm{y}_{\mathrm{ie}}$ ) | imaginary part of the small-signal short-circuit input admittance (common-emitter) |
| Yie(real) or $\operatorname{Re}\left(y_{i e}\right)$ | real part of the small-signal shortcircuit input admittance (common-emitter) |
| Yob. Yoe | small-signal shortcircuit output admittance (common-base, common-emitter) |
| $\begin{gathered} \text { Yoe(imag) } \\ \text { or } \\ \operatorname{lm}\left(y_{\text {oee }}\right) \end{gathered}$ | imaginary part of the small-signal short-circuit output admittance (commonemitter) |
| Yoe(real) or Re(yoe) | real part of the small-signal shortcircuit output admittance (commonemitter) |
| Yrb, Yre | small-signal shortcircuit reverse transfer admittance (common-base, commonemitter) |

## Definition

That value of reverse collector-to-base voltage at which the space-charge region of the collector-base junction extends to the space-charge region of the emitter-base junction. (Ref IEEE 255)

The ratio of rms output current to rms input voltage with the output short-circuited to ac.

The ratio of rms input current to rms input voltage with the output short-circuited to ac.

The ratio of rms input current to the rms out-ofphase (imaginary) component of the input voltage with the output short-circuited to ac.

The ratio of rms input current to the rms in-phase (real) component of the input voltage with the output short-circuited to ac.

The ratio of rms output current to rms output voltage with the input short-circuited to ac.

The ratio of rms output current to the out-of-phase (imaginary) component of the rms output voltage with the input short-circuited to ac.

The ratio of rms output current to the in-phase (real) component of the rms output voltage with the input short-circuited to ac.

The ratio of rms input current to rms output voltage with the input short-circuited to ac.

## GLOSSARY <br> UNLUNCTION TRANSISTORS

## UNIJUNCTION TRANSISTORS

## Terms and Definitions



A region of a semiconductor device into which minority carriers are injected.

A region from which charge carriers that are minority carriers in the base are injected into the base. (Ref. 60 IRE 28.S1)

A serniconductor junction normally biased in the forward direction to inject minority carriers into the base. (Ref 60 IRE 28.S1)

The point on the emitter current-voltage characteristic corresponding to the lowest current at which $\mathrm{dV}_{\mathrm{EB}} 1 / \mathrm{dI} \mathrm{E}=0$.

See page 1-16.

The point on the emitter current-voltage characteristic corresponding to the second lowest current at which $\mathrm{dV}_{\mathrm{EB}} 1 / \mathrm{dl} \mathrm{E}=0$.
unijunction transistor
A three-terminal semiconductor device having one junction and a stable negative-resistance characteristic over a wide temperature range.

Graphic symbols for unijunction transistors (Ref. ANS Y32.2):


P-N (N-Type Base)


NOTE: In the graphic symbols, the envelope is optional if no element is connected to the envelope.

Letter Symbols, Terms, and Definitions

| Symbol | Term |
| :--- | :--- |
| $\eta$ | intrinsic standoff <br> ratio |
| IB2(mod) $^{\text {IEB2O }}$ | interbase modulated <br> current |
|  | emitter reverse <br> current |

ip
peak-point current

## Definition

The ratio $\left(V_{P}-V_{F}\right) / V_{B 2 B 1}$, where $V_{F}$ is the forward voltage drop of the emitter junction.

The current into the base-2 terminal when the emitter current is greater than the valley-point current.

The current into the emitter terminal when it is biased in the reverse direction with respect to the base-2 terminal and the base-1 terminal is opencircuited.

The emitter current at the peak point.

## UNLUNCTION TRANSISTORS



DIAGRAM ILLUSTRATING CURRENT-VOLTAGE CHARACTERISTIC

## GLOSSARY <br> FIELD-EFFECT TRANSISTORS

## FIELD-EFFECT TRANSISTORS

## Terms and Definitions

## Term

channel . . . . . .
depletion-mode operation .

A region of semiconductor material in which current flow is influenced by a transverse electrical field. A channel may physically be an inversion layer, a diffused layer, or bulk material. The type of channel is determined by the type of majority carriers during conduction; i.e., p-channel or n-channel.


## Term

n-channel
field-effect transistor
p-channel

## Definition

A field-effect transistor that has an n-type conduction channel.

A field-effect transistor that has a p-type conduction channel.
field-effect transistor
source (S, s)
A region from which majority carriers flow into the channel.
substrate ( $\mathrm{U}, \mathrm{u}$ ) (of a junction
A semiconductor material that contains a channel, a source, and a
field-effect transistor or an insulated-
gate field-effect transistor)
substrate (of a thin-film.
field-effect transistor)
tetrode field-effect transistor .
triode field-effect transistor
drain and which may be connected to a terminal.

An insulating material that supports the thin semiconductor layer, the insulating layer, and the source, gate, and drain electrodes.

A field-effect transistor having two independent gates, a source, and a drain. An active substrate terminated externally and independently of other elements is considered a gate for the purpose of this definition.

A field-effect transistor having a gate, a source, and a drain.

## GRAPHIC SYMBOLS FOR FIELD-EFFECT TRANSISTORS

|  |  | JUNCTION-GATE | INSULATED.GATE |  |
| :---: | :---: | :---: | :---: | :---: |
|  |  | DEPLETION-TYPE |  | ENHANCEMENT-TYPE |
|  |  |  |  |  |
|  |  |  |  | G2 |
| 岂 | $\begin{aligned} & \frac{\mu}{a} \\ & \frac{0}{\tilde{I}} \\ & \hline \end{aligned}$ |  |  |  |
| $\left\|\begin{array}{c} \mathbf{4} \\ \mathbf{U} \\ \dot{Q} \end{array}\right\|$ |  |  |  |  |

In the above drawings of the insulated-gate devices, the substrate (bulk) is shown terminated either internally or externally. The symbol at the right illustrates an


## GLOSSARY <br> FIELD-EFFECT TRANSISTORS

| Letter Symbols, Terms, and Definitions |  |
| :---: | :---: |
| Symbol Ter |  |
| $\mathrm{b}_{\text {fs, }}$ | common-source small- |
| $\mathrm{b}_{\text {is }}$. | signal (forward transfer, |
| $b_{\text {os, }}$ | input, output, reverse |
| brs | transfer) susceptance |
| $C_{d s}$ | drain-source capacitance |
| $C_{\text {du }}$ | drain-substrate capacitance |
| $\mathrm{C}_{\text {iss }}$ | short-circuit input |
|  | capacitance, common- |
|  | source |
| Coss | short-circuit output |
|  | capacitance, commonsource |
| Crss | short-circuit reverse |
|  | transfer capacitance, common-source |
| $\bar{F}$ or $F$ | noise figure, average or spot |
| Gfs, <br> Gis, <br> gos. <br> grs | common-source small- |
|  | signal (forward transfer, |
|  | input, output, reverse |
|  | transfer) conductance |
| $\begin{aligned} & \mathrm{G}_{\mathrm{pg}}, \\ & \mathrm{G}_{\mathrm{ps}} \end{aligned}$ | small-signal insertion |
|  | power gain, (common- |
|  | gate, common-source) |
| $\begin{aligned} & \mathrm{G}_{\mathrm{tg}} \\ & \mathrm{G}_{\mathrm{ts}} \end{aligned}$ | small-signal transducer |
|  | power gain (common- |
|  | gate, common-source) |
| 10 | drain current, dc |
| IDloff) | drain cutoff current |

## Definition

The imaginary part of the corresponding admittance. See Yfs. Yis, Yos, and Yrs. Symbols in the forms $\mathrm{b}_{\mathrm{xx}}$ and $y_{x x}$ (imag) are equivalent.

The capacitance between the drain and source terminals with the gate terminal connected to the guard terminal of a three-terminal bridge.

The capacitance between the drain and substrate terminals with the gate and source terminals connected to the guard terminal of a three-terminal bridge.

The capacitance between the input terminals (gate and source) with the drain short-circuited to the source for alternating current. (Ref. IEEE 255)

The capacitance between the output terminals (drain and source) with the gate short-circuited to the source for alternating current. (Ref. IEEE 255)

The capacitance between the drain and gate terminals with the source connected to the guard terminal of a three-terminal bridge.

## See page 1-3.

The real part of the corresponding admittance. See Yfs. Yis, Yos, and Yrs. Symbols in the forms $\mathrm{g}_{\mathrm{xx}}$ and $Y_{x x}$ (real) are equivalent.

The ratio, usually expressed in dB , of the signal power delivered to the load to the signal power delivered to the input.

The ratio, usually expressed in dB , of the signal power delivered to the load to the maximum signal power available from the source.

The direct current into the drain terminal.

The direct current into the drain terminal of a depletion-type transistor with a specified reversa gate-source voltage applied to bias the device to the off state.

| Symbol | Term | Definition |
| :---: | :---: | :---: |
| ID(on) | on-state drain current | The direct current into the drain terminal with a specified forward gate-source voltage applied to bias the device to the on state. |
| ' DSS | zero-gate-voltage drain current | The direct current into the drain terminal when the gate-source voltage is zero. This is an on-state current in a depletion-type device, an off-state current in an enhancement-type device. |
| ${ }^{1} \mathbf{G}$ | gate current, dc | The direct current into the gate terminal. |
| IGF | forward gate current | The direct current into the gate terminal with a forward gate-source voltage applied. See VGSF. |
| IGR | reverse gate current | The direct current into the gate terminal with a reverse gate-source voltage applied. See $\mathrm{V}_{\text {GSR }}$ - |
| IGSS | reverse gate current, drain short-circuited to source | The direct current into the gate terminal of a junction-gate field-effect transistor when the gate terminal is reverse-biased with respect to the source terminal and the drain terminal is short-circuited to the source terminal. |
| IGSSF | forward gate current, drain short-circuited to source | The direct current into the gate terminal of an insulated-gate field-effect transistor with a forward gate-source voltage applied and the drain terminal short-circuited to the source terminal. See VGSF. |
| IGSSR | reverse gate current, drain short-circuited to source | The direct current into the gate terminal of an insulated-gate field-effect transistor with a reverse gate-source voltage applied and the drain terminal short-circuited to the source terminal. See $\mathrm{V}_{\mathrm{GSR}}$. |
| In | noise current, equivalent input | See page 1-3. |
| $\begin{aligned} & \operatorname{Im}\left(y_{\mathrm{fs}}\right), \\ & \operatorname{Im}\left(y_{i s}\right), \\ & \operatorname{Im}\left(y_{o s}\right), \\ & \operatorname{Im}\left(y_{r s}\right) \end{aligned}$ |  | See preferred symbols: $b_{f s}$ or $\mathrm{yfs}_{\mathrm{f}}$ (imag). $b_{\text {is }}$ or $\mathrm{Vis}(\mathrm{imag})$. <br> $b_{0 s}$ or Yos(imag). <br> $b_{r s}$ or $\mathrm{Yrs}_{\text {(imag) }}$ |
| Is | source current, dc | The direct current into the source terminal. |
| ${ }^{1}$ S(off) | source cutoff current | The direct current into the source terminal of a depletion-type transistor with a specified gate-drain voltage applied to bias the device to the off state. |
| ${ }^{\prime}$ SDS | zero-gate-voltage source current | The direct current into the source terminal when the gate-drain voltage is zero. This is an on-state current in a depletion-type device, an off-state current in an enhancement-type device. |

## GLOSSARY <br> FIELD-EFFECT TRANSISTORS

| Symbol | Term | Definition |
| :---: | :---: | :---: |
| $\overline{N F}$ or NF* | noise figure, average or spot | See page 1-3. |
| $\mathrm{r}_{\text {ds }}(\mathrm{On})$ | small-signal drainsource on-state resistance | The small-signal resistance between the drain and source terminals with a specified gate-source voltage applied to bias the device to the on state. For a depletion-type device, this gate-source voltage may be zero. |
| rDS(on) | static drain-source on-state resistance | The dc resistance between the drain and source terminals with a specified gate-source voltage applied to bias the device to the on state. For a depletiontype device, this gate-source voltage may be zero. |
| Re(yfs), <br> Re(yis), <br> Re(Yos). <br> Re(Yrs) |  | See preferred symbols: $\mathrm{gfs}_{\mathrm{f}}$ or $\mathrm{Yfs}($ real), <br> $g_{\text {is }}$ or $y_{\text {is }}($ real $)$, <br> gos or Yos(real). <br> Grs or $\mathrm{Y}_{\mathrm{rs}}$ (real) |
| $\mathbf{R}_{\boldsymbol{\theta}}$ | thermal resistance | See pages 1-2 and 1-3. |
| Sfg or $\mathbf{5 2 1 g}$. <br> Sfs or s21s | forward transmission coefficient (common-gate, common-source) | The respective forward or reverse transmission coefficient with the transistor in the indicated configuration. See pages 1-3 and 1-4. |
| $\begin{aligned} & \mathrm{s}_{\text {rg }} \text { or } \mathrm{s} 12 \mathrm{~g} \\ & \mathrm{~s}_{\text {rs }} \text { or }{ }^{2} 2 \mathrm{~s} \end{aligned}$ | reverse transmission coefficient (common-gate, common-source) |  |
| $\mathrm{sig}_{\mathrm{ig}}$ or $\mathrm{S}_{1} 1 \mathrm{~g}$. <br> sis or $\mathrm{s}_{11}$ s | input refiection coefficient (common-gate, common-source) | The respective input or output reflection coefficient with the transistor in the indicated configuration. See page 1-4. |
| sog or s22g. <br> sos or S22s | output reflection coefficient (common-gate, common-source) |  |
| TJ | junction temperature | See page 1-4. |
| ${ }^{\text {t }}$ ( $($ off) | turn-off delay time | The time interval from a point 90 percent of the maximum amplitude on the trailing edge of the input pulse to a point 90 percent of the maximum amplitude on the trailing edge of the output pulse. This corresponds to storage time for a multijunction transistor. See pages 1-5 and 1-6. <br> NOTE: This definition assumes a device initially in the off state with an input pulse applied of proper polarity to switch the device to the on state. |

- $\overline{N F}$ and NF bboreviations are often used for sumbols $\bar{F}$ and $F$; however, the symbols $\bar{F}$ and $F$ are preferred.


## GLOSSARY <br> FIELD-EFFECT TRANSISTORS

| Symbol | Term | Definition |
| :---: | :---: | :---: |
| $t_{\text {d }}(\mathrm{on})$ | turn-on delay time | The time interval from a point 10 percent of the maximum amplitude on the leading edge of the input |
|  |  | pulse to a point 10 percent of the maximum amplitude on the leading edge of the output pulse. |
|  |  | This corresponds to delay time for a multijunction transistor. See pages 1-5 and 1.6. |
|  |  | NOTE: This definition assumes a device initially in the off state with an input pulse applied of proper polarity to switch the device to the on state. |
| $\mathbf{t f}^{\text {f }}$ | fall time | See pages 1-5 and 1-6. |
| toff | turn-off time | The sum of $t_{d}(\mathrm{off})+\mathrm{tf}^{\text {. See pages }} 1.5$ and 1-6. |
| $\tau_{0}$ | turn-on time | The sum of $t_{d}(\mathrm{on})+t_{\text {r }}$. See pages 1.5 and 1.6. |
| ${ }_{\text {t }}$ | pulse time | See pages 1-5 and 1-6. |
| $\mathrm{tr}_{\mathbf{r}}$ | rise time | See pages 1-5 and 1-6. |
| $t_{w}$ | pulse average time | See page 1-6. |
| $V_{(B R) G S S}$ | gate-source breakdown voltage | The breakdown voltage between the gate and source terminals with the drain terminal short-circuited to the source terminal. |
|  |  | NOTE: The symbol V(BR)GSS is primarily used with junction-gate field-effect transistors. The |
|  |  | symbols $V_{\text {(BR) GSSR }}$ or $V_{\text {(BR) }}$ GSSF should be used with insulated-gate transistors having shunting diodes or similar voltage-limiting devicas. |
| $V_{\text {(BR) }}$ GSSF | forward gate-source breakdown voltage | The breakdown voltage between the gate and source terminals with a forward gate-source voltage applied and the drain terminal short-circuited to the source terminal. See VGSF. |
| $V_{\text {(BR) }}$ GSSR | reverse gate-source breakdown voltage | The breakdown voltage between the gate and source terminals with a reverse gate-source voltage applied and the drain terminal short-circuited to the source terminal. See VGSR. |
| $\begin{aligned} & \text { VDD. } \\ & \text { VGG }_{\text {GG }}, \\ & \text { V }_{\text {SS }} \end{aligned}$ | supply voltage, dc (drain, gate, source) | The dc supply voltage applied to a circuit connected to the reference terminal. |
| VDG | drain-gate voltage | The dc voltage between the drain and gate terminals. |
| VDS | drain-source voltage | The dc voltage between the drain and source terminals. |

## GLOSSARY <br> FIELD-EFFECT TRANSISTORS

| Symbol | Term | Definition |
| :---: | :---: | :---: |
| $V_{\text {DS }}(0 n)$ | drain-source on-state voltage | The dc voltage between the drain and source terminals with a specified forward gate-source voltage applied to bias the device to the on state. |
| VDU | drain-substrate voltage | The dc voltage between the drain and substrate terminals. |
| $V_{\text {GS }}$ | gate-source voltage | The dc voltage between the gate and source terminals. |
| VGSF | forward gate-source voltage | The dc voltage between the gate and source terminals of such polarity that an increase in its magnitude causes the channel resistance to decrease. |
| $\mathbf{V}_{\text {GSR }}$ | reverse gate-source voltage | The dc voltage between the gate and source terminals of such polarity that an increase in its magnitude causes the channel resistance to increase. |
| $\mathbf{V}_{\mathbf{G S} \text { (off) }}$ | gate-source cutoff voltage | The reverse gate-source voltage at which the magnitude of the drain current of a depletion-type field-effect transistor has been reduced to a specified low value. |
| $\mathbf{V}_{\mathbf{G S}(\mathrm{th})}$ | gate-source threshold voltage | The forward gate-source voltage at which the magnitude of the drain current of an enhancement-type field-effect transistor has been increased to a specified low value. |
| $V_{\text {GU }}$ | gate-substrate voltage | The dc voltage between the gate and substrate terminals. |
| $V_{n}$ | noise voltage, equivalent input | See page 1-6. |
| $\mathbf{V}_{\mathbf{S U}}$ | source-substrate voltage | The dc voltage between the source and substrate terminals. |
| Yfs | common-source smallsignal short-circuit forward transfer admittance | The ratio of rms drain current to rms gate-source voltage with the drain terminal ac short-circuited to the source terminal. |
| Yis | common-source smallsignal short-circuit input admittance | The ratio of rms gate current to rms gate-source voltage with the drain terminal ac short-circuited to the source terminal. |
| Yos | common-source smallsignal short-circuit output admittance | The ratio of rms drain current to rms drain-source voltage with the gate terminal ac short-circuited to the source terminal. |


| Symbol | Term |  |
| :--- | :--- | :--- |
| Yrs | common-source small- <br> signal short-circuit <br> reverse transfer <br> admittance | The ratio of rms gate current to rms drain-source <br> voltage |
| the source therminal. |  |  |

## SEMICONDUCTOR STANDARDS DOCUMENTS

Following are sources of standards material relating to low-power transistors and diodes:

## EIA and JEDEC Standards

Electronic Industries Association
2001 Eye St. N.W.
Washington, D.C. 20006
Telephone: 202-659-2200
Registered Outlines and Gauges for Semiconductor Devices-JEDEC Publication No. 12
Preferred Lead Configurations for Field-Effect Transistors-JEDEC Publication No. 69A
JEDEC Recommendations for Letter Symbols, Abbreviations, Terms, and Definitions for Semiconductor Device Data Sheets and Specifications-JEDEC Publication No. 77
Recommended Practice for Measurement of Transistor Lead Temperature-JEDEC Publication No. 84
Quality Program Requirements for Solid-State Device Manufacturers-JEDEC Publication No. 85
Standard Test Methods for Electronic Component Parts-EIA Standard RS-186-C
Test Methods for the Collector-Base Time Constant and the Resistive Part of the Common-Emitter Input Impedance-EIA Standard RS-284

Forward Transient Measurement on Semiconductor Diodes-EIA Standard RS-286
Measurement of Small-Signal HF, VHF, and UHF Power Gain of Transistors-EIA Standard RS-306
Voltage Regulator Diode Noise Voltage Measurement-EIA Standard RS-307
Measurement of Transistor Noise Figure at MF through VHF-EIA Standard RS-311A
Measurement of Reverse Recovery Time for Semiconductor Diodes-EIA Standard RS-318
Characterization of a Reverse Recovery Test Fixture-EIA Standard RS-318-1
Thermal Equilibrium Conditions for Measurement of Diode Static Parameters-EIA Standard RS-320
Numbering of Electrodes in Multiple Electrode Semiconductor Devices and Designation of Units in Multiple Unit Semiconductor Devices-EIA Standard RS-321A

The Measurement of ICrel-EIA Standard RS-340
The Measurement of Transistor Noise Figure at Frequencies up to 20 kHz by Sinusoidal Signal-Generator Method-EIA Standard RS-353

Measurement of Transistor Equivalent Noise Voltage and Equivalent Noise Current at Frequencies up to 20 kHz -EIA Standard RS-354

Designation System for Discrete Semiconductor Devices-EIA Standard RS-370
The Measurement of Small-Signal VHF-UHF Transistor Short-Circuit Forward Current Transfer Ratio-EIA Standard RS-371

The Measurement of Small-Signal VHF.UHF Transistor Admittance Parameters-EIA Standard RS. 372
Method of Diode "O" Measurement-EIA Standard RS-381
Measurement of Small Values of Transistor Capacitance-EIA Standard RS-398
Method of Direct Measurement of Diode Stored Charge-JEDEC Suggested Standard No. 1
The Measurement of Small-Signal Transistor Scattering Parameters-JEDEC Tentative Standard No. 10

## STANDARDS

International Electrotechnical Commission (IEC) Standards
American National Standards Institute, Inc.
1430 Broadway
New York, N.Y. 10018
Telephone: 212-868-1220
Publication 147: Essential Ratings and Characteristics of Semiconductor Devices and General Principles of Measuring Methods.

Part 0 - General and Terminology
Part 1 - Essential Ratings and Characteristics
Part 2 - General Principles of Measuring Methods
Part 3 - Reference Methods of Measurement
Publication 148: Letter Symbols for Semiconductor Devices and Integrated Microcircuits
Publication 191: Mechanical Standardization of Semiconductor Devices

## Military Standards

Commanding Officer
U.S. Naval Publications and Forms Center

5801 Tabor Avenue
Philadelphia, Pa. 19120
MIL-S-19500: Semiconductor Devices, General Specification for
MIL-STD-105: Sampling Procedures and Tables for Inspection by Attributes
MIL-STD-202: Test Methods for Electronic and Electrical Component Parts
MIL-STD-750: Test Methods for Semiconductor Devices
MIL-STD-883: Test Methods and Procedures for Microelectronics

# Transistor <br> Selection Guides 

## TRANSISTOR SELECTION GUIDES

These guides are arrayed into families according to transistor structure and applications. These families are:
FAMILY GUIDE ..... Page
N.P.N Low-Level Amplifiers ..... 2.1
P-N-P Low-Level Amplifiers ..... $2-2$
N-P.N High-Voltage Amplifiers ..... 2.3
P-N-P High-Voltage Amplifiers ..... $2 \cdot 3$
N-P-N High-Frequency Amplifiers ..... 2-4
P-N.P High-Frequency Amplifiers ..... 2-4
N-P-N General Purpose ..... 2-5
P-N-P General Purpose ..... 2-7
N-P.N Switches ..... 2.9
P-N-P Switches ..... $2 \cdot 10$
N-P-N Choppers ..... $2-11$
P-N-P Choppers ..... 2.11
N-P-N Matched Duals ..... 2-12
P-N-P Matched Duals ..... 2.12
N-P-N Unmatched Duals ..... $2 \cdot 13$
P-N-P Unmatched Duals ..... 2-13
N-P-N and
P-N-P Quads ..... 2.13
JFET N-Channel Low-Frequency, Low-Noise Amplifiers ..... 2.14
JFET P-Channel Low-Frequency, Low-Noise Amplifiers ..... 2.14
JFET N-Channel General Purpose Amplifiers ..... 2-15
JFET P-Channel General Purpose Amplifiers ..... 2-15
JFET High-Frequency Amplifiers ..... $2 \cdot 16$
IGFET High-Frequency Amplifiers ..... 2-16
JFET N-Channel Switches and Choppers ..... $2 \cdot 17$
JFET P-Channel Switches and Choppers ..... 2-17
IGFET N-Channel Switches and Choppers ..... 2.18
IGFET P-Channel Switches and Choppers ..... 2-18
JFET Duals ..... $2-18$
IGFET Duals ..... $2-18$
Unijunction, Conventional ..... $2 \cdot 19$
Unijunction, Programmable ..... 2-19

The tabular entries within these families are not made on the usual manner of increasing type number, which would have little inherent utility, but rather are ranked by the most-significant electrical characteristic of that family. Where there is more than one transistor type having the identical primary characteristic, the types within that group are further ranked by a secondary characteristic, and so on.

This form of organization works most efficiently when the user's selection criteria coincides with the organizational lay-out, but should not present undue difficulties if it does not.

It should be noted that the entries are nonexclusive; that is a transistor type may appear in more than one family if its specifications so dictate.

Grown-junction transistors and certain other types not recommended for new design do not appear in these guides.

## N-P-N LOW-LEVEL AMPLIFIERS

| ${ }^{1} \mathrm{IC}$ | MIN-MAX | $V_{\text {(BR)CEO }}$ MIN | NOISE FIGURE <br> F $f$ <br> F (NOISE BW) MAX | DEVICE TYPE | PACKAGE* <br> -See page 2-20. | CHIP |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| $10 \mu \mathrm{~A}$ | $30-$ | 30 V |  | 2N4138 | T0-46 | N18 |
| $10 \mu \mathrm{~A}$ | 30. | 30 V |  | 2N2432 | TO-18 | N18 |
| $10 \mu \mathrm{~A}$ | 30. | 45 V |  | 2N2432A | T0-18 | N18 |
| $10 \mu \mathrm{~A}$ | 40-120 | 45 V | 4 dB (15.7 kHz) | 2N929 | T0-18 | N11 |
| $10 \mu \mathrm{~A}$ | 40-120 | 60 V | 4 dB @ 1 kHz | 2N2483 | TO-18 | N11 |
| $10 \mu \mathrm{~A}$ | 100-300 | 45 V | उdB $(15.7 \mathrm{kHz})$ | 2N930 | TO-18 | N11 |
| $10 \mu \mathrm{~A}$ | 100-500 | 60 V | 3 dB @ 1 kHz | 2N2484 | TO-18 | N11 |
| $10 \mu \mathrm{~A}$ | 120-360 | 45 V |  | 2N2586 | TO-18 | N11 |
| $10 \mu \mathrm{~A}$ | 250-500 | 60 V | 15 dB @ 10 Hz | 2N3117 | TO-18 | N11 |
| $10 \mu \mathrm{~A}$ | 400-800 | 60 V | 15 dB @ 10 Hz | 2N4104 | TO-18 | N11 |
| $100 \mu \mathrm{~A}$ | 100-300 | 50 V | उठB (15.7 kHz) | 2N5209 | TO-92 | N21 |
| $100 \mu \mathrm{~A}$ | 100-300 | 50 V | 3 dB (15.7 kHz) | A5T5209 | AAA | N21 |
| $100 \mu \mathrm{~A}$ | 100-400 | 30 V | $5 \mathrm{~dB}(15.7 \mathrm{kHz})$ | A8T3707 | TO-92 | N21 |
| $100 \mu \mathrm{~A}$ | 100-400 | 30 V | $\overline{5 \mathrm{~dB}}(15.7 \mathrm{kHz})$ | 2N3707 | TO-92 | N21 |
| $100 \mu \mathrm{~A}$ | 100-400 | 30 V | $\overline{5 \mathrm{~dB}}(15.7 \mathrm{kHz})$ | A5T3707 | AAA | N21 |
| $100 \mu \mathrm{~A}$ | 200-600 | 50 V | $2 \mathrm{~dB}(15.7 \mathrm{kHz})$ | 2N5210 | TO-92 | N21 |
| $100 \mu \mathrm{~A}$ | 200-600 | 50 V | $2 \overline{d \bar{B}}(15.7 \mathrm{kHz})$ | A5T5210 | AAA | N21 |
| $100 \mu \mathrm{~A}$ | 250-700 | 40 V | 2 dB @ 1 kHz | TIS94 | TO-92 | N21 |
| $100 \mu \mathrm{~A}$ | 250-700 | 40 V | 2 dB @ 1 kHz | TIS97 | AAA | N21 |
| 1 mA | 45-165 | 30 V |  | A813709 | TO-92 | N21 |
| 1 mA | 45-165 | 30 V |  | 2N3709 | TO-92 | N21 |
| 1 mA | 45-165 | 30 V |  | A5T3709 | AAA | N21 |
| 1 mA | 45-660 | 30 V |  | A8T3708 | TO-92 | N21 |
| 1 mA | 45-660 | 30 V |  | 2N3708 | TO.92 | N21 |
| 1 mA | 45-660 | 30 V |  | A5T3708 | AAA | N21 |
| 1 mA | 90-330 | 30 V |  | A8T3710 | TO-92 | N21 |
| 1 mA | 90-330 | 30 V |  | 2N3710 | TO-92 | N21 |
| 1 mA | 90-330 | 30 V |  | A5T3710 | AAA | N21 |
| 1 mA | 100-300 | 60 V |  | TiS95 | TO-92 | N21 |
| 1 mA | 100-300 | 60 V |  | TIS98 | AAA | N21 |
| 1 mA | 150-600 | 25 V |  | A5T3565 | AAA | N21 |
| 1 mA | 180-660 | 30 V |  | A813711 | TO-92 | N21 |
| 1 mA | 180-660 | 30 V |  | 2N3711 | TO-92 | N21 |
| 1 mA | 180-660 | 30 V |  | A5T3711 | AAA | N21 |
| 2 mA | 35-500 | 15 V |  | 2N5219 | TO-92 | N21 |
| 2 mA | 35-500 | 15 V |  | A5T5219 | AAA | N21 |
| 2 mA | 50-800 | 20 V |  | 2N5223 | TO-92 | N21 |
| 2 mA | 50-800 | 20 V |  | A5T5223 | AAA | N21 |
| 2 mA | 150-300 | 25 V |  | A5T3392 | AAA | N21 |
| 2 mA | 150-300 | 25 V |  | A7T3392 | TO-92 | N21 |
| 2 mA | 150-300 | 25 V |  | A8T3392 | TO-92 | N21 |
| 2 mA | 250-500 | 25 V |  | A5T3391 | AAA | N21 |
| 2 mA | 250-500 | 25 V | $\overline{5 \mathrm{~dB}} \mathbf{( 1 5 . 7} \mathrm{kHz})$ | A5T3391A | AAA | N21 |
| 2 mA | 250-500 | 25 V |  | A7T3391 | TO-92 | N21 |
| 2 mA | 250-500 | 25 V | $5 \mathrm{~dB}(15.7 \mathrm{kHz})$ | ATT3391A | TO-92 | N21 |
| 2 mA | 250-500 | 25 V |  | A8T3391 | TO-92 | N21 |
| 2 mA | 250-500 | 25 V | $5 \mathrm{~dB}(15.7 \mathrm{kHz})$ | A8T3391A | T0-92 | N21 |
| 100 mA | 55-300 | 65 V |  | TIS96 | TO-92 | N21 |
| 100 mA | 55-300 | 65 V |  | TIS99 | AAA | N21 |

P-NP LOW-LEVEL AMPLIFIERS

| (3) ${ }^{1} \mathbf{C}$ | MIN-MAX | $V_{\text {(BR)CEO }}$ MIN | $\begin{aligned} & \text { NOISE FIGURE } \\ & \text { F@f} \\ & \bar{F} \text { (NOISE BW) } \\ & \text { MAX } \end{aligned}$ | Device TYPE | PACKAGE* | CHIP |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| $10 \mu \mathrm{~A}$ | 40-120 | 45 V | $\overline{4 \mathrm{~dB}}$ (15.7 kHz) | A5T 2604 | AAA | P19 |
| $10 \mu \mathrm{~A}$ | 40-120 | 45 V | 4 dB ( 15.7 kHz ) | 2N2604 | TO-46 | P19 |
| $10 \mu \mathrm{~A}$ | 100-300 | 45 V | $\overline{3 \mathrm{~dB}}(45.7 \mathrm{kHz})$ | A5T 2605 | AAA | P19 |
| $10 \mu \mathrm{~A}$ | 100-300 | 45 V | 3 ${ }^{\text {dB }}$ ( 15.7 kHz ) | 2N2605 | TO-46 | P19 |
| $10 \mu \mathrm{~A}$ | 100-300 | 60 V | $3 \mathrm{~dB} @ 1 \mathrm{kHz}$ | 2N3962 | TO. 18 | P18 |
| $10 \mu \mathrm{~A}$ | 100-300 | 80 V | 3 dB @ 1 kHz | 2N3963 | TO-18 | P18 |
| $10 \mu A$ | 100-400 | 30 V | $5 \mathrm{~dB}(15.7 \mathrm{kHz})$ | 2N4058 | TO-92 | P18 |
| $10 \mu \mathrm{~A}$ | 100-400 | 30 V | $5 \mathrm{~dB}(15.7 \mathrm{kHz})$ | A5T4058 | AAA | P18 |
| $10 \mu \mathrm{~A}$ | 250-500 | 45 V | 2 dB @ 1 kHz | 2N3964 | TO-18 | P18 |
| $10 \mu \mathrm{~A}$ | 250-500 | 60 V | 2 dB @ 1 kHz | 2N3965 | TO-18 | P18 |
| $100 \mu \mathrm{~A}$ | 50- | 40 V |  | A5T4248 | AAA | P18 |
| $100 \mu \mathrm{~A}$ | 100-300 | 60 V | 3 dB @ 1 kHz | A5T4249 | AAA | P18 |
| $100 \mu \mathrm{~A}$ | 100-400 | 30 V | $5 \mathrm{~dB}(15.7 \mathrm{kHz})$ | A8T4058 | TO-92 | P18 |
| $100 \mu \mathrm{~A}$ | 150-500 | 50 V | 3 dB @ 1 kHz | 2N5086 | TO-92 | P18 |
| $100 \mu \mathrm{~A}$ | 150-500 | 50 V | 3 dB @ 1 kHz | A5T5086 | AAA | P18 |
| $100 \mu \mathrm{~A}$ | 250-700 | 40 V | 2 dB @ 1 kHz | A5T4250 | AAA | P18 |
| $100 \mu \mathrm{~A}$ | 250-800 | 50 V | 2 dB @ 1 kHz | 2N5087 | TO-92 | P18 |
| $100 \mu \mathrm{~A}$ | 250-800 | 50 V | 2 dB @ 1 kHz | A5T5087 | AAA | P18 |
| $500 \mu \mathrm{~A}$ | 150-450 | 60 V | 3 dB @ 1 kHz | 2N3798 | TO-18 | P19 |
| $500 \mu \mathrm{~A}$ | 300-900 | 60 V | 1.5 dB @ 1 kHz | 2N3799 | TO-18 | P19 |
| 1 mA | 25. | 32 V |  | TIS38 | TO-92 | P24 |
| 1 mA | 25- | 32 V |  | TIS138 | AAA | P24 |
| 1 mA | 30. | 35 V |  | 2N2946 | TO-46 | P14 |
| 1 mA | 40. | 20 V |  | 2N2945 | TO-46 | P14 |
| 1 mA | 45- | 32 V | 2.5 dB typ @ 1 MHz | TIS37 | TO-92 | P24 |
| 1 mA | 45- | 32 V | 2.5 d8 typ@ 1 MHz | TIS137 | AAA | P24 |
| 1 mA | 45-165 | 30 V |  | A8T4060 | TO-92 | P18 |
| 1 mA | 45-165 | 30 V |  | 2N4060 | TO-92 | P18 |
| 1 mA | 45-165 | 30 V |  | A5T4060 | AAA | P18 |
| 1 mA | 45-660 | 30 V |  | A8T4059 | TO-92 | P18 |
| 1 mA | 45-660 | 30 V |  | 2N4059 | T0.92 | P18 |
| 1 mA | 45-660 | 30 V |  | A5T4059 | AAA | P18 |
| 1 mA | 50 | 35 V |  | 2N2946A | TO-46 | P14 |
| 1 mA | 70. | 20 V |  | 2N2945A | TO-46 | P14 |
| 1 mA | 80 | 10 V |  | 2N2944 | TO-46 | P14 |
| 1 mA | 90.330 | 30 V |  | A8T4061 | TO-92 | P18 |
| 1 mA | 90-330 | 30 V |  | 2N4061 | TO-92 | P18 |
| 1 mA | 90-330 | 30 V |  | A5T4061 | AAA | P18 |
| 1 mA | 100. | 10 V |  | 2N2944A | TO-46 | P14 |
| 1 mA | 180-660 | 30 V |  | A8T4062 | TO-92 | P18 |
| 1 mA | 180-660 | 30 V |  | 2N4062 | TO-92 | P18 |
| 1 mA | 180-660 | 30 V |  | A5T4062 | AAA | P18 |
| 2 mA | 50-700 | 30 V |  | A5T5227 | AAA | P18 |
| 2 mA | 50-700 | 30 V |  | 2N5227 | TO-92 | P18 |
| 12 mA | 30-400 | 24 V |  | A8T404 | T0.92 | P14 |
| 12 mA | 30-400 | 35 V |  | A8T404A | TO-92 | P14 |
| 12 mA | 30-400 | 24 V |  | A5T404 | AAA | P14 |
| 12 mA | 30-400 | 35 V |  | A5T404A | AAA | P14 |

[^4]N-P-N HIGH-VOLTAGE AMPLIFIERS

| $\begin{gathered} \mathbf{V}_{\text {(BR)CEO }} \\ \text { MIN } \end{gathered}$ | $h_{\text {FE }}$ |  | DEVICE <br> TYPE | PACKAGE* | CHIP |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  | @ lc | MIN-MAX |  |  |  |
| 140 V | 1 mA | 60- | 2N5550 | TO-92 | N27 |
| 140 V | 1 mA | 60 | A5T5550 | AAA | $\mathbf{N} 27$ |
| 150 V | 30 mA | 30-120 | 2N3114 | TO-39 | N15 |
| 150 V | 25 mA | $30-$ | TIS101 | AAA | N27 |
| 160 V | 1 mA | 80 | 2N5551 | TO-92 | N27 |
| 160 V | 1 mA | 80 | A5T5551 | AAA | N27 |
| 180 V | 25 mA | 30. | TIS100 | AAA | N27 |
| 250 V | 30 mA | 30-150 | A5T5059 | AAA | N15 |
|  | 30 mA | 30-150 | 2N5059 | TO-39 | N15 |
| 300 V | 30 mA | 35-150 | A5T5058 | AAA | N15 |
| 300 V | 30 mA | 35-150 | 2N5058 | TO-39 | N15 |

P-N-P HIGH-VOLTAGE AMPLIFIERS

| $\begin{gathered} \mathrm{V}_{\text {tBR)CEO }} \\ \text { MIN } \end{gathered}$ | ${ }_{9} \mathbf{C}$ | MIN-MAX | DEVICE <br> TYPE | PACKAGE* | CHIP |
| :---: | :---: | :---: | :---: | :---: | :---: |
| 80 V | 1 mA | 40- | 2N3494 | TO-5 | P17 |
| 80 V | 1 mA | 40. | A5T3496 | AAA | P17 |
| 80 V | 1 mA | 40- | 2N3496 | T0-18 | P17 |
| 120 V | 1 mA | 40- | 2N3495 | TO-5 | P17 |
| 120 V | 1 mA | 40- | A5T3497 | AAA | P17 |
| 120 V | 1 mA | 40 | 2N3497 | TO-18 | P17 |
| 120 V | 10 mA | 40-180 | A5T5400 | AAA | P22 |
| 120 V | 10 mA | 40-180 | 2N5400 | TO-92 | P22 |
| 140 V | 50 mA | 50-150 | 2N3634 | TO-39 | P22 |
| 140 V | 50 mA | 100-300 | 2N3635 | TO-39 | P22 |
| 150 V | 10 mA | 60-240 | A5T5401 | AAA | P22 |
| 150 V | 10 mA | 60-240 | 2N5401 | TO-92 | P22 |
| 175 V | 50 mA | 50-150 | 2N3636 | TO-39 | P22 |
| 175 V | 50 mA | 100-300 | 2N3637 | T0-39 | P22 |

*See package drawings on page 2-20.

## TRANSISTOR SELECTION GUIDES

N-P-N HIGH-FREQUENCY AMPLIFIERS

| fT | V(br)ceo | CAPACITANCE |  | DEVICE <br> TYPE | PACKAGE* | CHIP |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| MIN | MIN | PARAMETER | MAX |  |  |  |
| 500 MHz | 12 V | Ccb | 1.3 pF | TIS64A | AAA | N22 |
| 300 MHz | 45 V | ccb | 1 pF | TIS105 | AAA | N20 |
| 350 MHz | 30 V | Cres | 0.4 pF | TIS84 | AAA | N17 |
| 350 MHz | 30 V | Cres | 0.4 pF | TIS108 | AAA | N17 |
| 500 MHz | 12 V | Ccb | 1.3 pF | TIS63A | AAA | N22 |
| 450 MHz | 30 V | Cce | 0.3 pF | TIS125 | AAA | N26 |
| 450 MHz | 15 V | Ccb | 1.3 pF | 2N5222 | TO-92 | N24 |
| 450 MHz | 15 V | Ccb | 1.3 pF | A6T5222 | AAA | N24 |
| 500 MHz | 12 V | $\mathrm{C}_{\text {cb }}$ | 1.3 pF | TIS62A | AAA | N22 |
| 500 MHz | 30 V | Cres | 0.45 pF | TIS86 | AAA | N16 |
| 500 MHz | 45 V | Cres | 0.45 pF | TIS87 | AAA | N16 |
| 500 MHz | 15 V | Cobo | 1.7 pF | 2N917 | TO-72 | N22 |
| 600 MHz | 15 V | Cobo | 1.7 pF | 2N918 | TO.72 | N22 |
| 600 MHz | 18 V | Ccb | 0.45 pF | 2N4252 | TO-72 | N16 |
| 600 MHz | 18 V | Ccb | 0.45 pF | 2N4253 | TO-72 | N16 |
| 600 MHz | 18 V | Ccb | 0.65 pF | 2N4996 | AAA | N16 |
| 600 MHz | 18 V | Ccb | 0.65 pF | 2N4997 | AAA | N16 |
| 600 MHz | 40 V | Ccb | 0.36 pF | TIS126 | AAA | N29 |
| 800 MHz | 25 V | $\mathrm{C}_{\text {cb }}$ | 0.8 pF | TIS129 | AAA | N30 |
| 1000 MHz | 13 V | Ccb | 0.85 pF | A5T3572 | AAA | N28 |
| 1000 MHz | 13 V | Ccb | 0.85 pF | 2N3572 | TO-72 | N28 |
| 1200 MHz | 15 V | Ccb | 0.85 pF | A5T3571 | AAA | N28 |
| 1200 MHz | 15 V | Ccb | 0.85 pF | 2N3571 | TO-72 | N28 |
| 1500 MHz | 15 V | ccb | 0.75 pF | 2N3570 | TO-72 | N28 |

P-NP HIGH-FREQUENCY AMPLIFIERS

| ${ }^{\text {f }}$ | V(BR)CEO MIN | CAPACITANCE |  | DEVICE | PACKAGE* | CHIP |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| MIN |  | PARAMETER | MAX | TYPE |  |  |
| 50 MHz | 32 V | Ccb | 1.7 pF | TIS38 | TO-92 | P24 |
| 50 MHz | 32 V | Ccb | 1.7 pF | TIS138 | AAA | P24 |
| 80 MHz | 32 V | Ccb | 1.7 pF | TIS37 | TO-92 | P24 |
| $80 \mathrm{MHz}$ | 32 V | Ccb | 1.7 pF | TIS137 | AAA | P24 |
| 650 MHz | 45 V | $\mathrm{C}_{\text {ce }}$ | 0.3 pF | TIS128 | AAA | P25 |
| 1600 MHz | 15 V | Ccb | 2.5 pF | 2N4260 | TO-72 | P27 |
| 1600 MHz | 15 V | Ccb | 2.5 pF | A5T4260 | AAA | P27 |
| 2000 MHz | 15 V | Ccb | 2.5 pF | 2N4261 | TO. 72 | P27 |
| 2000 MHz | 15 V | Ccb | 2.5 pF | A5T4261 | AAA | P27 |

[^5]N-P-N GENERAL PURPOSE

| V(br)ceo | hfe |  | $\begin{gathered} \mathrm{f} \mathrm{~T} \\ \mathrm{MiN} \end{gathered}$ | DEVICE TYPE | PACKAGE* | CHIP |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| MIN | - IC | MIN-MAX |  |  |  |  |
| 15 V | 50 mA | 30-600 | 100 MHz | 2N5220 | TO-92 | N24 |
| 15 V | 50 mA | 30-600 | 100 MHz | A5T5220 | AAA | N24 |
| 20 V | 50 mA | 30-600 | 100 MHz | A8T3706 | TO-92 | N24 |
| 20 V | 50 mA | 30-600 | 100 MHz | 2N3706 | TO-92 | N24 |
| 20 V | 50 mA | 30-600 | 100 MHz | 2N5451 | AAA | N24 |
| 25 V | 1 mA | 150-600 | 40 MHz | A5T3565 | AAA | N21 |
| 25 V | 2 mA | 120-360 | 300 MHz | A5T4124 | AAA | N14 |
| 25 V | 2 mA | 120-360 | 300 MHz | 2N4124 | TO-92 | N14 |
| 25 V | 2 mA | 150-300 |  | A5T3392 | AAA | N21 |
| 25 V | 2 mA | 150-300 |  | A7T3392 | TO-92 | N21 |
| 25 V | 2 mA | 150-300 |  | A8T3392 | T0-92 | N21 |
| 25 V | 2 mA | 250-500 |  | A5T3391 | AAA | N21 |
| 25 V | 2 mA | 250-500 |  | A5T3391A | AAA | N21 |
| 25 V | 2 mA | 250-500 |  | A7T3391 | TO-92 | N21 |
| 25 V | 2 mA | 250-500 |  | A7T3391A | T0.92 | N21 |
| 25 V | 2 mA | 250-500 |  | A8T3391 | T0.92 | N21 |
| 25 V | 2 mA | 250-500 |  | A873391A | TO-92 | N21 |
| 25 V | 10 mA | 100-500 |  | A5T5172 | AAA | N21 |
| 25 V | 10 mA | 100-500 |  | ATT5172 | TO-92 | N21 |
| 25 V | 10 mA | 100-500 |  | A8T5172 | T0-92 | N21 |
| 25 V | 50 mA | 30-600 | 50 MHz | 2N5225 | TO-92 | N24 |
| 25 V | 50 mA | 30-600 | 50 MHz | A5T5225 | AAA | N24 |
| 30 V | 2 mA | 50-150 | 250 MHz | A5T4123 | AAA | N14 |
| 30 V | 2 mA | 50-150 | 250 MHz | 2N4123 | TO-92 | N14 |
| 30 V | 10 mA | 1000- | 200 MHz | 2N5526 | T0-92 | N21 |
| 30 V | 10 mA | $5000-$ | 200 MHz | 2N5525 | TO-92 | N21 |
| 30 V | 50 mA | 50-150 | 100 MHz | A8T3705 | TO-92 | N24 |
| 30 V | 50 mA | 50-150 | 100 MHz | 2N3705 | TO.92 | N24 |
| 30 V | 50 mA | 50-150 | 100 MHz | 2N5450 | AAA | N24 |
| 30 V | 50 mA | 100-300 | 100 MHz | A8T3704 | TO-92 | N24 |
| 30 V | 50 mA | 100-300 | 100 MHz | 2N3704 | TO-92 | N24 |
| 30 V | 50 mA | 100-300 | 100 MHz | 2N5449 | AAA | N24 |
| 30 V | 150 mA | 20-60 | 250 MHz | 2N2217 | TO-5 | N24 |
| 30 V | 150 mA | 20-60 | 250 MHz | 2N2220 | TO-18 | N24 |
| 30 V | 150 mA | 40-120 | 250 MHz | 2N2218 | TO-5 | N24 |
| 30 V | 150 mA | 40-120 | 250 MHz | 2N2221 | TO-18 | N24 |
| 30 V | 150 mA | 100-400 | 250 MHz | TIS109 | AAA | N24 |
| 30 Vt | 150 mA | 100-300 | 70 MHz | 2N956 | TO-18 | N24 |
| 30 V | 150 mA | 100-300 | 50 MHz | 2N1420 | TO-5 | N24 |
| 30 V | 150 mA | 100-300 | 50 MHz | 2N1507 | TO-5 | N24 |
| 30 V | 150 mA | 100-300 | 250 MHz | 2N2219 | TO-5 | N24 |
| 30 V | 150 mA | 100-300 | 250 MHz | Q2T2222 | TO-116 | N24 |
| 30 V | 150 mA | 100-300 | 250 MHz | A5T2222 | AAA | N 24 |
| 30 V | 150 mA | 100-300 | 250 MHz | 2N2222 | TO. 18 | N24 |
| 40 V | $100 \mu \mathrm{~A}$ | 250-700 | 200 MHz | TIS94 | TO-92 | N21 |
| 40 V | $100 \mu \mathrm{~A}$ | 250.700 | 200 MHz | TIS97 | AAA | N21 |
| 40 V | 10 mA | 50-150 | 250 MHz | A5T3903 | AAA | N14 |
| 40 V | 10 mA | - 50-150 | 250 MHz | 2N3903 | TO-92 | N14 |
| 40 V | 10 mA | 100-300 | 300 MHz | A5T3904 | AAA | N14 |

-See package drawings on page 2-20. $\quad t V_{(B R) C E O}$ approximated from $V_{\text {(BR)CER }}$.

N-P-N GENERAL PURPOSE (Continued)

| $\mathbf{V}_{\text {(BR)CEO }}$ MIN | (2) ${ }^{\text {c }}$ | MIN-MAX | $\begin{aligned} & \text { TT } \\ & \text { MIN } \end{aligned}$ | DEVICE TYPE | PACKAGE* | CHIP |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 40 V | 10 mA | 100-300 | 300 MHz | 2N3904 | TO-92 | N14 |
| 40 V | 50 mA | 100-300 |  | TIS90 | TO-92 | N24 |
| 40 V | 50 mA | 100-300 |  | TIS92 | AAA | N24 |
| 40 V | 100 mA | 7000-70,000 |  | 2N997 | TO-18 | N23 |
| 40 V | 150 mA | 20-60 | 40 MHz | 2N696 | TO-5 | N24 |
| $40 \mathrm{~V} \ddagger$ | 150 mA | 20-60 | 40 MHz | 2N717 | TO-18 | N24 |
| 40 V | 150 mA | 20-60 | 40 MHz | 2N730 | TO-18 | N24 |
| 40 V | 150 mA | 20-60 | 50 MHz | 2N2194 | T0-39 | N23 |
| 40 V | 150 mA | 20-60 | 50 MHz | 2N2194A | TO-39 | N23 |
| $40 \mathrm{~V} \ddagger$ | 150 mA | 40-120 | 50 MHz | 2N697 | TO-5 | N24 |
| $40 \mathrm{~V} \ddagger$ | 150 mA | 40-120 | 50 MHz | 2N718 | TO-18 | N24 |
| $40 \mathrm{~V}{ }^{\top}$ | 150 mA | 40-120 | 60 MHz | 2N718A | TO-18 | N24 |
| 40 V | 150 mA | 40-120 | 50 MHz | 2N731 | TO-18 | N24 |
| $40 \mathrm{~V}{ }^{\dagger}$ | 150 mA | 40-120 | 60 MHz | 2N1613 | TO-5 | N24 |
| 40 V | 150 mA | 40-120 | 250 MHz | 2N2218A | TO-5 | N24 |
| 40 V | 150 mA | 40-120 | 250 MHz | 2N2221A | TO-18 | N24 |
| 40 V | 150 mA | 50-150 | 200 MHz | TIS110 | AAA | N24 |
| 40 V | 150 mA | 50-250 | 100 MHz | 2N3053 | TO. 39 | N13 |
| 40 V | 150 mA | 100-300 | 250 MHz | TIS111 | AAA | N24 |
| $40 \mathrm{~V} \dagger$ | 150 mA | 100-300 | 70 MHz | 2N1711 | TO-5 | N24 |
| 40 V | 150 mA | 100-300 | 50 MHz | A5T2192 | AAA | N23 |
| 40 V | 150 mA | 100-300 | 50 MHz | 2N2192 | TO.39 | N23 |
| 40 V | 150 mA | 100-300 | 50 MHz | 2N2192A | TO-39 | N23 |
| 40 V | 150 mA | 100-300 | 300 MHz | 2N2219A | TO-5 | N24 |
| 40 V | 150 mA | 100-300 | 300 MHz | 2N2222A | TO-18 | N24 |
| 45 V | 150 mA | 50-200 | 100 MHz | 2N2270 | T0.39 | N23 |
| 50 V | 10 mA | 60-400 | 60 MHz | 2N4409 | TO-92 | N23 |
| 50 V | 10 mA | 60-400 | 60 MHz | A5T4409 | AAA | N23 |
| 50 V | 150 mA | 40-120 | 50 MHz | A5T2193 | AAA | N23 |
| 50 V | 150 mA | 40-120 | 50 MHz | 2N2193 | TO-39 | N23 |
| 50 V | 150 mA | 40-120 | 50 MHz | 2N2193A | TO-39 | N23 |
| 60 V | 1 mA | 100-300 | 200 MHz | TIS95 | TO-92 | N21 |
| 60 V | 1 mA | 100-300 | 200 MHz | TIS98 | AAA | N21 |
| 60 V | 5 mA | 60-200 | 60 MHz | 2N1566 | TO-39 | N23 |
| 60 V | 10 mA | 15. | 40 MHz | 2N1975 | TO-39 | N23 |
| 60 V | 10 mA | 15. | 40 MHz | 2N912 | TO-18 | N23 |
| 60 V | 10 mA | 35. | 50 MHz | 2N911 | TO-18 | N23 |
| 60 V | 10 mA | 35 | 50 MHz | 2N1974 | TO. 39 | N23 |
| 60 V | 10 mA | 75 | 60 MHz | 2N910 | TO-18 | N23 |
| 60 V | 10 mA | 75 | 60 MHz | 2N1973 | T0-39 | N23 |
| 60 V | 10 mA | 1600-8000 |  | 2N998 | TO-72 | N23 |
| 60 V | 100 mA | 7000-70,000 |  | 2N999 | TO-72 | N23 |
| 60 V | 150 mA | 20-60 | 40 MHz | 2N698 | TO-39 | N23 |
| $60 \mathrm{~V}{ }^{\dagger}$ | 150 mA | 20-60 | 40 MHz | 2N719 | TO-18 | N23 |
| 60 V | 150 mA | 20-60 | 40 MHz | 2N719A | TO.18 | N23 |
| $60 \mathrm{~V}{ }^{\dagger}$ | 150 mA | 40-120 | 50 MHz | 2N699 | TO-39 | N23 |
| $60 \mathrm{~V}{ }^{\dagger}$ | 150 mA | 40-120 | 50 MHz | 2N720 | T0-18 | N23 |
| 60 V | 150 mA | 40-120 | 50 MHz | 2N870 | TO-18 | N23 |

[^6]NP-N GENERAL PURPOSE (Continued)

| $\begin{gathered} \hline \text { V(BR)CEO } \\ \text { MIN } \end{gathered}$ | - $\mathrm{Ic}_{6}$ | MIN-MAX | $\begin{aligned} & \text { IT } \\ & \text { MIN } \end{aligned}$ | DEVICE TYPE | PACKAGE* | CHIP |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 60 V | 150 mA | 40-120 | 50 MHz | 2N1889 | T0.39 | N23 |
| 60 V | 150 mA | 100-300 | 60 MHz | 2N871 | TO-18 | N23 |
| 60 V | 150 mA | 100-300 | 60 MHz | 2N1890 | TO. 39 | N23 |
| 65 V | 150 mA | 40-120 | 60 MHz | 2N2102 | T0.39 | N23 |
| 65 V | 150 mA | 40-120 | 60 MHz | 2N2102A | T0.39 | N23 |
| 65 V | 100 mA | 55-300 | 200 MHz | TIS96 | T0.92 | N21 |
| 65 V | 100 mA | 56-300 | 200 MHz | TIS98 | AAA | N21 |
| 80 V | 10 mA | 60-400 | 60 MHz | 2N4410 | TO-92 | N23 |
| 80 V | 10 mA | 60-400 | 60 MHz | A5T4410 | AAA | N23 |
| 80 V | 150 mA | 40.120 | 50 MHz | 2N720A | TO-18 | N23 |
| 80 V | 160 mA | 40-120 | 50 MHz | 2N1893 | T0-39 | N23 |
| 80 V | 160 mA | 40-120 | 50 MHz | A5T2243 | AAA | N23 |
| 80 V | 150 mA | 40-120 | 50 MHz | 2N2243 | TO-39 | N23 |
| 80 V | 150 mA | 40-120 | 50 MHz | 2N2243A | T0-39 | N23 |
| 80 V | 150 mA | 50-150 | 50 MHz | 2N3036 | T0.39 | N23 |

P.N.P GENERAL PURPOSE

| V(BR)CEO | hfe |  | $\begin{gathered} \mathbf{F T}^{\prime} \\ \text { MIN } \end{gathered}$ | DEVICE TYPE | PACKACE* | CHIP |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| MIN | - Ic | MIN-MAX |  |  |  |  |
| 15V | 60 mA | 30-600 | 100 MHz | A5T5221 | AAA | P20 |
| 15 V | 50 mA | $30-600$ | 100 MHz | 2N5221 | TO-92 | P20 |
| 25 V | 2 mA | 120-360 | 250 MHz | 2N4126 | TO-92 | P15 |
| 25 V | 2 mA | 120-360 | 250 MHz | A5T4126 | AAA | P15 |
| 25 V | 50 mA | 30. | 100 MHz | A5T3638 | AAA | P20 |
| 25 V | 50 mA | 30-600 | 50 MHz | 2N5226 | TO-92 | P20 |
| 25 V | 60 mA | 30-600 | 50 MHz | A5T5226 | AAA | P20 |
| 25 V | 50 mA | 60-300 | 100 MHz | 2N3702 | TO-92 | P20 |
| 25 V | 50 mA | 60-300 | 100 MHz | A8T3702 | TO-92 | P20 |
| 25 V | 50 mA | 60-300 | 100 MHz | 2N5447 | AAA | P20 |
| 25 V | 50 mA | 100- | 150 MHz | A5T3638A | AAA | P20 |
| 30 V | 2 mA | 50-150 | 200 MHz | A5T4125 | AAA | P15 |
| 30 V | 2 mA | 50-150 | 200 MHz | 2N4125 | TO-92 | P15 |
| 30 V | 50 mA | 30-150 | 100 MHz | 2N3703 | TO-92 | P20 |
| 30 V | 50 mA | 30-150 | 100 MHz | A8T3703 | T0.92 | P20 |
| 30 V | 50 mA | 30-150 | 100 MHz | 2N5448 | AAA | P20 |
| 35 V | 150 mA | $20-45$ | 50 MHz | 2N721 | TO-18 | P20 |
| 35 V | 150 mA | 20-46 | 50 MHz | 2N1131 | T0-39 | P20 |
| 35 V | 150 mA | 30-90 | 60 MHz | 2N722 | T0-18 | P20 |
| 35 V | 150 mA | 30-90 | 60 MHz | 2N1132 | T0.39 | P20 |
| 35 V | 150 mA | 75-200 | 60 MHz | 2N2303 | TO-5 | P20 |
| 40 V | 10 mA | 50-160 | 250 MHz | 2N3250 | TO-18 | P23 |
| 40 V | 10 mA | 50-150 | 200 MHz | A5T3905 | AAA | P15 |
| 40 V | 10 mA | 50-150 | 200 MHz | 2N3905 | TO-92 | P15 |
| 40 V | 10 mA | 100-300 | 300 MHz | 2N3251 | TO-18 | P23 |
| 40 V | 10 mA | 100-300 | 250 MHz | A5T3906 | AAA | P15 |
| 40 V | 10 mA | 100-300 | 250 MHz | 2N3906 | TO-92 | P15 |
| 40 V | 50 mA | 100-300 |  | TIS91 | TO-92 | P20 |
| 40 V | 50 mA | 100-300 |  | TiS93 | AAA | P20 |

*See pack ege drawings on page 2-20.

## transistor selection guides

P-N-P GENERAL PURPOSE (Continued)

| V(BR)CEO | hFE |  | $\mathbf{f}_{\mathbf{T}}$MIN | DEVICE TYPE | PACKACE* | CHIP |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| MIN | - Ic | MIN-MAX |  |  |  |  |
| 40 V | 150 mA | 40-120 | 200 MHz | 2N2904 | TO-6 | P20 |
| 40 V | 150 mA | 40-120 | 200 MHz | 2N2906 | TO-18 | P20 |
| 40 V | 150 mA | 40-120 | 200 MHz | 2N3485 | TO-46 | P20 |
| 40 V | 150 mA | 50-150 | 150 MHz | A5T4402 | AAA | P20 |
| 40 V | 150 mA | 50-150 | 150 MHz | 2N4402 | TO.92 | P20 |
| 40 V | 150 mA | 100-300 | 200 MHz | TIS112 | AAA | P20 |
| 40 V | 150 mA | 100-300 | 200 MHz | Q2T2905 | TO-116 | P20 |
| 40 V | 150 mA | 100-300 | 200 MHz | 2N2905 | TO-5 | P20 |
| 40 V | 150 mA | 100-300 | 200 MHz | A5T2907 | AAA | P20 |
| 40 V | 150 mA | 100-300 | 200 MHz | 2N2907 | TO-18 | P20 |
| 40 V | 150 mA | 100-300 | 200 MHz | 2N3486 | TO-46 | P20 |
| 40 V | 150 mA | 100-300 | 200 MHz | A5T4403 | AAA | P20 |
| 40 V | 150 mA | 100-300 | 200 MHz | 2N4403 | TO-92 | P20 |
| 45 V | 150 mA | 100-300 | 200 MHz | 2N3502 | TO-5 | P20 |
| 45 V | 150 mA | 100-300 | 200 MHz | A5T3504 | AAA | P20 |
| 45 V | 150 mA | 100-300 | 200 MHz | 2N3504 | TO-18 | P20 |
| 45 V | 150 mA | 100-300 | 200 MHz | A5T3644 | AAA | P20 |
| 60 V | 10 mA | 50-150 | 250 MHz | 2N3250A | TO-18 | P23 |
| 60 V | 10 mA | 100-300 | 300 MHz | 2N3251A | T0-18 | P23 |
| 60 V | 100 mA | 40-120 | 100 MHz | A8T4026 | TO-92 | P16 |
| 60 V | 100 mA | 40-120 | 100 MHz | A5T4026 | AAA | P16 |
| 60 V | 100 mA | 40-120 | 100 MHz | 2N4026 | TO-18 | P16 |
| 60 V | 100 mA | 40-120 | 100 MHz | 2N4030 | TO-39 | P16 |
| 60 V | 100 mA | 100-300 | 150 MHz | A8T4028 | TO-92 | P16 |
| 60 V | 100 mA | 100-300 | 150 MHz | A5T4028 | AAA | P16 |
| 60 V | 100 mA | 100-300 | 150 MHz | 2N4028 | TO-18 | P16 |
| 60 V | 100 mA | 100-300 | 150 MHz | 2N4032 | T0-39 | P16 |
| 60 V | 150 mA | 40-120 | 200 MHz | 2N2904A | TO-5 | P20 |
| 60 V | 150 mA | 40-120 | 200 MHz | 2N2906A | TO-18 | P20 |
| 60 V | 150 mA | 40-120 | 200 MHz | 2N3485A | TO-46 | P20 |
| 60 V | 150 mA | 100-300 | 200 MHz | 2N2905A | TO-5 | P20 |
| 60 V | 160 mA | 100-300 | 200 MHz | 2N2907A | TO-18 | P20 |
| 60 V | 150 mA | 100-300 | 200 MHz | 2N3486A | TO-46 | P20 |
| 60 V | 150 mA | 100-300 | 200 MHz | 2N3503 | TO-5 | P20 |
| 60 V | 150 mA | 100-300 | 200 MHz | A5T3505 | AAA | P20 |
| 60 V | 150 mA | 100-300 | 200 MHz | 2N3505 | TO-18 | P20 |
| 60 V | 150 mA | 100-300 | 200 MHz | A5T3645 | AAA | P20 |
| 80 V | 100 mA | 40-120 | 100 MHz | A8T4027 | TO-92 | P16 |
| 80 V | 100 mA | 40-120 | 100 MHz | A6T4027 | AAA | P16 |
| 80 V | 100 mA | 40-120 | 100 MHz | 2N4027 | TO-18 | P16 |
| 80 V | 100 mA | 40-120 | 100 MHz | 2N4031 | TO-39 | P16 |
| 80 V | 100 mA | 100-300 | 150 MHz | A8T4029 | TO-92 | P16 |
| 80 V | 100 mA | 100-300 | 150 MHz | A5T4029 | AAA | P16 |
| 80 V | 100 mA | 100-300 | 150 MHz | 2N4029 | TO-18 | P16 |
| 80 V | 100 mA | 100-300 | 150 MHz | 2N4033 | TO-39 | P16 |

[^7]
## TRANSISTOR SELECTION GUIDES

NP-N SWITCHES

| SWITCHING TIMES |  |  | V(Br)ceo MIN |  | device TYPE | PACKAGE* | CHIP |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| - ic | ton MAX | $\begin{aligned} & \text { toff }^{\text {MAX }} \end{aligned}$ |  |  |  |  |  |
| 10 mA | 70 ns | 225 ns | 40 V | 0.2 V (10 mA | A5T3903 | AAA | N14 |
| 10 mA | 70 ns | 225 ns | 40 V | 0.2 V (10 10 mA | 2N3903 | TO-92 | N14 |
| 10 mA | 70 ns | 250 ns | 40 V | $0.2 \mathrm{~V}=10 \mathrm{~mA}$ | A6T3904 | AAA | N14 |
| 10 mA | 70 ns | 250 ns | 40 V | $0.2 \mathrm{~V} \odot 10 \mathrm{~mA}$ |  | то.92 | N14 |
| 10 mA | 22 typ ns | 32 typ ns | 30 V | $0.3 V$ ¢ 50 mA | 2N4123 | TO-92 | N14 |
| 10 mA | 22 typ ns | 32 typ ns | 30 V | 0.3 V - 50 mA | A6T4123 | AAA | N14 |
| 10 mA | 22 typ ns | 32 typ ns | 25 V | 0.3 V ¢ 50 mA | 2N4124 | TO-92 | N14 |
| 10 mA | 22 typ ns | 32 typ ns | 25 V | $0.3 \mathrm{~V} @ 50 \mathrm{~mA}$ | A5T4124 | AAA | N14 |
| 160 mA | 20 typ ns | 113 typ ns | 40 V | $0.4 V$ ¢ 150 mA | TIS110 | AAA | N24 |
| 150 mA | 20 typ ns | 113 typ ns | 40 V | $0.4 V$ ¢ 150 mA | TIS111 | AAA | N24 |
| 150 mA | 35 ns | 285 ns | 40 V | $0.3 \mathrm{~V} @ 160 \mathrm{~mA}$ | 2N2218A | TO-5 | N24 |
| 160 mA | 35 ns | 285 ns | 40 V | $0.3 V$ ¢ 150 mA | 2N2218A | TO-5 | N24 |
| 160 mA | 35 ns | 285 ns | 40 V | 0.3 V 9150 mA | 2N2221A | TO-18 | N24 |
| 150 mA | 36 ns | 285 ns | 40 V | $0.3 \mathrm{~V}-150 \mathrm{~mA}$ | 2N2222A | T0-18 | N24 |
| 150 mA | 40 ns | 40 ns | 30 V | 0.45 V - 150 mA | 2N2537 | TO-5 | N19 |
| 150 mA | 40 ns | 40 ns | 30 V | 0.45 V - 150 mA | 2N2538 | TO-5 | N19 |
| $150 \mathrm{~mA}$ | 40 ns | 40 ns | 30 V | 0.45 V - 150 mA | 2N2539 | TO-18 | N18 |
| 150 mA | 40 ns | 40 ns | 30 V | 0.45 V -150 mA | 2N2540 | TO-18 | N19 |
| 150 mA | 20 typ ns | 113 typ ns | 30 V | 0.4 V -150 mA | TIS109 | AAA | N24 |
| 150 mA | 20 typ ns | 113 typ ns | 30 V | 0.4 V ¢ 150 mA | $2 N 2217$ | TO-5 | N24 |
| 150 mA | 20 typ ns | 113 typ ns | 30 V | 0.4 V 9150 mA | 2N2218 | TO-5 | N24 |
| 150 mA | 20 typ ns | 113 typ ns | 30 V | 0.4 V © 150 mA | 2N2219 | TO-5 | N24 |
| 160 mA | 20 typ ns | 113 typ ns | 30 V | 0.4 V ¢ 150 mA | 2N2220 | TO-18 | N24 |
| 150 mA | 20 typ ns | 113 typ ns | 30 V | 0.4 V -150 mA | 2N2221 | T0-18 | N24 |
| 150 mA | 20 typ ns | 113 typ ns | 30 V | 0.4 V © 150 mA | O2T2222 | TO-116 | N24 |
| 150 mA | 20 typ ns | 113 typ ns | 30 V | 0.4 V ¢ 150 mA | A5T2222 | AAA | N24 |
| 150 mA | 20 typ ns | 113 typ ns | 30 V | 0.4 V - 150 mA | 2N2222 | TO. 18 | N24 |
| 600 mA | 35 ns | 60 ns | 30 V | 0.65 V ¢ 500 mA | TIS133 | AAA | N13 |
| 500 mA | 35 ns | 60 ns | 30 V | $0.72 \mathrm{~V} \oplus 500 \mathrm{~mA}$ | TiS134 | AAA | N13 |
| 500 mA | 35 ns | 60 ns | 50 V | 0.65 V ¢ 5000 mA | TIS 135 | AAA | N13 |
| 500 mA | 35 ns | 60 ns | 40 V | 0.72 V @ 500 mA | TIS136 | AAA | N13 |
| 600 mA | 35 ns | 60 ns | 30 V | 0.42 V © 500 mA | 2N3724 | T0.39 | N13 |
| 500 mA | 35 ns | 65 ns | 40 V | 0.52 V 500 mA | 0213725 | TO-116 | N13 |
| 500 mA | 35 ns | 60 ns | 50 V | 0.62 V @ 500 mA | 2N3725 | T0-39 | N13 |
| 500 mA | 36 ns | 60 ns | 30 V | 0.42 V ¢ 500 mA | 2N4013 | TO-18 | N13 |
| 500 mA | 35 ns | 60 ns | 60 V | $0.52 \mathrm{~V} \oplus 500 \mathrm{~mA}$ | 2N4014 | T0-18 | N13 |
| 500 mA | 40 ns | 60 ns | 30 V | 1 V ¢ 500 mA | 2N3015 | TO-5 | N19 |
| 500 mA | 45 ns | 70 ns | 30 V | 0.5 V ¢ 500 mA | 2N3252 | T0-39 | N13 |
| 600 mA | 50 ns | 70 ns | 40 V | 0.6 V @ 500 mA | 2N3253 | T0.39 | N13 |
| 500 mA | 50 ns | 70 ns | 50 V | $0.6 \mathrm{~V} \oplus 500 \mathrm{~mA}$ | 2N3444 | TO-39 | N13 |
| 1 A | 30 ns | 50 ns | 30 V | 0.76 V ¢ 1 A | 2N3724A | T0.39 | N13 |
| 1 A | 30 ns | 50 ns | 50 V | $0.9 \mathrm{~V} \bigcirc 1 \mathrm{~A}$ | 2N3725A | T0.39 | N13 |
| 1 A | 48 ns | 60 ns | 30 V | 0.9 V ¢ 1 A | 2N3734 | T0-39 | N13 |
| 1 A | 48 ns | 60 ns | 50 V | 0.9 V -1 A | 2N3735 | T0-39 | N13 |
| 1 A | 50 ns | 105 ns | 30 V | 1 V ¢ 1 A | 2N3554 | TO-39 | N13 |

*See package drawings on page 2-20.

P-N-P SWITCHES

| SWITCHING TIMES |  |  | $V_{\text {(BR)CEO }}$ MIN | $\mathbf{V C E}_{\text {(sat) }}$ @ IC | DEVICE TYPE | PACKACE* | CHIP |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Olc | $\begin{array}{r} \text { ton } \\ \text { MAX } \end{array}$ | $\begin{aligned} & \mathbf{t}_{\text {off }} \\ & \text { MAX } \end{aligned}$ |  |  |  |  |  |
| 10 mA | 30 ns | 50 ns | 15 V | 0.15 V ¢ 10 mA | 2N3576 | TO-18 | P11 |
| 10 mA | 70 ns | 225 ns | 40 V | 0.25 V ¢ 10 mA | 2N3250 | TO-18 | P23 |
| 10 mA | 70 ns | 225 ns | 60 V | 0.25 V ¢ 10 mA | 2N3250A | TO-18 | P23 |
| 10 mA | 70 ns | 250 ns | 40 V | 0.25 V @ 10 mA | 2N3251 | TO-18 | P23 |
| 10 mA | 70 ns | 250 ns | 60 V | 0.25 V @ 10 mA | 2N3251A | TO-18 | P23 |
| 10 mA | 70 ns | 260 ns | 40 V | 0.25 V @ 10 mA | A5T3905 | AAA | P15 |
| 10 mA | 70 ns | 260 ns | 40 V | 0.25 V @ 10 mA | 2N3906 | TO-92 | P15 |
| 10 mA | 70 ns | 300 ns | 40 V | 0.25 V @ 10 mA | A5T3906 | AAA | P15 |
| 10 mA | 70 ns | 300 ns | 40 V | 0.25 V © 10 mA | 2N3906 | TO.92 | P15 |
| 10 mA | 26 typ ns | 82 typ ns | 30 V | 0.4 V @ 50 mA | A5T4125 | AAA | P15 |
| 10 mA | 26 typ ns | 82 typ ns | 30 V | 0.4 V ¢ 50 mA | 2N4125 | TO-92 | P15 |
| 10 mA | 26 typ ns | 82 typ ns | 25 V | 0.4 V @ 50 mA | A5T4126 | AAA | P15 |
| 10 mA | 26 typ ns | 82 typ ns | 25 V | 0.4 V ¢ 50 mA | 2N4126 | TO-92 | P15 |
| 30 mA | 25 ns | 65 ns | 20 V | 0.18V @ 30 mA | 2N3829 | TO-62 | P11 |
| 30 mA | 60 ns | 75 ns | 12 V | 0.2 V @ 30 mA | 2N3012 | T0.18 | P11 |
| 30 mA | 60 ns | 90 ns | 12 V | 0.2 V @ 30 mA | 2N2894 | TO.18 | P11 |
| 150 mA | 35 ns | 255 ns | 40 V | 0.4 V © 150 mA | A5T4402 | AAA | P20 |
| 150 mA | 35 ns | 255 ns | 40 V | 0.4 V @ 150 mA | 2N4402 | TO-92 | P20 |
| 150 mA | 35 ns | 255 ns | 40 V | 0.4 V @ 150 mA | A5T4403 | AAA | P20 |
| 150 mA | 35 ns | 255 ns | 40 V | 0.4 V @ 150 mA | 2N4403 | TO-92 | P20 |
| 150 mA | 45 ns | 140 ns | 40 V | 0.4 V @ 150 mA | TIS112 | AAA | P20 |
| 150 mA | 45 ns | 100 ns | 40 V | 0.4 V @ 150 mA | 2N2904 | TO-5 | P20 |
| 150 mA | 45 ns | 100 ns | 60 V | 0.4 V @ 150 mA | 2N2904A | TO-5 | P20 |
| 150 mA | 45 ns | 100 ns | 40 V | $0.4 \mathrm{~V} @ 150 \mathrm{~mA}$ | Q2T2905 | TO-116 | P20 |
| 150 mA | 45 ns | 100 ns | 40 V | 0.4 V @ 150 mA | 2N2905 | TO.5 | P20 |
| 150 mA | 45 ns | 100 ns | 60 V | 0.4 V @ 150 mA | 2N2905A | TO-5 | P20 |
| 150 mA | 45 ns | 100 ns | 40 V | 0.4 V ¢ 150 mA | 2N2906 | TO-18 | P20 |
| 150 mA | 45 ns | 100 ns | 60 V | $0.4 \mathrm{~V} @ 150 \mathrm{~mA}$ | 2N2906A | TO-18 | P20 |
| 150 mA | 45 ns | 100 ns | 40 V | 0.4 V (150 mA | A5T2907 | AAA | P20 |
| 150 mA | 45 ns | 100 ns | 40 V | 0.4 V @ 150 mA | 2N2907 | TO-18 | P20 |
| 150 mA | 45 ns | 100 ns | 60 V | 0.4 V @ 150 mA | 2N2907A | TO-18 | P20 |
| 150 mA | 50 ns | 110 ns | 40 V | $0.4 \mathrm{~V} @ 150 \mathrm{~mA}$ | 2N3485 | 70-46 | P20 |
| 150 mA | 50 ns | 110 ns | 60 V | 0.4 V @ 150 mA | 2N3485A | TO-46 | P20 |
| 150 mA | 50 ns | 110 ns | 40 V | 0.4 V @ 150 mA | 2N3486 | TO-46 | P20 |
| 150 mA | 50 ns | 110 ns | 60 V | 0.4 V © 150 mA | 2N3486A | TO-46 | P20 |
| 150 mA | 19 typ ns | 80 typ ns | 35 V | 1.5 V @ 150 mA | 2N721 | TO-18 | P20 |
| 150 mA | 19 typ ns | 80 typ ns | 35 V | 1.5 V @ 150 mA | 2N722 | TO-18 | P20 |
| 300 mA | 40 ns | 100 ns | 45 V | 1 V @ 300 mA | 2N3502 | TO-5 | P20 |
| 300 mA | 40 ns | 100 ns | 60 V | 1 V @ 300 mA | 2N3503 | TO-5 | P20 |
| 300 mA | 40 ns | 100 ns | 45 V | 1 V @ 300 mA | A5T3504 | AAA | P20 |
| 300 mA | 40 ns | 100 ns | 60 V | 1 V ¢ 300 mA | A5T3505 | AAA | P20 |
| 300 mA | 40 ns | 100 ns | 45 V | 1 V @ 300 mA | 2N3504 | TO-18 | P20 |
| 300 mA | 40 ns | 100 ns | 60 V | 1 V @ 300 mA | 2N3505 | TO-18 | P20 |
| 300 mA | 40 ns | 100 ns | 45 V | 1 V © 300 mA | A5T3644 | AAA | P20 |
| 300 mA | 40 ns | 100 ns | 60 V | 1 V @ 300 mA | A5T3645 | AAA | P20 |
| 300 mA | 75 ns | 170 ns | 25 V | 1 V @ 300 mA | A5T3638 | AAA | P20 |
| 300 mA | 75 ns | 170 ns | 25 V | 1 V @ 300 mA | A5T3638A | AAA | P20 |
| 500 mA | 40 ns | 90 ns | 40 V | 0.5 V @ 500 mA | 2N3467 | TO.39 | P12 |

[^8]
## transistor selection guides

## P-N-P SWITCHES (Continued)

| SWITCHING TIMES |  |  | $\begin{aligned} & \text { V(BR)CEO } \\ & \text { MIN } \end{aligned}$ | VCe(sat) ${ }^{\text {e }} \mathbf{I C}$ | DEVICE TYPE | PACKAGE* | CHIP |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| - Ic | $\begin{aligned} & t_{\text {on }} \\ & \text { MAX } \end{aligned}$ | $\begin{aligned} & \text { toff }_{\text {off }} \end{aligned}$ |  |  |  |  |  |
| 500 mA | 40 ns | 90 ns | 50 V | $0.6 \mathrm{~V} @ 500 \mathrm{~mA}$ | 2N3468 | TO.39 | P12 |
| 500 mA | 55 ns | 165 ns | 50 V | $0.6 \mathrm{~V} @ 500 \mathrm{~mA}$ | 2N3245 | TO-39 | P12 |
| 500 mA | 50 ns | 185 ns | 40 V | $0.5 \mathrm{~V} @ 500 \mathrm{~mA}$ | 0273244 | TO-116 | P12 |
| 500 mA | 50 ns | 185 ns | 40 V | $0.5 \mathrm{~V} @ 500 \mathrm{~mA}$ | 2N3244 | TO-39 | P12 |
| 500 mA | 100 ns | 400 ns | 60 V | $0.5 \mathrm{~V} @ 500 \mathrm{~mA}$ | A5T4026 | AAA | P16 |
| 500 mA | 100 ns | 400 ns | 60 V | $0.5 \mathrm{~V} @ 500 \mathrm{~mA}$ | 2N4026 | TO-18 | P16 |
| 500 mA | 100 ns | 400 ns | 60 V | $0.5 \mathrm{~V} @ 500 \mathrm{~mA}$ | A5T4028 | AAA | P16 |
| 500 mA | 100 ns | 400 ns | 60 V | $0.5 \mathrm{~V} @ 500 \mathrm{~mA}$ | 2N4028 | TO-18 | P16 |
| 500 mA | 100 ns | 400 ns | 60 V | $0.5 \mathrm{~V} @ 500 \mathrm{~mA}$ | 2N4030 | TO-39 | P16 |
| 500 mA | 100 ns | 400 ns | 60 V | 0.5 V @ 500 mA | 2N4032 | TO.39 | P16 |
| 500 mA | 100 ns | 400 ns | 80 V | 0.5 V @ 500 mA | A5T4027 | AAA | P16 |
| 500 mA | 100 ns | 400 ns | 80 V | $0.5 \mathrm{~V} @ 500 \mathrm{~mA}$ | 2N4027 | TO-18 | P16 |
| 500 mA | 100 ns | 400 ns | 80 V | $0.5 \mathrm{~V} @ 500 \mathrm{~mA}$ | A5T4029 | AAA | P16 |
| 500 mA | 100 ns | 400 ns | 80 V | 0.5 V @ 500 mA | 2N4029 | TO-18 | P16 |
| 500 mA | 100 ns | 400 ns | 80 V | $0.5 \mathrm{~V} @ 500 \mathrm{~mA}$ | 2N4031 | TO. 39 | P16 |
| 500 mA | 100 ns | 400 ns | 80 V | $0.5 \mathrm{~V} @ 500 \mathrm{~mA}$ | 2N4033 | TO-39 | P16 |

## N-P-N CHOPPERS

| Offset voltage <br> Veclofs) <br>  MAX | ON-STATE RESISTANCE <br> Pecion) <br> $r_{\text {ele }}{ }^{\text {§ }}$ | $h_{\text {FE (inv) }}$ MIN | $V_{\text {(BR)EBO }}$ MIN | Device <br> TYPE | POLARITY | PACKAGE* | CHIP |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| \$50 $\mu \mathrm{V}$ @ 1 mA | $840 \Omega$ |  | 18 V | 3N74 | NPN | TO-72 | N12 |
| §100 $\mu \mathrm{V}$ @ 1 mA | §40 $\Omega$ |  | 18 V | 3N75 | NPN | T0-72 | N12 |
| $\$ 50 \mu \mathrm{~V}$ @ 1 mA | \$50 $\Omega$ |  | 12 V | 3N77 | NPN | TO.72 | N12 |
| \$200 $\mu \mathrm{V}$ @ 1 mA | $850 \Omega$ |  | 18 V | 3N76 | NPN | TO-72 | N12 |
| $\$ 100 \mu \mathrm{~V}$ @ 1 mA | §50 $\Omega$ |  | 12 V | 3N78 | NPN | TO-72 | N12 |
| $8200 \mu \mathrm{~V}$ @ 1 mA | $\S 60 \Omega$ |  | 12 V | 3N79 | NPN | T0-72 | N12 |
| 0.7 mV @ 1 mA | $15 \Omega$ | 3 | 18 V | 2N2432A | NPN | TO-18 | N18 |
| 1 mV @1 mA | $20 \Omega$ | 2 | 15 V | 2N2432 | NPN | TO-18 | N18 |
| 1 mV @1 1 mA | $20 \Omega$ | 2 | 15 V | 2N4138 | NPN | TO-46 | N18 |

P-N-P CHOPPERS

| OFFSET VOLTAGE <br> VEC(ofs) <br> VE1E2(ofs) ${ }^{\text {§ }}$ @ $\mathbf{I B}_{B}$ MAX | ON-STATE RESISTANCE $\qquad$ $r_{e 1 e} 2^{8}$ | hFE(inv) MIN | $V_{\text {(BR)EBO }}$ MIN | DEVICE TYPE | POLARITY | PACKAGE* | CHIP |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| $830 \mu \mathrm{~V}$ @ 1 mA | §50 $\Omega$ |  | 50 V | 3N108 | PNP | TO-72 | P13 |
| §30 $\mu \mathrm{V}$ @ 1 mA | $850 \Omega$ |  | 30 V | 3N110 | PNP | T0-72 | P13 |
| $\S 150 \mu \mathrm{~V}$ @ 1 mA | §50 $\Omega$ |  | 50 V | 3N109 | PNP | TO. 72 | P13 |
| § $150 \mu \mathrm{~V}$ @ 1 mA | §50 $\Omega$ |  | 30 V | 3N111 | PNP | T0-72 | P13 |
| 0.6 mV @ 1 mA | $4 \Omega$ | 50 | 15 V | 2N2944A | PNP | TO-46 | P14 |
| 0.6 mV @ 1 mA | $20 \Omega$ | 6 | 15 V | 2N2944 | PNP | TO-46 | P14 |
| $1 \mathrm{mV} @ 1 \mathrm{~mA}$ | $6 \Omega$ | 30 | 25 V | 2N2945A | PNP | TO-46 | P14 |
| 1 mV @ 1 mA | $35 \Omega$ | 4 | 25 V | 2N2945 | PNP | T0-46 | P14 |
| $2 \mathrm{mV} @ 1 \mathrm{~mA}$ | $8 \Omega$ | 20 | 40 V | 2N2946A | PNP | TO-46 | P14 |
| 2 mV @ 1 mA | $45 \Omega$ | 3 | 40 V | 2N2946 | PNP | TO-46 | P14 |

[^9]N-P-N MATCHED DUALS

| (1) ${ }^{\text {c }}$ | MIN-MAX | $\begin{aligned} & \text { hFE1 } \\ & \text { hFE2 } \\ & \text { MIN } \end{aligned}$ | $\Delta V_{B E}$ <br> MAX | $\frac{\Delta V_{B E}}{\Delta T}$ | DEVICE TYPE | POLARITY | PACKAGE* | CHIP |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| $10 \mu \mathrm{~A}$ | 50-300 | 0.9 | 5 mV | $10 \mu \mathrm{~V} /{ }^{\circ} \mathrm{C}$ | 2N2639 | NPN | T0-78 | N11 |
| $10 \mu \mathrm{~A}$ | 50-300 | 0.8 | 10 mV | $20 \mu \mathrm{~V} /{ }^{\circ} \mathrm{C}$ | 2N2640 | NPN | TO-78 | N11 |
| $10 \mu \mathrm{~A}$ | 60-240 | 0.9 | 1.5 mV | $5 \mu \mathrm{~V} /{ }^{\circ} \mathrm{C}$ | 2N2915A | NPN | TO.78 | N11 |
| $10 \mu \mathrm{~A}$ | 60-240 | 0.9 | 1.5 mV | $5 \mu \mathrm{~V} /{ }^{\circ} \mathrm{C}$ | 2N2919A | NPN | T0-78 | N11 |
| $10 \mu \mathrm{~A}$ | 60-240 | 0.9 | 3 mV | $10 \mu \mathrm{~V} /{ }^{\circ} \mathrm{C}$ | 2N2919 | NPN | T0-78 | N11 |
| $10 \mu \mathrm{~A}$ | 60-240 | 0.9 | 3 mV | $10 \mu \mathrm{~V} /{ }^{\circ} \mathrm{C}$ | 2N2974 | NPN | T0.71 | N11 |
| $10 \mu \mathrm{~A}$ | 60-240 | 0.9 | 3 mV | $10 \mu \mathrm{~V} /{ }^{\circ} \mathrm{C}$ | 2N2915 | NPN | T0-78 | N11 |
| $10 \mu \mathrm{~A}$ | 60-240 | 0.9 | 3 mV | $10 \mu \mathrm{~V} /{ }^{\circ} \mathrm{C}$ | 2N2978 | NPN | TO-71 | N11 |
| $10 \mu \mathrm{~A}$ | 60-240 | 0.8 | 5 mV | $20 \mu \mathrm{~V} /{ }^{\circ} \mathrm{C}$ | 2N2917 | NPN | TO-78 | N11 |
| $10 \mu \mathrm{~A}$ | 60-240 | 0.8 | 5 mV | $20 \mu \mathrm{~V} /{ }^{\circ} \mathrm{C}$ | 2N2976 | NPN | TO-71 | N11 |
| $10 \mu \mathrm{~A}$ | 100-300 | 0.9 | 5 mV | $10 \mu \mathrm{~V} /{ }^{\circ} \mathrm{C}$ | 2N2642 | NPN | T0.78 | N11 |
| $10 \mu \mathrm{~A}$ | 100-300 | 0.8 | 10 mV | $20 \mu \mathrm{~V} /{ }^{\circ} \mathrm{C}$ | 2N2643 | NPN | T0.78 | N11 |
| $10 \mu \mathrm{~A}$ | $150-600$ | 0.9 | 1.5 mV | $5 \mu \mathrm{~V} /{ }^{\circ} \mathrm{C}$ | 2N2920A | NPN | T0.78 | N17 |
| $10 \mu \mathrm{~A}$ | 150-600 | 0.9 | 1.5 mV | $5 \mu \mathrm{~V} \rho^{\circ} \mathrm{C}$ | 2N2916A | NPN | TO-78 | N11 |
| $10 \mu \mathrm{~A}$ | 150-600 | 0.9 | 3 mV | $10 \mu \mathrm{VPC}$ | 2N2916 | NPN | TO-78 | N11 |
| $10 \mu \mathrm{~A}$ | 150-600 | 0.9 | 3 mV | $5 \mu \mathrm{~V} /{ }^{\circ} \mathrm{C}$ | 2N3680 | NPN | T0.78 | N11 |
| $10 \mu \mathrm{~A}$ | 150-600 | 0.9 | 3 mV | $10 \mu \mathrm{~V} /{ }^{\circ} \mathrm{C}$ | 2N2920 | NPN | TO-78 | N11 |
| $10 \mu \mathrm{~A}$ | 150-600 | 0.9 | 3 mV | $10 \mu \mathrm{~V} /{ }^{\circ} \mathrm{C}$ | 2N2975 | NPN | T0.71 | N11 |
| $10 \mu \mathrm{~A}$ | 150-600 | 0.9 | 3 mV | $10 \mu \mathrm{~V} /{ }^{\circ} \mathrm{C}$ | 2N2979 | NPN | TO-71 | N11 |
| $10 \mu \mathrm{~A}$ | 150-600 | 0.8 | 5 mV | $20 \mu \mathrm{~V} /{ }^{\circ} \mathrm{C}$ | 2N2918 | NPN | T0-78 | N11 |
| $10 \mu \mathrm{~A}$ | 150-600 | 0.8 | 5 mV | $20 \mu \mathrm{~V} /{ }^{\circ} \mathrm{C}$ | 2N2977 | NPN | TO-71 | N11 |
| $100 \mu \mathrm{~A}$ | 25-150 | 0.9 | 5 mV | $25 \mu \mathrm{~V} /{ }^{\circ} \mathrm{C}$ | 2N2223A | NPN | TO-78 | N23 |
| $100 \mu \mathrm{~A}$ | 25-150 | 0.8 | 15 mV | $25 \mu \mathrm{~V} /{ }^{\circ} \mathrm{C}$ | 2N2223 | NPN | T0.78 | N23 |
| $100 \mu \mathrm{~A}$ | 30-90 | 0.9 | 5 mV | $10 \mu \mathrm{~V} /{ }^{\circ} \mathrm{C}$ | 2N2060 | NPN | TO-78 | N23 |
| 1 mA | 150-600 | 0.9 | 3 mV | $10 \mu \mathrm{~V} /{ }^{\circ} \mathrm{C}$ | 2N2453 | NPN | TO-78 | N11 |

P-N-P MATCHED DUALS

| $h_{\text {FE }}$ |  | $\begin{aligned} & \frac{h_{\text {FE }}}{} \\ & \hline h_{\text {FE2 }} \\ & \text { MIN } \end{aligned}$ | $\Delta V_{B E}$ <br> MAX | $\frac{\Delta V_{B E}}{\Delta_{T}}$ | DEVICE <br> TYPE | POLARITY | PACKAGE* | CHIP |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| $10 \mu \mathrm{~A}$ | 40-300 | 0.9 | 5 mV | $10 \mu \mathrm{~V} /{ }^{\circ} \mathrm{C}$ | 2N3347 | PNP | TO-78 | P19 |
| $10 \mu \mathrm{~A}$ | 40.300 | 0.8 | 10 mV | $20 \mu \mathrm{~V} /{ }^{\circ} \mathrm{C}$ | 2N3348 | PNP | TO-78 | P19 |
| $10 \mu \mathrm{~A}$ | 40-300 | 0.6 | 20 mV | $40 \mu \mathrm{~V}{ }^{\circ} \mathrm{C}$ | 2N3349 | PNP | TO-78 | P19 |
| $10 \mu \mathrm{~A}$ | 100-300 | 0.9 | 5 mV | $10 \mu \mathrm{~V} /{ }^{\circ} \mathrm{C}$ | 2N3350 | PNP | 10.78 | P19 |
| $10 \mu \mathrm{~A}$ | 100-300 | 0.8 | 10 mV | $20 \mu \mathrm{~V} /{ }^{\circ} \mathrm{C}$ | 2N3351 | PNP | TO-78 | P19 |
| $10 \mu \mathrm{~A}$ | 100-300 | 0.6 | 20 mV | $40 \mu \mathrm{~V} /{ }^{\circ} \mathrm{C}$ | 2N3352 | PNP | TO-78 | P19 |
| $100 \mu \mathrm{~A}$ | 20-120 | 0.9 | 5 mV | $10 \mu \mathrm{~V} /{ }^{\circ} \mathrm{C}$ | 2N2802 | PNP | T0-78 | P19 |
| $100 \mu \mathrm{~A}$ | 20-120 | 0.8 | 10 mV | $20 \mu \mathrm{~V} /{ }^{\circ} \mathrm{C}$ | 2N2803 | PNP | TO-78 | P19 |
| $100 \mu \mathrm{~A}$ | 40-120 | 0.9 | 5 mV | $10 \mu \mathrm{~V} /{ }^{\circ} \mathrm{C}$ | 2N2805 | PNP | TO-78 | P19 |
| $100 \mu \mathrm{~A}$ | 40-120 | 0.8 | 10 mV | $20 \mu \mathrm{~V} /{ }^{\circ} \mathrm{C}$ | 2N2806 | PNP | T0-78 | P19 |
| $100 \mu \mathrm{~A}$ | 150-450 | 0.9 | 3 mV | $10 \mu \mathrm{~V} /{ }^{\circ} \mathrm{C}$ | 2N3810 | PNP | T0.78 | P19 |
| $100 \mu \mathrm{~A}$ | 150-450 | 0.8 | 5 mV | $20 \mu \mathrm{~V} /{ }^{\circ} \mathrm{C}$ | 2N3808 | PNP | T0-78 | P19 |
| $100 \mu \mathrm{~A}$ | 300-900 | 0.9 | 3 mV | $10 \mu \mathrm{~V} /{ }^{\circ} \mathrm{V}$ | 2N3811 | PNP | T0.78 | P19 |
| $100 \mu \mathrm{~A}$ | 300-900 | 0.8 | 5 mV | $20 \mu \mathrm{~V} / \mathrm{V}$ | 2N3809 | PNP | TO-78 | P19 |

[^10]N-P-N UNMATCHED DUALS

| ¢ IC | E MIN-MAX | $\begin{gathered} \mathbf{V}_{\text {(BR)CEO }} \\ \text { MIN } \end{gathered}$ | NOISE FIGURE <br> Fef <br> $\bar{F}$ (Noise BW) <br> MAX | DEVICE TYPE | POLARITY | PACKAGE* | CHIP |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| $10 \mu \mathrm{~A}$ | 50-300 | 45 V | $4 \mathrm{~dB}(15.7 \mathrm{kHz})$ | 2N2641 | NPN | T0.78 | N11 |
| $10 \mu \mathrm{~A}$ | 60-240 | 45 V | 4 dB @ 1 kHz | 2N2913 | NPN | T0.78 | N11 |
| $10 \mu \mathrm{~A}$ | 60-240 | 45 V | 4 dB @ 1 kHz | 2N2972 | NPN | T0.71 | N11 |
| $10 \mu \mathrm{~A}$ | 100-300 | 45 V | 4 dB (15.7 kHz) | 2N2644 | NPN | T0-78 | N11 |
| $10 \mu \mathrm{~A}$ | 150-600 | 45 V | 3 dB @ 1 kHz | 2N2914 | NPN | TO-78 | N11 |
| $10 \mu \mathrm{~A}$ | 150-600 | 45 V | 3 dB @ 1 kHz | 2N2973 | NPN | T0.71 | N11 |
| 3 mA | 20. | 15 V | $6 \mathrm{~dB} @ 60 \mathrm{MHz}$ | D2T918 | NPN | TO-78 | N22 |
| 50 mA | 100-300 | 40 V |  | TIS90M | NPN | TO-92 | N24 |
| 50 mA | 100-300 | 40 V |  | TIS92M | NPN | AAA | N24 |
| 150 mA | 40-120 | 30 V |  | D2T2218 | NPN | TO-78 | N24 |
| 150 mA | 40-120 | 40 V |  | D2T22184 | NPN | T0-78 | N24 |
| 150 mA | 40-120 | 40 V | 8 dB @ 1 kHz | 2N4855 | N/P | TO-78 | N24, P20 |
| 150 mA | 100-300 | 30 V |  | D2T2219 | NPN | TO-78 | N24 |
| 150 mA | 100-300 | 40 V |  | D2T2219A | NPN | TO-78 | N24 |
| 150 mA | 100-300 | 40 V | $8 \mathrm{dB@1} \mathrm{kHz}$ | 2N4854 | N/P | TO-78 | N24, P20 |

P-N.P UNMATCHED DUALS

| elc | E MIN-MAX | $\begin{gathered} \text { V(BRICEO } \\ \text { MIN } \end{gathered}$ | NOISE FIGURE <br> Fef <br> $\bar{F}$ (Noise BW) <br> MAX | DEVICE TYPE | POLARITY | PACKAGE* | CHIP |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| $100 \mu \mathrm{~A}$ | 20-120 | 20 V | $4 \mathrm{~dB}(15.7 \mathrm{kHz})$ | 2N2804 | PNP | T0.78 | P19 |
| $100 \mu \mathrm{~A}$ | 40-120 | 20 V | $\overline{4 \mathrm{~dB}}$ (15.7 kHz) | 2N2807 | PNP | T0-78 | P19 |
| 1 mA | 150-450 | 60 V | 3 dB @ 1 kHz | 2N3806 | PNP | T0-78 | P19 |
| 1 mA | 300-900 | 60 V | 1.5 dB @ 1 kHz | 2N3807 | PNP | TO-78 | P19 |
| 50 mA | 100-300 | 40 V |  | TIS91M | PNP | TO-92 | P20 |
| 50 mA | 100-300 | 40 V |  | TIS93M | PNP | AAA | P20 |
| 150 mA | 40-120 | 40 V |  | D2T2904 | PNP | TO-78 | P20 |
| 150 mA | 40-120 | 40 V | 8 dB @ 1 kHz | 2N4855 | N/P | T0-78 | N24, P20 |
| 150 mA | 40-120 | 60 V |  | D2T2904A | PNP | T0.78 | P20 |
| 150 mA | 100-300 | 40 V |  | D2T2905 | PNP | T0-78 | P20 |
| 150 mA | 100-300 | 40 V | 8 dB @ 1 kHz | 2N4854 | N/P | T0-78 | N24, P20 |
| 150 mA | 100-300 | 60 V |  | D2T2905A | PNP | T0-78 | P20 |

N.P-N AND P-N-P QUADS

| POLARITY | $\begin{gathered} V_{\text {(BR)CEO }} \\ \text { MIN } \end{gathered}$ | hfe |  | DEVICE TYPE | PACKAGE* | CHIP |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | - ic | MIN-MAX |  |  |  |
| N-P-N | 30 V | 150 mA | 100-300 | O2T2222 |  | N24 |
| N-P.N | 40 V | 100 mA | 60-200 | 0273725 | IDUAL-IN-LINE | N13 |
| P-N-P | 40 V | 150 mA | 100-300 | 02 T 2905 | (DUAL-IN-LINE | P20 |
| P-N-P | 40 V | 500 mA | 50-150 | 0273244 |  | P12 |

[^11]
## TRANSISTOR SELECTION GUIDES

JFET N-CHANNEL LOW-FREQUENCY, LOW-NOISE AMPLIFIERS

| $\begin{gathered} \text { NOISE FIGURE } \\ \text { F f } \\ \text { MAX } \end{gathered}$ | $\begin{gathered} \text { IDSS } \\ \text { MIN-MAX } \end{gathered}$ | $V_{\text {(BR)GSS }}$ MIN | DEVICE TYPE | CHANNEL POLARITY | PACKAGE* | CHIP |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 1.5 dB @ 10 Hz | $5 \mathrm{~mA}-20 \mathrm{~mA}$ | 20 V | 2N6451 | N | TO-72 | JN55 |
| 1.5 dB @ 10 Hz | $15 \mathrm{~mA}-50 \mathrm{~mA}$ | 20 V | 2N6453 | N | TO-72 | JN55 |
| 2.5 dB @ 100 Hz | $0.8 \mathrm{~mA}-1.6 \mathrm{~mA}$ | 40 V | 2N5359 | N | TO-72 | JN51 |
| 2.5 dB @ 10 Hz | $5 \mathrm{~mA}-20 \mathrm{~mA}$ | 25 V | 2N6452 | N | TO-72 | JN55 |
| 2.5 dB @ 100 Hz | $9 \mathrm{~mA}-18 \mathrm{~mA}$ | 40 V | 2N5364 | N | T0.72 | JN51 |
| $2.5 \mathrm{~dB} @ 10 \mathrm{~Hz}$ | $15 \mathrm{~mA}-50 \mathrm{~mA}$ | 25 V | 2N6454 | N | TO-72 | JN55 |
| 5 dB @ 10 Hz | $0.5 \mathrm{~mA}-2.5 \mathrm{~mA}$ | 50 V | A5T3821 | N | AAA | JN51 |
| 5 dB @ 10 Hz | $0.5 \mathrm{~mA}-2.5 \mathrm{~mA}$ | 50 V | 2N3821 | N | TO-72 | JN51 |
| 5 dB @ 10 Hz | $2 \mathrm{~mA}-10 \mathrm{~mA}$ | 50 V | 2N3822 | N | TO-72 | JN51 |
| 5 dB @ 10 Hz | $2 \mathrm{~mA}-10 \mathrm{~mA}$ | 50 V | A5T3822 | N | AAA | JN51 |
| 4 dB @ 20 Hz | $0.2 \mathrm{~mA}-1 \mathrm{~mA}$ | 50 V | 2N3460 | N | TO-18 | JN51 |
| 4 dB @ 20 Hz | $0.8 \mathrm{~mA}-4 \mathrm{~mA}$ | 50 V | 2N3459 | N | T0.18 | JN51 |
| 6 dB @ 20 Hz | $3 \mathrm{~mA}-15 \mathrm{~mA}$ | 50 V | 2N3458 | N | TO-18 | JN51 |
| 2.5 dB @ 100 Hz | $0.5 \mathrm{~mA}-1 \mathrm{~mA}$ | 40 V | 2N5358 | N | T0.72 | JN51 |
| 2.5 dB @ 100 Hz | $1.5 \mathrm{~mA}-3 \mathrm{~mA}$ | 40 V | 2N5360 | N | TO. 72 | JN51 |
| 2.5 dB @ 100 Hz | $2.5 \mathrm{~mA}-5 \mathrm{~mA}$ | 40 V | 2N5361 | N | TO-72 | JN51 |
| $2.5 \mathrm{~dB} @ 100 \mathrm{~Hz}$ | $4 \mathrm{~mA}-8 \mathrm{~mA}$ | 40 V | 2N5362 | N | TO-72 | JN51 |
| 2.5 dB @ 100 Hz | 7 mA 14 mA | 40 V | 2N5363 | N | TO. 72 | JN51 |
| 2 dB @ 1000 Hz | $2.5 \mathrm{~mA}-5 \mathrm{~mA}$ | 30 V | 2N5953 | N | AAA | JN51 |
| 2 dB @ 1000 Hz | 4 mA 8 mA | 30 V | 2N5952 | N | AAA | JN51 |
| 2 dB @ 1000 Hz | 7 mA 13 mA | 30 V | 2N5951 | N | AAA | JN51 |
| 2 dB @ 1000 Hz | $10 \mathrm{~mA}-15 \mathrm{~mA}$ | 30 V | 2N5950 | N | AAA | JN51 |
| 2 dB @ 1000 Hz | 12 mA -18 mA | 30 V | 2N5949 | N | AAA | JN51 |

JFET P-CHANNEL LOW-FREQUENCY, LOW-NOISE AMPLIFIERS

| $\begin{aligned} & \text { NOISE FIGURE } \\ & \text { F © f } \\ & \text { MAX } \\ & \hline \end{aligned}$ | $\begin{gathered} \text { IDSS } \\ \text { MIN-MAX } \end{gathered}$ | $\begin{gathered} \mathbf{V}_{\text {(BR)GSS }} \\ \text { [V(BR)DGO] } \\ \text { MIN } \end{gathered}$ | DEVICE TYPE | CHANNEL POLARITY | PACKAGE* | CHIP |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 5 dB @ 10 Hz | $1 \mathrm{~mA}-6 \mathrm{~mA}$ | [20 V] | 2N2500 | P | TO-5 | JP71 |
| 5 dB @ 10 Hz | 1 mA 6 mA | 20 V | 2N3332 | P | TO. 72 | JP71 |
| 2.5 dB @ 100 Hz | 1 mA 5 mA | 40 V | 2N5460 | P | TO-92 | JP71 |
| 2.5 dB @ 100 Hz | $1 \mathrm{~mA}-5 \mathrm{~mA}$ | 40 V | A5T5460 | P | AAA | JP71 |
| 2.5 dB @ 100 Hz | $2 \mathrm{~mA}-9 \mathrm{~mA}$ | 40 V | 2N5461 | P | TO-92 | JP71 |
| 2.5 dB @ 100 Hz | $2 \mathrm{~mA}-9 \mathrm{~mA}$ | 40 V | A5T5461 | P | AAA | JP71 |
| 2.5 dB @ 100 Hz | $4 \mathrm{~mA}-16 \mathrm{~mA}$ | 40 V | 2N5462 | P | TO-92 | JP71 |
| 2.5 dB @ 100 Hz | $4 \mathrm{~mA}-16 \mathrm{~mA}$ | 40 V | A5T5462 | P | AAA | JP71 |
| 3 dB @ 1000 Hz | $0.9 \mathrm{~mA}-4.5 \mathrm{~mA}$ | 30 V | 2N2608 | P | TO-18 | JP71 |
| 3 dB @ 1000 Hz | $1 \mathrm{~mA}-3 \mathrm{~mA}$ | [20 V] | 2N2497 | P | TO-5 | JP71 |
| 3 dB @ 1000 Hz | $1 \mathrm{~mA}-3 \mathrm{~mA}$ | 20 V | 2N3329 | P | TO-72 | JP71 |
| 3 dB @ 1000 Hz | 2 mA 6 mA | [20 V] | 2N2498 | P | TO-5 | JP71 |
| 3 dB @ 1000 Hz | $2 \mathrm{~mA}-6 \mathrm{~mA}$ | 20 V | 2N3330 | P | TO.72 | JP71 |
| 3 dB @ 1000 Hz | $2 \mathrm{~mA}-10 \mathrm{~mA}$ | 30 V | 2N2609 | P | TO-18 | JP71 |
| 4 dB @ 1000 Hz | $5 \mathrm{~mA} \cdot 15 \mathrm{~mA}$ | [20 V] | 2N2499 | P | TO-5 | JP71 |
| 4 dB @ 1000 Hz | $5 \mathrm{~mA}-15 \mathrm{~mA}$ | 20 V | 2N3331 | P | TO-72 | JP71 |

[^12]JFET N-CHANNEL GENERAL PURPOSE AMPLIFIERS

| $\begin{aligned} & \text { IDss } \\ & \text { MIN-MAX } \end{aligned}$ | $\begin{aligned} & \text { Wfilef } \\ & \text { MIN-MAX } \end{aligned}$ | $\begin{gathered} \mathbf{V}_{\text {(BR)GSS }} \\ \text { MIN } \end{gathered}$ | DEVICE TYPE | CHANNEL POLARITY | PACKAGE* | CHIP |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| $0.5 \mathrm{~mA}-1 \mathrm{~mA}$ | 1.3 mmho 01 kHz | 40 V | 2N5358 | N | TO-72 | JN51 |
| 0.5 mA 3 mA | $1-4$ mmho © 1 kHz | 30 V | 2N4220 | $N$ | T0-72 | JN51 |
| $0.5 \mathrm{~mA}-3 \mathrm{~mA}$ | 1.4 mmho 1 kHz | 30 V | 2N4220A | $N$ | T0.72 | JN51 |
| $0.8 \mathrm{~mA}-1.6 \mathrm{~mA}$ | 1.2-3.6 mmho 1 ¢ 1 kz | 40 V | 2N5359 | N | T0.72 | JN51 |
| $1.5 \mathrm{~mA}-3 \mathrm{~mA}$ | $1.44 .2 \mathrm{mmho}{ }^{\text {e }} 1 \mathrm{kHz}$ | 40 V | 2N5360 | N | T0.72 | JN51 |
| $2 \mathrm{~mA}-6 \mathrm{~mA}$ | $2-5 \mathrm{mmho}$ - 1 kHz | 30 V | 2N4221 | N | T0-72 | JN51 |
| $2 \mathrm{~mA}-6 \mathrm{~mA}$ | 2-5 mmho 1 kHz | 30 V | 2N4221A | $N$ | T0.72 | JN51 |
| $2 \mathrm{~mA}-10 \mathrm{~mA}$ | $0.6-3 \mathrm{mmho} 1 \mathrm{kHz}$ | 200 V | A5T6450 | N | AAA | JN54 |
| $2 \mathrm{~mA}-10 \mathrm{~mA}$ | $0.5-3 \mathrm{mmho}$ - 1 kHz | 200 V | 2N6450 | N | TO-39 | JN54 |
| $2 \mathrm{~mA}-10 \mathrm{~mA}$ | $0.5-3 \mathrm{mmho}$ - 1 kHz | 300 V | A5T6449 | N | AAA | JN54 |
| $2 \mathrm{~mA}-10 \mathrm{~mA}$ | $0.5-3$ mmho 1 kHz | 300 V | 2N6449 | $N$ | T0.39 | JN54 |
| $2 \mathrm{~mA}-10 \mathrm{~mA}$ | $3-6.5$ mmho e 1 kHz | 50 V | 2N3822 | N | TO-72 | JN51 |
| 2 mA .10 mA | 3.6 .5 mmho 1 kHz | 50 V | A5T3822 | N | AAA | JN51 |
| $2 \mathrm{~mA}-20 \mathrm{~mA}$ | 2-6.5 mmho 1 kHz | 25 V | 2N3819 | N | TO.92 | JN51 |
| 2.5 mA .5 mA | 1.5-4.5 mmho 1 kHz | 40 V | 2N5361 | $N$ | TO-72 | JN51 |
| $2.5 \mathrm{~mA}-5 \mathrm{~mA}$ | $2-6.5$ mmho 01 kHz | 30 V | 2N5953 | $N$ | AAA | JN51 |
| $2.5 \mathrm{~mA}-8 \mathrm{~mA}$ | 4 typ mmho 1 kHz | 25 V | TIS58 | N | TO-92 | JN51 |
| $4 \mathrm{~mA}-8 \mathrm{~mA}$ | 2-5.5 mmho © 1 kHz | 40 V | 2N5362 | $N$ | T0.72 | JN51 |
| $4 \mathrm{~mA}-8 \mathrm{~mA}$ | $2-6.5$ mmho $@ 1 \mathrm{kHz}$ | 30 V | 2N5952 | $N$ | AAA | JN51 |
| $5 \mathrm{~mA}-15 \mathrm{~mA}$ | 2.56 mmho @ 1 kHz | 30 V | 2N4222 | $N$ | T0.72 | JN5 |
| $5 \mathrm{~mA}-15 \mathrm{~mA}$ | $2.5-6 \mathrm{mmho} 91 \mathrm{kHz}$ | 30 V | 2N4222A | N | T0.72 | JN51 |
| $6 \mathrm{~mA}-25 \mathrm{~mA}$ | 4.8 typ mmho © 1 kHz | 25 V | TIS59 | N | T0-92 | JN51 |
| $7 \mathrm{~mA}-13 \mathrm{~mA}$ | 3.5-6.6 mmho © 1 kHz | 30 V | 2N5951 | N | AAA | JN51 |
| $7 \mathrm{~mA}-14 \mathrm{~mA}$ | $2.5-8 \mathrm{mmho}$ © 1 kHz | 40 V | 2N5363 | N | TO-72 | JN51 |
| 9 mA 18 mA | 2.7-6.5 mmho ${ }^{\text {© }} 1 \mathrm{kHz}$ | 40 V | 2N5364 | N | TO-72 | JN51 |
| $10 \mathrm{~mA}-16 \mathrm{~mA}$ | 3.5-7.5 mmho @ 1 kHz | 30 V | 2N5950 | N | AAA | JN51 |
| $12 \mathrm{~mA}-18 \mathrm{~mA}$ | 3.5-7.5 mmho © 1 kHz | 30 V | 2N5949 | $N$ | AAA | JN51 |
| $12 \mathrm{~mA}-24 \mathrm{~mA}$ |  | 50 V | 2N3824 | N | TO.72 | JN51 |
| $12 \mathrm{~mA}-24 \mathrm{~mA}$ |  | 50 V | A5T3824 | N | AAA | JN51 |

JFET P-CHANNEL GENERAL PURPOSE AMPLIFIERS

| $\begin{aligned} & \text { IDss } \\ & \text { MINAMX } \end{aligned}$ | $\begin{aligned} & \text { Mfslef } \\ & \text { MaNHAX } \end{aligned}$ | $\begin{gathered} \text { Vibr)Gss } \\ \text { MIN } \end{gathered}$ | DEVICE TYPE | CHANNEL POLARITY | PACKAGE* | CHIP |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| $0.3 \mathrm{~mA}-15 \mathrm{~mA}$ | 0.8-5 mmho 9 \% 1 kHz | 20 V | 2N3820 | P | TO-92 | JP71 |
| $0.3 \mathrm{~mA}-15 \mathrm{~mA}$ | 1.5 mmho © 1 kHz | 20 V | 2N3909 | P | T0-72 | JP71 |
| 1 mA 5 mA | $1-4$ mmho 1 kHz | 40 V | 2N5460 | P | TO-92 | JP71 |
| $1 \mathrm{~mA}-6 \mathrm{~mA}$ | 14 mmho 1 kHz | 40 V | A5T5460 | P | AAA | JP71 |
| $1 \mathrm{~mA}-15 \mathrm{~mA}$ | 2.2-6 mmho 1 kHz | 20 V | 2N2386A | P | TO-5 | JP71 |
| $1 \mathrm{~mA}-15 \mathrm{~mA}$ | 2.2-6 mmho 1 kHz | 20 V | 2N3909A | P | T0.72 | JP71 |
| $2 \mathrm{~mA}-9 \mathrm{~mA}$ | 1.5-5 mmho © 1 kHz | 40 V | 2N5461 | P | TO-92 | JP71 |
| $2 \mathrm{~mA}-9 \mathrm{~mA}$ | $1.5-5$ mmho 1 kHz | 40 V | A5T5461 | P | AAA | JP71 |
| $4 \mathrm{~mA}-16 \mathrm{~mA}$ | 2.6 mmho - 1 kHz | 40 V | 2N5462 | P | T0.92 | JP71 |
| $4 \mathrm{~mA}-16 \mathrm{~mA}$ | 2.6 mmho $1 . \mathrm{kHz}$ | 40 V | A5T5462 | P | AAA | JP71 |

[^13]
## JFET HIGH-FREQUENCY AMPLIFIERS (N-CHANNEL)

| $\begin{aligned} & C_{\text {MAX }} \\ & \end{aligned}$ | \|yficis MIN | NOISE FIGURE Fef MAX | $\begin{aligned} & \hline \text { GAIN } \\ & \text { G}_{\text {ps }} \text { © } \\ & \text { MIN } \end{aligned}$ | DEVICE TYPE | PACKAGE* | CHIP |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 0.8 pF | 4 mmho (100 MHz | 4 dB 9400 MHz | 10 dB 9400 MHz | 2N4416 | T0-72 | JN53 |
| 0.8 pF | 4 mmho ( 400 MHz | $4 \mathrm{~dB} \bigcirc 400 \mathrm{MHz}$ | 10 dB (9) 400 MHz | 2N4416A | TO.72 | JN53 |
| 1 pF | 2.5 mmho © 400 MHz |  |  | 2N5246 | AAA | JN63 |
| 1 pF | 4 mmho 9 400 MHz | 4 dB ¢ 400 MHz | 10 dB -9 400 MHz | 2N5245 | AAA | JN63 |
| 1 pF | 4 mmho 400 MHz |  |  | 2N5247 | AAA | JN53 |
| 1.2 pF | 5.5 mmho 460 MHz | 3.5 dB 9450 MHz | 15 dB - 450 MHz | 2N6397 | TO.72 |  |
| 1.3 pF | 5 mmho -460 MHz |  |  | 2N6398 | T0.72 |  |
| 2 pF | 0.8 mmho (100 MHz | 2.5 dB -100 Hz |  | 2NE358 | T0.72 | JN51 |
| 2 pF | 0.9 mmho 100 MHz | 2.6 dB -100 Hz |  | 2N6389 | TO-72 | JNE1 |
| 2 pF | 1.4 mmho 100 MHz | 2.5 dB © 100 Hz |  | 2N6360 | T0.72 | JN51 |
| 2 pF | 1.7 mmho 100 MHz | 2.6 dB © 100 Hz |  | 2NE361 | T0.72 | JN51 |
| 2 pF | 1.7 mmho A 200 MHz |  |  | 2N4224 | T0.72 | JN51 |
| 2 pF | 1.8 mmho 100 MHz | 2.6 dB 9100 Hz |  | 2N5362 | TO.72 | JN61 |
| 2 pF | 2.1 mmho © 100 MHz | 2.6 dB ¢ 100 Hz |  | 2N5363 | TO-72 | JNE1 |
| 2 pF | 2.2 mmho 100 MHz | 2.6 dB ¢ 100 Hz |  | 2N5364 | TO.72 | JN51 |
| 2 pF | 2.7 mmho © 200 MHz | $5 \mathrm{~dB} \oplus 200 \mathrm{MHz}$ | 10 dB (9) 200 MHz | 2N4223 | TO.72 | JN51 |
| 2 pF | 3 mmho - 200 MHz |  |  | 2N5248 | TO-92 | JN51 |
| 2 pF | 3.2 mmho © 200 MHz | 2.5 dB ¢ 100 MHz |  | 2N3823 | T0.72 | JN54 |
| 2 pF | 3.2 mmho © 200 MHz | 2.5 dB @ 100 MHz |  | A5T3823 | AAA | JN51 |

IGFET HIGH-FREQUENCY AMPLIFIERS (N-CHANNEL, DEPLETION-TYPE)

| $C_{\text {ress }}$ MAX | Vislef MIN-MAX | $\begin{gathered} \text { NOISE FIGURE } \\ \text { F F f } \\ \text { MAX } \\ \hline \end{gathered}$ | $\begin{aligned} & \hline \text { GAIN } \\ & \mathbf{G}_{\mathrm{ps}} \boldsymbol{1} \mathrm{f} \\ & \text { MIN } \\ & \hline \end{aligned}$ | DEVICE TYPE | PACKACE* | CHIP |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 0.03 pF | 7.17 mmho 1 kHz | 4 dB @ 45 MHz | 25 dB ¢ 46 MHz | 3N206 | TO-72 | MN81 |
| 0.03 pF | 7.15 mmho © 1 kHz | 6 dB @ 45 MHz | 20 dB @ 45 MHz | 3N203 | T0.72 | MN81 |
| 0.03 pF | $8-20$ mmho 1 kHz | 4.5 dB © 200 MHz | 15 dB @ 200 MHz | 3N201 | TO-72 | MN81 |
| 0.03 pF | $8-20$ mmho @ 1 kHz |  | 15 dB ¢ 200 MHz | 3N202 | T0.72 | MN81 |
| 0.03 pF | $10-22$ mmho @ 1 kHz | $\mathbf{5}$ dB © 450 MHz | 14 dB 9450 MHz | 3N204 | T0.72 | MN81 |
| 0.03 pF | 10.22 mmho - 1 kHz |  | 17 dB (3) 200 MHz | 3N205 | T0-72 | MN81 |
| 0.05 pF | 15.35 mmho 1 kHz | 4 dB @ 45 MHz | 27 dB @ 45 MHz | 3N213 | T0-72 | MN85 |
| 0.06 pF | 17-40 mmho © 1 kHz | 3.5 dB ¢ 200 MHz | 24 dB ¢ 200 MHz | 3N211 | T0.72 | MN85 |
| 0.05 pF | 17-40 mmho 1 kHz |  | 21 dB (4) 200 MHz | 3N212 | T0-72 | MN85 |
| 0.35 pF | 5.12 mmho @ 1 kHz | 5 dB ¢ 200 MHz | 13.5 dB @ 200 MHz | 3N128 | T0-72 | MN82 |

[^14]JFET N-CHANNEL SWITCHES AND CHOPPERS

| $\begin{aligned} & r_{\text {dsfon) }} \\ & \text { MAX } \end{aligned}$ | Vas ioff) MIN-MAX | $\mathbf{V}_{\text {(br) }}$ (fiss MIN | Ioss MIN-MAX | DEvice TYPE | Packace* | CHIP |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| $25 \Omega$ | 410 V | 30 V | $50-\mathrm{mA}$ | Tis73 | AAA | JN52 |
| $25 \Omega$ | 4.10 V | 30 V | 50- mA | 2N4859 | T0-18 | JN52 |
| $25 \Omega$ | 4.10 V | 30 V | $50-\mathrm{mA}$ | 2N4859A | T0.18 | JN52 |
| $25 \Omega$ | $4-10 \mathrm{~V}$ | 40 V | 50- mA | 2N4856 | T0.18 | JN52 |
| $25 \Omega$ | 4.10 V | 40 V | $50-\mathrm{mA}$ | 2N4856A | T0.18 | JN62 |
| $30 \Omega$ | $4-10 \mathrm{~V}$ | 40 V | 50-150 mA | 2N3970 | T0.18 | JN52 |
| $30 \Omega$ | $4-10 \mathrm{~V}$ | 40 V | 50-150 mA | 2N4391 | T0-18 | JN52 |
| $30 \Omega$ | 6.10 V | 40 V | $30 . \mathrm{mA}$ | 2N4091 | T0.18 | JN52 |
| $40 \Omega$ | 2-6 V | 30 V | 20.100 mA | TIS74 | AAA | JN62 |
| $40 \Omega$ | 2.6 V | 30 V | 20-100 mA | 2N4860 | T0-18 | JN52 |
| $40 \Omega$ | 2.6 V | 30 V | 20.100 mA | 2N4860A | T0-18 | JN52 |
| $40 \Omega$ | 2.6 V | 40 V | 20.100 mA | 2N4857A | T0-18 | JN52 |
| $40 \Omega$ | 2-6V | 40 V | 20-100 mA | 2N4857 | T0-18 | JN52 |
| $50 \Omega$ | 2.7 V | 40 V | 15- mA | 2N4092 | T0-18 | JN52 |
| $60 \Omega$ | 0.8-4 V | 30 V | $8-80 \mathrm{~mA}$ | TIS75 | AAA | JN62 |
| $60 \Omega$ | 0.84 V | 30 V | 8-80 mA | 2N4861 | TO-18 | JN62 |
| $60 \Omega$ | 0.84 V | 30 V | 8.80 mA | 2N4861A | T0-18 | JN52 |
| $60 \Omega$ | 0.8-4 V | 40 V | 8.80 mA | 2N4858 | T0.18 | JN52 |
| $60 \Omega$ | 0.8-4 V | 40 V | 8-80 mA | 2N4858A | T0-18 | JN52 |
| $60 \Omega$ | 2.5 V | 40 V | 25-75 mA | 2N3971 | T0-18 | JN52 |
| $60 \Omega$ | 2-5 V | 40 V | 25-75 mA | 2N4392 | T0.18 | JN52 |
| $80 \Omega$ | 1.5 V | 40 V | 8 - mA | 2N4093 | T0-18 | JN52 |
| $100 \Omega$ | 0.5-3 V | 40 V | 5.30 mA | 2N3972 | T0-18 | JN52 |
| $100 \Omega$ | 0.5-3 V | 40 V | 5-30 mA | 2N4393 | T0-18 | JN52 |
| $100 \Omega$ | 2-6 V | 40 V | 10.60 mA | 2N5549 | TO-18 | JN52 |
| $200 \Omega$ | 3-7 V | 30 V | 12.18 mA | 2N5949 | AAA | JN51 |
| $210 \Omega$ | 2.5-6 V | 30 V | 10.15 mA | 2N5950 | AAA | JN51 |
| $220 \Omega$ | 4.6 V | 30 V | 2. mA | 2N3966 | T0.72 | JN51 |
| $250 \Omega$ |  | 50 V | 12-24 mA | 2N3824 | TO-72 | JN51 |
| $250 \Omega$ |  | 50 V | 12.24 mA | A5T3824 | AAA | JN51 |

JFET P-CHANNEL SWITCHES AND CHOPPERS

| rds(on) MAX | $V_{\text {gS }}($ off $)$ MIN-MAX | $\begin{gathered} \hline \mathbf{V}_{\text {(BR)GSS }} \\ \text { MIN } \\ \hline \end{gathered}$ | $\begin{aligned} & \text { IDSs } \\ & \text { MIN-MAX } \end{aligned}$ | $\begin{gathered} \hline \text { DEVICE } \\ \text { TYPE } \\ \hline \end{gathered}$ | PACKAGE* | CHIP |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| $300 \Omega$ | 1-5.5 V | 25 V | 2- mA | 2N3994 | T0.72 | JP72 |
| $300 \Omega$ | 1-5.5 V | 25 V | 2- mA | 2N3994A | T0.72 | JP72 |
| $400 \Omega$ | $1.8-9 \mathrm{~V}$ | 40 V | 4.16 mA | 2N5462 | т0.92 | JP71 |
| $400 \Omega$ | $1.8-9 \mathrm{~V}$ | 40 V | 4-16 mA | A5T5462 | AAA | JP71 |
| $800 \Omega$ | 1-7.5 V | 40 V | $2-9 \mathrm{~mA}$ | 2N5461 | T0.92 | JP71 |
| $800 \Omega$ | 1.7 .5 V | 40 V | 2.9 mA | A5T5461 | AAA | JP71 |

[^15]TRANSISTOR SELECTION GUIDES

IGFET NCHANNEL SWITCHES AND CHOPPERS

| $r_{\text {ds }}(o n)$ MAX | $\begin{aligned} & V_{\text {GS }(t h)} \\ & \text { MIN-MAX } \end{aligned}$ | $\mathbf{V}$ (BR)DSS MIN | ID(on) MIN-MAX |  | DEVICE TYPE | ENH/DEPL | PACKAEE* | CHIP |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| $20 \Omega$ |  | 20 V | 50 | mA | 3N214 | D | T0.72 | MN84 |
| $35 \Omega$ |  | 20 V | $50-$ | mA | 3N215 | D | TO-72 | MN84 |
| $50 \Omega$ |  | 20 V | 50 | $m A$ | 3N216 | D | T0.72 | MN84 |
| $70 \Omega$ |  | 20 V | 50. | $m A$ | 3N217 | D | T0.72 | MN84 |
| $200 \Omega$ | 0.6-1.5 V | 25 V | 10- | mA | 3N169 | E | TO.72 | MN83 |
| $200 \Omega$ | 1-2 V | 25 V | 10- | $m A$ | 3N170 | E | T0-72 | MN83 |
| $200 \Omega$ | 1.5-3 V | 25 V | 10- | $m A$ | 3N171 | E | T0.72 | MN83 |
| $300 \Omega$ |  | 20 V | $5-$ | mA | 3N153 | D | TO. 72 | MN82 |

IGFET P-CHANNEL SWITCHES AND CHOPPERS

| $\begin{aligned} & \mathbf{r}_{\text {dsax }} \text { (on) } \\ & \text { MAX } \end{aligned}$ | $\begin{aligned} & \mathbf{V G S}(t h) \\ & \text { MINMAX } \end{aligned}$ | $V_{(B R) D S S}$ <br> MIN | ID(on) MINMAX | DEvice TYPE | ENH/DEPL | PACKAGE* | CHIP |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 60 typ $\Omega$ | 1.5-5 V | 25 V | 40-120 mA | 3N160 | E | T0.72 | MP92 |
| 60 typ $\Omega$ | 1.5-5 V | 25 V | 40-120 mA | 3N161 | E | T0.72 | MP92 |
| $250 \Omega$ | 2-5 V | 40 V | 5-30 mA | 3N163 | E | T0.72 | MP91 |
| $300 \Omega$ | 2-5 V | 30 V | 3-30 mA | 3N164 | E | T0.72 | MP91 |
| $300 \Omega$ | 1.5-3.2 V | 50 V | 5- mA | 3N165A | E | TO-72 | MP91 |
| $300 \Omega$ | 3-5 V | 50 V | 5. mA | 3N156A | E | T0.72 | MP91 |
| $600 \Omega$ | 1.5-3.2 V | 50 V | 5- mA | 3N155 | E | TO-72 | MP91 |
| $600 \Omega$ | 3-5 V | 50 V | 5- mA | 3N166 | E | T0.72 | MP91 |
| $1000 \Omega$ | $2-6 \mathrm{~V}$ | 30 V | 3-12 mA | 3N174 | E | TO.72 | MP93 |

JFET DUALS (N-CHANNEL)

| IDSS MIN-MAX | $\begin{aligned} & \text { IDSS1 } \\ & \text { IDSS2 } \\ & \text { MIN } \end{aligned}$ | $\begin{aligned} & \frac{\left\|V_{\mathrm{fs}}\right\|}{\left\|\mathrm{ffs}_{\mathrm{s}}\right\|} \\ & \text { MIN } \end{aligned}$ | $\Delta V \mathbf{G S}$ MAX | device TYPE | PACKAGE* | CHIP |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| $0.5-8 \mathrm{~mA}$ | 0.95 | 0.97 | 5 mV | 2N5545 | TO-71 | JN51 |
| 0.6-8 mA | 0.95 | 0.95 | 5 mV | 2N5045 | T0.71 | JN51 |
| 0.5-8 mA | 0.95 | 0.95 | 5 mV | TIS25 | T0.78 | JN51 |
| 0.5-8 mA | 0.9 | 0.95 | 10 mV | 2N5546 | TO.71 | JN51 |
| 0.6-8 mA | 0.9 | 0.9 | 10 mV | TIS69 | 2 T0.92 | JN61 |
| 0.5-8 mA | 0.9 | 0.9 | 10 mV | 2N5046 | T0.71 | JN51 |
| 0.5-8 mA | 0.9 | 0.9 | 15 mV | 2N5547 | T0.71 | JN51 |
| $0.5-8 \mathrm{~mA}$ | 0.9 | 0.9 | 10 mV | TIS28 | T0.78 | JN54 |
| 0.5-8 mA | 0.8 | 0.8 | 15 mV | 2N5047 | T0-71 | JN51 |
| $0.5-8 \mathrm{~mA}$ | 0.8 | 0.8 | 15 mV | TiS27 | T0-78 | JN61 |
| 0.6-8 mA | 0.8 | 0.8 | 15 mV | TIS70 | 2 T0.92 | JN51 |

IGFET DUALS (P-CHANNEL, ENHANCEMENT-TYPE)

| rdsion) <br> MAX | VGS(th) <br> MIN/MAX | ID(on) <br> MIN | DEVICE <br> TYPE | PACKAGE* | CHIP |
| :---: | :---: | :---: | :---: | :---: | :---: |
| $400 \Omega$ | $-3 /-6 \mathrm{~V}$ | -1.5 mA | 3N207 | TO-76 | MP94 |
| $400 \Omega$ | $-3 /-6 \mathrm{~V}$ | -1.5 mA | 3N208 | TO-76 | MP94 |

[^16]
## UNIJUNCTION, CONVENTIONAL

| $\frac{\eta}{\text { MIN-MAX }}$ | $I_{p}$ | $\begin{gathered} \text { IV } \\ \text { MIN } \end{gathered}$ | rBB MIN-MAX | DEVICE TYPE | PACKAGE* | CHIP |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 0.47-0.62 | $6 \mu \mathrm{~A}$ | 8 mA | $4.7-9.1 \mathrm{k} \Omega$ | 2N1671B | U |  |
| 0.47-0.62 | $25 \mu \mathrm{~A}$ | 8 mA | 4.7-9.1 k | 2N1671 | U |  |
| 0.47-0.62 | $25 \mu \mathrm{~A}$ | 8 mA | 4.7-9.1 k $\Omega$ | 2N1671A | U | BAR |
| 0.47-0.80 | $25 \mu \mathrm{~A}$ | 8 mA | 4-12 k $\Omega$ | 2N2160 | $\cup$ |  |
| 0.51-0.62 | $6 \mu \mathrm{~A}$ | 8 mA | $4.7-6.8 \mathrm{k} \Omega$ | 2N489B | U | BAR |
| 0.51-0.62 | $6 \mu \mathrm{~A}$ | 8 mA | $6.2-9.1 \mathrm{k} \Omega$ | 2N490B | U | BAR |
| 0.51-0.62 | $12 \mu \mathrm{~A}$ | 8 mA | $4.7-6.8 \mathrm{k} \Omega$ | 2N489 | U | BAR |
| 0.51-0.62 | $12 \mu \mathrm{~A}$ | 8 mA | $4.7-6.8 \mathrm{k} \Omega$ | 2N489A | U | BAR |
| 0.51-0.62 | $12 \mu \mathrm{~A}$ | 8 mA | $6.2-9.1 \mathrm{k} \Omega$ | 2N490 | U | R |
| 0.51-0.62 | $12 \mu \mathrm{~A}$ | 8 mA | 6.2-9.1 k | 2N490A | U |  |
| 0.51-0.69 | $2 \mu \mathrm{~A}$ | 4 mA | $4-9.1 \mathrm{k} \Omega$ | 2N4892 | AAA | U42 |
| 0.51-0.69 | $2 \mu \mathrm{~A}$ | 4 mA | $4-9.1 \mathrm{k} \Omega$ | 2N4947 | 000 | U42 |
| 0.55-0.82 | $2 \mu \mathrm{~A}$ | 2 mA | 4-12 k $\Omega$ | 2N4893 | AAA | $\mathbf{4 2}$ |
| 0.55-0.82 | $2 \mu \mathrm{~A}$ | 2 mA | $4-12 \mathrm{k} \Omega$ | 2N4948 | 000 | U42 |
| 0.55-0.82 | $5 \mu A$ | 2 mA | 4-9.1 ks | TIS43 | TO-92 | U42 |
| 0.55-0.82 | $5 \mu \mathrm{~A}$ | 2 mA | $4.9 .1 \mathrm{k} \Omega$ | 2N4891 | AAA | U42 |
| 0.56-0.68 | $6 \mu A$ | 8 mA | $4.7-6.8 \mathrm{k} \Omega$ | 2N491B | U | BAR |
| 0.56-0.68 | $6 \mu \mathrm{~A}$ | 8 mA | $6.2-9.1 \mathrm{k} \Omega$ | 2N492B | U | BAR |
| 0.56-0.68 | $12 \mu \mathrm{~A}$ | 8 mA | $4.7-6.8 \mathrm{k} \Omega$ | 2N491 | U | R |
| 0.56-0.68 | $12 \mu \mathrm{~A}$ | 8 mA | $4.7-6.8 \mathrm{kS}$ | 2N491A | U | BAR |
| 0.56-0.68 | $12 \mu \mathrm{~A}$ | 8 mA | $6.2-9.1 \mathrm{k} \Omega$ | 2 N 492 | U |  |
| 0.56-0.68 | $12 \mu \mathrm{~A}$ | 8 mA | $6.2-9.1 \mathrm{k} \Omega$ | 2N492A | U | BAR |
| 0.56-0.75 | $5 \mu \mathrm{~A}$ | 4 mA | 4.7-9.1 k | 2N2646 | 000 | U42 |
| 0.56-0.75 | $2 \mu \mathrm{~A}$ | 2 mA | 4.7-9.1 k | 2N4851 | 000 | U42 |
| 0.62-0.75 | $6 \mu \mathrm{~A}$ | 8 mA | $4.7-6.8 \mathrm{k} \Omega$ | 2N493B | U | BAR |
| 0.62-0.75 | $12 \mu \mathrm{~A}$ | 8 mA | $4.7-6.8 \mathrm{k} \Omega$ | 2N493 | U | BAR |
| 0.62-0.75 | $12 \mu \mathrm{~A}$ | 8 mA | $4.7 .6 .8 \mathrm{k} \Omega$ | 2N493A | U | BAR |
| 0.68-0.82 | $2 \mu \mathrm{~A}$ | 8 mA | $4.7-9.1 \mathrm{k} \Omega$ | 2N2647 | 000 | U42 |
| 0.68-0.82 | $2 \mu \mathrm{~A}$ | 1 mA | 4-8 k $\Omega$ | 2N3980 | 000 | U42 |
| 0.70-0.85 | $2 \mu \mathrm{~A}$ | 4 mA | $4.7-9.1 \mathrm{k} \Omega$ | 2N4852 | 000 | 442 |
| 0.70-0.85 | $0.4 \mu \mathrm{~A}$ | 6 mA | $4.7-9.1 \mathrm{k} \Omega$ | 2N4853 | 000 | U42 |
| 0.74-0.86 | $1 \mu \mathrm{~A}$ | 2 mA | 4-12 k $\Omega$ | 2N4894 | AAA | 442 |
| 0.74-0.86 | $1 \mu \mathrm{~A}$ | 2 mA | 4-12 k $\Omega$ | 2N4949 | 000 | U42 |

UNIJUNCTION, PROGRAMMABLE

| $\mathbf{I P}_{\mathbf{p}}{ }^{(1)} \mathbf{R}_{\mathbf{G}}$ MAX | IV $\mathbf{R e}_{G}$ MIN | DEVICE TYPE | PACKAGE* | CHIP |
| :---: | :---: | :---: | :---: | :---: |
| $1 \mu \mathrm{~A} @ 10 \mathrm{k} \Omega$ | $25 \mu \mathrm{~A} @ 10 \mathrm{k}$ ת | A7T6028 | TO-92 | $U 4$ |
| $1 \mu \mathrm{~A} @ 10 \mathrm{k} \Omega$ | $50 \mu \mathrm{~A}$ ¢ $10 \mathrm{k} \Omega$ | 2N6118 | TO-18 | U41 |
| $1 \mu \mathrm{~A} @ 10 \mathrm{k} \Omega$ | $50 \mu \mathrm{~A}$ @ $10 \mathrm{k} \Omega$ | A5T6118 | AAA | 441 |
| $2 \mu \mathrm{~A}$ @ $10 \mathrm{k} \Omega$ | $50 \mu \mathrm{~A}$ @ $10 \mathrm{k} \Omega$ | 2N6117 | TO-18 | U41 |
| $2 \mu \mathrm{~A} @ 10 \mathrm{k} \Omega$ | $50 \mu \mathrm{~A} @ 10 \mathrm{k} \Omega$ | A5T6117 | AAA | U41 |
| $\cdot 5 \mu \mathrm{~A} @ 10 \mathrm{k} \Omega$ | $70 \mu \mathrm{~A} @ 10 \mathrm{k} \Omega$ | A7T6027 | TO-92 | U41 |
| $5 \mu \mathrm{~A} @ 10 \mathrm{k} \Omega$ | $70 \mu \mathrm{~A} @ 10 \mathrm{k} \Omega$ | 2N6116 | TO-18 | U41 |
| $5 \mu \mathrm{~A} @ 10 \mathrm{k} \Omega$ | $70 \mu \mathrm{~A} @ 10 \mathrm{k} \Omega$ | A5T6116 | AAA | 441 |

[^17]TRANSISTOR SELECTION GUIDES


## Transistor Interchangeability

## TRANSISTOR INTERCHANGEABILITY

These lists of low-power (generally one watt or less of power dissipation in free-air) transistors are designed to assist the design engineer in determining the recommended TI replacement when only the device type number is known. Also included is a summary of the significant ratings and electrical characteristics of the referenced types.

These lists are extensive (approximately 4600 entries) but not definitive. An attempt was made to include all current and recently obsolete domestic types, both JEDEC registered and nonregistered. Undoubtedly there are some inadvertent omissions. Purposely amitted are the European PROELECTRON types, Japanese 2S types, and "hobbyist" types.

Careful engineering judgement has been used to provide the recommended TI replacement based on the specifications alone; final application might dictate another choice. Equally careful judgement should be used in selecting a replacement except where the recommended replacement type number coincides with the referenced type.

In most cases, the recommended replacement has the same general package as the referenced type; that is, plastic for plastic and metal for metal. For plastic-encapsulated devices, the "recommended" replacement has the same or similar terminal assignments as the referenced type although this terminal assignment may not be truly preferred. The user may consider this.

## ORGANIZATION

These interchangeability lists are divided into six broad classes as follows:
Master List of Registered Types ..... 3-1
Master List of Nonregistered Types ..... 3.63
Registered Field-Effect Transistors ..... 3.92
Nonregistered Field-Effect Transistors ..... 3-104
Registered Unijunction Transistors ..... 3-115
Nonregistered Unijunction Transistors ..... 3-117

The Field-Effect Transistor and Unijunction Transistor lists are subsets of the appropriate Master List, either registered or nonregistered.

Every effort has been made to ensure the accuracy of each entry. However, TI makes no warranty as to the information furnished and the user assumes all risk in the use thereof.

## KEY TO MANUFACTURER CODES

CR - Crystallonics Division, Teledyne Incorporated
F - Fairchild Semiconductor Corporation
GE - General Electric Company
GI - General Instrument Corporation
IN - Intersil, Incorporated

M - Motorola Semiconductor Products
NA - National Semiconductor Corporation
RC - RCA Corporation
SI - Siliconix, Incorporated
TI - Texas Instruments Incorporated

# TRANSISTOR INTERCHANGEABILITY MASTER LIST OF REGISTERED TYPES 

| TYF NUME |  | CLASSIFICATION | TImemacementOR MEARESTEOUNALENT | MAXIMUM RATMNOS |  |  | ELCTILCAL CHARACTELSIICS |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  | $\begin{gathered} \mathrm{T}_{\mathrm{A}}=25^{\circ} \mathrm{C} \\ { }^{\mathrm{T}} \mathrm{C}=25^{\circ} \mathrm{C} \\ (\mathrm{~mW}) \end{gathered}$ | VCBO <br> (V) | $V_{\text {ceo }}$ <br> (V) | hTE    <br> MNN    <br> MAX ic   |  |  |  |
| $\left\lvert\, \begin{aligned} & 2 \mathrm{~N} 117 \\ & 2 \mathrm{~N} 118 \\ & 2 \mathrm{~N} 118 \mathrm{~A} \\ & 2 \mathrm{~N} 119 \end{aligned}\right.$ | $\begin{aligned} & \text { NPN } \\ & \text { NPN } \\ & \text { NPN } \\ & \text { NPN } \end{aligned}$ | $\begin{aligned} & G P \\ & G P \\ & G P \\ & G P \end{aligned}$ | $\begin{aligned} & \text { 2N117 } \\ & \text { 2N118 } \\ & \text { 2N118A } \\ & \text { 2N119 } \end{aligned}$ | $\begin{aligned} & 150 \\ & 150 \\ & 150 \\ & 150 \end{aligned}$ | $\begin{aligned} & 30 \\ & 30 \\ & 45 \\ & 30 \end{aligned}$ |  |  |  |  |  |
| $\begin{aligned} & 2 \mathrm{~N} 120 \\ & 2 \mathrm{~N} 160 \\ & 2 \mathrm{~N} 160 \mathrm{~A} \\ & 2 \mathrm{~N} 161 \end{aligned}$ | NPN <br> NPN <br> NTN <br> NPN | $\begin{aligned} & G P \\ & G P \\ & G P \\ & G P \end{aligned}$ | $\begin{aligned} & \text { 2N120 } \\ & \text { 2N2217 } \\ & \text { 2N2217 } \\ & \text { 2N2217 } \end{aligned}$ | $\begin{aligned} & 150 \\ & 150 \\ & 150 \\ & 150 \end{aligned}$ | $\begin{aligned} & 45 \\ & 40 \\ & 40 \\ & 40 \end{aligned}$ |  | $\begin{gathered} 76-333 \\ 9-19 \\ 9-19 \\ 19-39 \end{gathered}$ |  |  |  |
| $\begin{aligned} & 2 \mathrm{~N} 161 \mathrm{~A} \\ & 2 \mathrm{~N} 162 \\ & 2 \mathrm{~N} 162 \mathrm{~A} \\ & 2 \mathrm{~N} 163 \end{aligned}$ | $\begin{aligned} & \text { NPN } \\ & \text { NPN } \\ & \text { NPN } \\ & \text { NPN } \end{aligned}$ |  | $\begin{aligned} & \text { 2N2217 } \\ & \text { 2N2218 } \\ & \text { 2N2218 } \\ & \text { 2N2218 } \end{aligned}$ | $\begin{aligned} & 150 \\ & 150 \\ & 150 \\ & 150 \end{aligned}$ | $\begin{array}{r} 40 \\ 40 \\ 40 \\ 40 \end{array}$ |  | $\begin{aligned} & 19-39 \\ & 19-199 \\ & 19-199 \\ & 39-199 \end{aligned}$ |  |  |  |
| $\begin{aligned} & \text { 2N163A } \\ & \text { 2N243 } \\ & 2 N 244 \\ & 2 N 258 \end{aligned}$ | NPN <br> NPN <br> NPN <br> PNP | $\begin{aligned} & \text { GP } \\ & \text { GP } \\ & \text { GP } \\ & \text { GP } \end{aligned}$ | $\begin{aligned} & \text { 2N2218 } \\ & \text { 2N243 } \\ & \text { 2N244 } \\ & \text { 2N2906 } \end{aligned}$ | $\begin{aligned} & 150 \\ & 750 \\ & 750 \\ & 250 \end{aligned}$ | $\begin{aligned} & 40 \\ & 60 \\ & 60 \\ & 30 \end{aligned}$ | 30 | 39-199 |  | 15 |  |
| $\begin{aligned} & \text { 2N259 } \\ & \text { 2N260 } \\ & \text { 2N260A } \\ & \text { 2N261 } \end{aligned}$ | $\begin{aligned} & P N P \\ & P N P \\ & P N P \\ & P N P \end{aligned}$ | $\begin{aligned} & G P \\ & G P \\ & G P \\ & G P \end{aligned}$ | $\begin{aligned} & \text { 2N2906 } \\ & \text { 2N2906 } \\ & \text { 2N2906 } \\ & \text { 2N2906 } \end{aligned}$ | $\begin{aligned} & 250 \\ & 200 \\ & 200 \\ & 200 \end{aligned}$ | $\begin{aligned} & 30 \\ & 10 \\ & 30 \\ & 75 \end{aligned}$ | $30$ |  |  | 32 |  |
| $\begin{array}{\|l\|} \text { 2N262 } \\ \text { 2N262A } \\ \text { 2N263 } \\ \text { 2N264 } \end{array}$ | PNP <br> PNP <br> NPN <br> NPN | $\begin{aligned} & G P \\ & G P \\ & G P \\ & G P \end{aligned}$ | $\begin{aligned} & \text { 2N2906 } \\ & \text { 2N2906 } \\ & \text { 2N2218 } \\ & \text { 2N2217 } \end{aligned}$ | $\begin{aligned} & 200 \\ & 200 \\ & 150 \\ & 150 \end{aligned}$ | $\begin{aligned} & 10 \\ & 30 \\ & 45 \\ & 45 \end{aligned}$ | $\begin{aligned} & 30 \\ & 30 \end{aligned}$ | $\begin{array}{ll} 45-150 & 10 \\ 20-55 & 10 \end{array}$ | $\begin{array}{ll} 1.5 & 10 \\ 1.5 & 10 \end{array}$ | 39 |  |
| $\begin{aligned} & \text { 2N327 } \\ & \text { 2N327A } \\ & \text { 2N327: } \\ & \text { 2N328 } \end{aligned}$ | $\begin{array}{\|l\|} \hline \text { PNP } \\ \text { PNP } \\ \text { PNP } \\ \text { PNP } \end{array}$ | GP <br> GP <br> GP <br> GP | $\begin{aligned} & \text { 2N2904 } \\ & \text { 2N2904 } \\ & \text { 2N2904 } \\ & \text { 2N2904 } \end{aligned}$ | $\begin{aligned} & 350 \\ & 385 \\ & 385 \\ & 350 \end{aligned}$ | $\begin{aligned} & 50 \\ & 50 \\ & 50 \\ & 35 \end{aligned}$ | 40 | $\begin{array}{ll} 9-22 & 3 \\ 9-22 & 3 \end{array}$ | $\begin{array}{ll} .3 & 5 \\ .3 & 5 \end{array}$ | 18 |  |
| $\begin{aligned} & 2 \mathrm{~N} 328 \mathrm{~A} \\ & 2 \mathrm{~N} 3288 \\ & 2 \mathrm{~N} 329 \\ & 2 \mathrm{~N} 329 \mathrm{~A} \end{aligned}$ | PNP <br> PNP <br> PNP <br> PNP | GP <br> GP <br> GP <br> GP | 2N2904 <br> 2N2904 <br> 2N2904 <br> 2N2904 | $\begin{aligned} & 385 \\ & 385 \\ & 350 \\ & 385 \end{aligned}$ | $\begin{aligned} & 50 \\ & 50 \\ & 30 \\ & 50 \end{aligned}$ | $\begin{aligned} & 35 \\ & 35 \\ & 30 \end{aligned}$ | $18-44$ 3 <br> $18-44$ 3 <br> $36-88$ 3 | .5 10 <br> .5 10 <br>   <br> .6 15 | 36 |  |
| $\begin{aligned} & \text { 2N3290 } \\ & \text { 2N330 } \\ & \text { 2N330A } \\ & \text { 2N332 } \end{aligned}$ | $\begin{aligned} & \text { PNP } \\ & \text { PNP } \\ & \text { PNP } \\ & \text { NPN } \end{aligned}$ | GP <br> GP <br> GP <br> GP | 2N2904 <br> 2N2906 <br> 2N2908 <br> 2N332 | $\begin{aligned} & 385 \\ & 350 \\ & 385 \\ & 150 \end{aligned}$ | $\begin{aligned} & 50 \\ & 45 \\ & 50 \\ & 45 \end{aligned}$ | $\begin{aligned} & 30 \\ & 30 \end{aligned}$ | 36-88 3 | . 615 | 9 |  |
| $\begin{aligned} & \text { 2N332A } \\ & \text { 2N333 } \\ & \text { 2N333A } \\ & \text { 2N334 } \end{aligned}$ | NPN <br> NPN <br> NPN <br> NPN | GP <br> GP <br> GP <br> GP | $\begin{aligned} & \text { 2N332A } \\ & \text { 2N333 } \\ & \text { 2N333A } \\ & \text { 2N334 } \end{aligned}$ | $\begin{aligned} & 500 \\ & 150 \\ & 500 \\ & 150 \end{aligned}$ | $\begin{aligned} & 45 \\ & 45 \\ & 45 \\ & 45 \end{aligned}$ | $45$ |  | 1 5 <br> 1 5 |  |  |

## TRANSISTOR INTERCHANGEABILITY <br> MASTER LIST OF REGISTERED TYPES

| TYPE RUMEER | $\begin{aligned} & 8 \\ & 8 \\ & 8 \end{aligned}$ | $\begin{aligned} & z \\ & 6 \\ & 8 \\ & 8 \\ & 8 \\ & 8 \end{aligned}$ | $\begin{aligned} & \text { TI } \\ & \text { REPLACEMENT } \\ & \text { OR NIEAREST } \\ & \text { EQUVALENT } \end{aligned}$ | MAXIMUM RATMVOS |  |  | EECTRICAL CHARACTEISTICS |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  | $\begin{gathered} P_{T} \\ T_{A}=25^{\circ} \mathrm{C} \\ { }^{{ }^{\prime} \mathrm{T}} \mathbf{C}-25^{\circ} \mathrm{C} \\ (\mathrm{~mW}) \end{gathered}$ | Vceo <br> (V) | VCEO <br> (V) |  hFE  <br>    <br> MIN   <br>   MAX <br>   $(\mathrm{mA})$ | $V_{C E}$ (cent)  <br> MAX IC <br> (V) (mA) | $\begin{array}{\|c\|} \hline h_{f} \\ \\ 1 \mathrm{kftz} \\ \text { Mind } \\ \hline \end{array}$ |  |
| $\begin{aligned} & \text { 2N334A } \\ & \text { 2N334B } \\ & \text { 2N335 } \\ & \text { 2N335A } \end{aligned}$ | NPN NPN <br> NPN <br> NPN | GP GP GP GP | $\begin{aligned} & \text { 2N334A } \\ & \text { 2N334A } \\ & \text { 2N335 } \\ & \text { 2N335A } \end{aligned}$ | $\begin{aligned} & 500 \\ & 500 \\ & 150 \\ & 500 \end{aligned}$ | 45 60 45 45 | $\begin{aligned} & 45 \\ & 60 \\ & 45 \end{aligned}$ |  | $\begin{array}{ll} 1 & 5 \\ 1 & 5 \\ 1 & 5 \end{array}$ | 18 |  |
| $\begin{array}{\|l\|} \hline 2 N 3358 \\ 2 N 336 \\ 2 N 336 A \\ 2 N 337 \end{array}$ | NPN <br> NPN <br> NPN <br> NPN | GP <br> GP <br> GP <br> GP | $\begin{aligned} & \text { 2N335A } \\ & \text { 2N336 } \\ & \text { 2N336A } \\ & \text { 2N337 } \end{aligned}$ | $\begin{aligned} & 500 \\ & 150 \\ & 500 \\ & 125 \end{aligned}$ | $\begin{aligned} & 60 \\ & 45 \\ & 45 \\ & 45 \end{aligned}$ | $\begin{aligned} & 60 \\ & 45 \\ & 30 \end{aligned}$ | 20-55 10 | $\begin{array}{ll} 1 & 5 \\ 1 & 5 \end{array}$ | 37 |  |
| $\begin{aligned} & \text { 2N337A } \\ & \text { 2N338 } \\ & \text { 2N338A } \\ & \text { 2N339 } \end{aligned}$ | NPN NPN NPN NPN | $\begin{aligned} & G P \\ & G P \\ & G P \\ & G P \end{aligned}$ | $\begin{aligned} & \text { 2N337 } \\ & \text { 2N338 } \\ & \text { 2N338A } \\ & \text { 2N339 } \end{aligned}$ | 500 125 500 IW | 45 45 45 55 | 30 30 30 55 | $20-55$ 10 <br> $45-150$ 10 <br> $45-150$ 10 |  | $\begin{aligned} & 19 \\ & 39 \end{aligned}$ |  |
| $\begin{aligned} & 2 N 339 A \\ & 2 N 340 \\ & 2 N 340 A \\ & 2 N 341 \end{aligned}$ | NPN NPN NPN NPN | $\begin{aligned} & \text { GP } \\ & G P \\ & G P \\ & G P \end{aligned}$ | $\begin{aligned} & \text { 2N339 } \\ & \text { 2N340 } \\ & \text { 2N340 } \\ & \text { 2N341 } \end{aligned}$ | 16 16 16 16 | 60 85 85 125 | 60 85 85 85 |  |  | $\begin{aligned} & 25 \\ & 25 \end{aligned}$ | 10 10 |
| $\begin{aligned} & 2 N 341 A \\ & 2 N 342 \\ & 2 N 342 A \\ & 2 N 342 B \end{aligned}$ | NPN NPN NPN NPN | $\begin{aligned} & G P \\ & G P \\ & G P \\ & G P \end{aligned}$ | $\begin{aligned} & \text { 2N341A } \\ & \text { 2N342 } \\ & \text { 2N342A } \\ & \text { 2N342B } \end{aligned}$ | IW iW 16 750 | 125 60 85 85 | $\begin{array}{r} 125 \\ 60 \\ 85 \\ 85 \end{array}$ |  |  | 25 | 10 |
| $\begin{array}{\|l} \text { 2N343 } \\ \text { 2N343A } \\ \text { 2N343B } \\ \text { 2N354 } \end{array}$ | NPN NPN NPN PNP | $\begin{aligned} & G P \\ & G P \\ & G P \\ & G P \end{aligned}$ | $\begin{aligned} & \text { 2N343 } \\ & \text { 2N343 } \\ & \text { 2N343 } \\ & \text { 2N2906 } \end{aligned}$ | $1 W$ $1 W$ 750 150 | 60 60 65 25 | $\begin{aligned} & 60 \\ & 60 \\ & 65 \end{aligned}$ |  |  | 28 9 |  |
| $\begin{aligned} & \text { 2N355 } \\ & \text { 2N470 } \\ & \text { 2N471 } \\ & \text { 2N471A } \end{aligned}$ | PNP NPN NPN NPN | $\begin{aligned} & G P \\ & G P \\ & G P \\ & G P \end{aligned}$ | $\begin{aligned} & \text { 2N2906 } \\ & \text { 2N2217 } \\ & \text { 2N2217 } \\ & \text { 2N2217 } \end{aligned}$ | $\begin{aligned} & 150 \\ & 200 \\ & 200 \\ & 200 \end{aligned}$ | 10 15 30 30 | $\begin{aligned} & 15 \\ & 30 \\ & 30 \end{aligned}$ |  | .15 5 <br> 1.5 5 <br> 1 5 <br> 1 5 | 9 10 10 10 | 8 8 8 |
| $\begin{aligned} & \text { 2N472 } \\ & \text { 2N472A } \\ & \text { 2N473 } \\ & \text { 2N474 } \end{aligned}$ | NPN <br> NPN <br> NPN <br> NPN | GP <br> GP <br> GP <br> GP | $\begin{aligned} & \text { 2N2217 } \\ & \text { 2N2217 } \\ & \text { 2N2217 } \\ & \text { 2N2217 } \end{aligned}$ | 200 200 200 200 | 45 45 15 30 | $\begin{aligned} & 45 \\ & 45 \\ & 15 \\ & 30 \end{aligned}$ |  | $\begin{array}{rr} 1.5 & 5 \\ 1 & 5 \\ 1.5 & 5 \\ 1.5 & 5 \end{array}$ | 10 10 20 20 | 8 8 8 8 |
| $\begin{aligned} & \text { 2N474A } \\ & \text { 2N475 } \\ & \text { 2N475A } \\ & \text { 2N47S } \end{aligned}$ | NPN NPN NPN NPN | GP <br> GP <br> GP <br> GP | $\begin{aligned} & \text { 2N2217 } \\ & \text { 2N2217 } \\ & \text { 2N2217 } \\ & \text { 2N2217 } \end{aligned}$ | 200 200 200 200 | 30 45 45 15 | 30 45 45 15 |  | $\begin{array}{rl} 1 & 5 \\ 1.5 & 5 \\ 1 & 5 \\ 1.5 & 5 \end{array}$ | 20 20 20 30 | 8 8 8 12 |
| $\begin{aligned} & \text { 2N477 } \\ & \text { 2N478 } \\ & \text { 2N479 } \\ & \text { 2N479A } \end{aligned}$ | NPN NPN NPN NPN | GP GP GP GP | $\begin{aligned} & \text { 2N2217 } \\ & \text { 2N2218 } \\ & \text { 2N2217 } \\ & \text { 2N2217 } \end{aligned}$ | $\begin{aligned} & 200 \\ & 200 \\ & 200 \\ & 200 \end{aligned}$ | $\begin{aligned} & 30 \\ & 15 \\ & 30 \\ & 30 \end{aligned}$ | $\begin{aligned} & 30 \\ & 15 \\ & 30 \\ & 30 \end{aligned}$ |  | $\begin{array}{rr}1.5 & 5 \\ 1.5 & 5 \\ 1.5 & 5 \\ 1 & 5\end{array}$ | 30 40 40 40 | 12 20 20 20 |

## TRANSISTOR INTERCHANGEABILITY MASTER LIST OF REGISTERED TYPES

| TYPE |  | 7$\frac{7}{5}$5$\frac{2}{4}$$\frac{3}{8}$ |  | maximum ratinos |  |  | ELECTRKCAL CHARACTERISTICS |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  | $\begin{array}{\|ccc} \hline P_{T} & & \\ \mathrm{~T}_{A}=25^{\circ} \mathrm{C} & V_{C 20} & V_{C E O} \\ { }^{*} \mathrm{~T}_{\mathrm{C}}=25^{\circ} \mathrm{C} & & \\ (\mathrm{~mW}) & \text { (V) } & \text { (V) } \\ \hline \end{array}$ |  |  |  |  | $\mathbf{V}_{\text {CEIset }}$ |  | $\begin{gathered} \mathrm{h} \% \\ 1 \mathrm{kHt} \\ \mathrm{~mm} \end{gathered}$ |  |
| 2 N 48 O <br> 2N460A <br> 2N4B9 <br> 2N469A | $\begin{aligned} & \mathrm{N} \neq \mathrm{N} \\ & \mathrm{~N} \neq \mathrm{N} \\ & \mathrm{P} \cdot \mathrm{~N} \\ & \mathrm{P}-\mathrm{N} \end{aligned}$ | $\begin{aligned} & G P \\ & G P \\ & \text { GP } \\ & U J \\ & U J \end{aligned}$ | $\begin{aligned} & \text { 2N2217 } \\ & \text { 2N2217 } \\ & \text { 2N489 } \\ & \text { 2N489A } \end{aligned}$ | $\begin{aligned} & 200 \\ & 200 \\ & \text { SEE UNL } \\ & \text { SEE UNI } \end{aligned}$ | $45$ $45$ <br> UNCTIO UNCTIO |  | angeal NGEA |  | 1.5 | $\begin{aligned} & 5 \\ & 5 \end{aligned}$ | 40 40 | 20 20 |
| 2N4898 <br> 2 N 49 O <br> 2N490A <br> 2NA9OB | $\begin{aligned} & P-N \\ & P-N \\ & P-N \\ & P-N \end{aligned}$ | $\left[\begin{array}{l} u \\ u \\ u \\ u \\ u \\ u \\ \hline \end{array}\right.$ | 2NAB98 2N490 2N490A 2N4903 |  |  |  |  |  |  |  |  |  |
|  | $\begin{aligned} & P-N \\ & P-N \\ & P-N \\ & P-N \end{aligned}$ | $\left\lvert\, \begin{aligned} & \text { uJ } \\ & \text { UJ } \\ & \text { u } \\ & \text { UJ } \end{aligned}\right.$ | 2Na91 <br> 2N491A <br> 2N4918 <br> 2N492 |  |  | NTERC interc INTERC INIERC | HANGEABILT HANGEAB HANGEABHTI HANGEABH | $\begin{aligned} & \text { UST } \\ & \text { UST } \\ & \text { LST } \end{aligned}$ |  |  |  |  |
| $\begin{array}{\|l\|} \hline 2 \mathrm{~N} / 92 \mathrm{~A} \\ \text { 2N4928 } \\ \text { 2N493 } \\ \text { 2N493A } \end{array}$ | $\begin{aligned} & P-N \\ & P-N \\ & P-N \\ & P-N \end{aligned}$ | 虽 | $\begin{aligned} & \text { 2N492A } \\ & \text { 2N4928 } \\ & \text { 2N493 } \\ & \text { 2N493A } \end{aligned}$ | SEE UN SEE UNI SEE UN SEE UN |  | NTERC INTERC INTERC INTERC |  |  |  |  |  |  |
| 2N4938 <br> 2N494 <br> 2N494A <br> 2N4948 | $\begin{aligned} & P-N \\ & P-N \\ & P-N \\ & P-N \end{aligned}$ | $\left[\begin{array}{l} u J \\ u J \\ u J \\ u J \\ u J \end{array}\right.$ | 2N493E | SEE UNI <br> SEE UN SEE UN SEE UN | UNCTIO NCTIO NCTION UNCTON | INTERCH INTERC INTERCH INTERC | ANGEABITIT ANGEADIT ANGEABLIT ANGEABII |  |  |  |  |  |
| 2N494C <br> 2N495 <br> 2N496 <br> 2N497 | $\begin{array}{\|l\|l} \mathbf{P}-\mathbf{N} \\ \text { PNP } \\ \text { PNP } \\ \text { PNPN } \end{array}$ | $\begin{aligned} & \text { UJ } \\ & \text { SW } \\ & \text { SW } \\ & \text { GP } \end{aligned}$ | $\begin{array}{\|l\|} \hline \text { 2N2944 } \\ \text { 2N2944 } \\ \text { 2N2102 } \end{array}$ | $\begin{aligned} & \text { SEE UNUI } \\ & 150 \\ & 150 \\ & \cdot 4 W \\ & \hline \end{aligned}$ | UCTION 25 10 60 | INTERC |  | $\begin{array}{r} 15 \\ 200 \end{array}$ | . 15 | 5 | 15 9 | 7.2 |
| 2N497A <br> 2N498 <br> 2N498A <br> 2N541 | $\begin{aligned} & \text { NPN } \\ & \text { NPN } \\ & \text { NPN } \\ & \text { NPN } \end{aligned}$ | $\begin{aligned} & G P \\ & G P \\ & G P \\ & G P \\ & G P \end{aligned}$ | 2N2102 <br> 2N3036 <br> 2N3036 <br> 2N2218 | -5W <br> -4W <br> -5W <br> 200 | $\begin{array}{r} 60 \\ 100 \\ 100 \\ 15 \end{array}$ | $\begin{array}{r} 60 \\ 100 \\ 100 \end{array}$ | $\begin{aligned} & 12.36 \\ & 12.36 \\ & 12.36 \end{aligned}$ | $\begin{aligned} & 200 \\ & 200 \\ & 200 \end{aligned}$ | 1.5 | 5 | 80 | 10 |
| 2N541A <br> 2N542 <br> 2N542A <br> 2N543 | $\begin{aligned} & \text { NPN } \\ & \text { NPN } \\ & \text { NNN } \\ & \text { NPN } \end{aligned}$ | GP <br> GP <br> GP <br> GP | $\begin{array}{\|l\|l\|} \text { 2N2218 } \\ \text { 2N2219 } \\ \text { 2N2219 } \\ \text { 2N2218 } \end{array}$ | $\begin{aligned} & 200 \\ & 200 \\ & 200 \\ & 200 \end{aligned}$ | $\begin{aligned} & 15 \\ & 30 \\ & 30 \\ & 50 \end{aligned}$ | 15 <br> 30 50 | 80. | 1 | $\begin{array}{r} 1 \\ 1.5 \\ 1 \\ 1.5 \end{array}$ | $\begin{aligned} & 5 \\ & 5 \\ & 5 \\ & 5 \end{aligned}$ | $\begin{aligned} & 80 \\ & 80 \\ & 80 \\ & 80 \end{aligned}$ | 8 10 10 10 |
| 2N543A 2N545 2N546 2N547 | NPN NPN NPN NPN | $\begin{aligned} & G P \\ & G P \\ & G P \\ & G P \end{aligned}$ | $\begin{aligned} & \text { 2N2218 } \\ & \text { 2N2102 } \\ & \text { 2N2102 } \\ & \text { 2N2102 } \end{aligned}$ | $\begin{aligned} & 200 \\ & \cdot 5 w \\ & \cdot 5 w \\ & * 5 w \end{aligned}$ | $\begin{aligned} & 45 \\ & 60 \\ & 30 \\ & 60 \end{aligned}$ | $\begin{aligned} & 45 \\ & 60 \\ & 30 \\ & 60 \end{aligned}$ | $\begin{aligned} & 15-80 \\ & 15-80 \\ & 20-80 \end{aligned}$ | $\begin{aligned} & 500 \\ & 500 \\ & 500 \end{aligned}$ | 1 5 3 5 | 5 500 500 500 | 80 | 10 |
| 2N548 <br> 2NS49 <br> 2NS50 <br> 2N351 | NPN <br> NPN <br> NPN <br> NPN | $\begin{aligned} & G P \\ & G P \\ & G P \\ & G P \end{aligned}$ | $\begin{aligned} & \text { 2N2102 } \\ & \text { 2N2270 } \\ & \text { 2N2270 } \\ & \text { 2N2270 } \end{aligned}$ | $\begin{aligned} & \cdot 5 w \\ & \cdot 5 w \\ & \cdot 5 w \\ & \cdot 5 w \end{aligned}$ | $\begin{aligned} & 30 \\ & 60 \\ & 30 \\ & 80 \end{aligned}$ | $\begin{aligned} & 30 \\ & 60 \\ & 30 \\ & 60 \end{aligned}$ | $\begin{aligned} & 20-80 \\ & 20-80 \\ & 20-80 \\ & 20-80 \end{aligned}$ | $\begin{array}{r} 500 \\ 200 \\ 200 \\ 50 \end{array}$ | $\begin{aligned} & 3 \\ & 4 \\ & 4 \\ & 2 \end{aligned}$ | $\begin{array}{r} 500 \\ 200 \\ 200 \\ 50 \\ 50 \end{array}$ |  | 4 4 4 3 |

## TRANSISTOR INTERCHANGEABILITY MASTER LIST OF REGISTERED TYPES

| TYFE NUMEER |  | $\begin{aligned} & \frac{7}{8} \\ & \frac{3}{8} \\ & \frac{3}{3} \\ & 8 \end{aligned}$ | $\begin{aligned} & \text { TI } \\ & \text { REPLACEMENT } \\ & \text { OR NIAREST } \\ & \text { EPUVALENT } \end{aligned}$ | MAXLINLM RATINOS |  |  | EIECIRICAL CMARACTERSTICS |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  | $\begin{gathered} P_{T} \\ \mathbf{T}_{A}-25^{\circ} \mathrm{C} \\ { }^{{ }^{\circ} \mathrm{T} C=25^{\circ} \mathrm{C}} \\ (\mathrm{~mW}) \end{gathered}$ | Vcso <br> (V) | Vcro <br> (V) | hpe | $\begin{gathered} \mathbf{I C} \\ (\mathrm{mA}) \end{gathered}$ | VCE MAX (V) | $\begin{aligned} & \text { set } \\ & \hline \mathrm{IC} \\ & (\mathrm{~mA}) \end{aligned}$ |  | $\begin{gathered} T \\ \text { MiN } \\ \left(M_{1}+z\right) \end{gathered}$ |
| $\begin{aligned} & \text { 2N552 } \\ & \text { 2N560 } \\ & \text { 2N619 } \\ & \text { 2N620 } \end{aligned}$ | NPN <br> NPN <br> NPN <br> NPN | $\begin{aligned} & G P \\ & G P \\ & G P \\ & G P \end{aligned}$ | $\begin{aligned} & \text { 2N2270 } \\ & \text { 2N1893 } \end{aligned}$ | +5W 500 175 175 | 30 60 50 50 | 30 60 40 35 | $20-80$ $20-$ $9-22$ $18-4$ | 50 100 5 5 | 2 .5 .5 .4 | 50 10 8 8 |  | 3 |
| $\begin{array}{\|l\|} \text { 2N621 } \\ \text { 2N622 } \\ \text { 2N656 } \\ \text { 2N656A } \end{array}$ | NPN <br> NPN <br> NPN <br> NPN | $\begin{array}{\|l} \text { GP } \\ \text { SW } \\ \text { GP } \\ \text { GP } \end{array}$ | 2N2432 <br> 2N3036 <br> 2N3036 | $\begin{array}{r} 175 \\ 385 \\ -4 W \\ \hline 5 W \end{array}$ | $\begin{aligned} & 50 \\ & 50 \\ & 60 \\ & 60 \end{aligned}$ | $\begin{aligned} & 30 \\ & 30 \\ & 60 \\ & 60 \end{aligned}$ | $\begin{aligned} & 36-88 \\ & \\ & 30-90 \\ & 30-90 \end{aligned}$ | $\begin{array}{r} 5 \\ 200 \\ 200 \end{array}$ | . 3 | 8 |  |  |
| $\begin{array}{\|l\|} \hline \text { 2N657 } \\ \text { 2N657A } \\ \text { 2N696 } \\ \text { 2N696A } \end{array}$ | NPN NPN NPN NPN | $\begin{aligned} & G P \\ & G P \\ & G P \\ & G P \end{aligned}$ | $\begin{aligned} & \text { 2N3036 } \\ & \text { 2N3036 } \\ & \text { 2N696 } \\ & \text { 2N696 } \end{aligned}$ | $\begin{aligned} & 4 W \\ & * 5 w \\ & 600 \\ & 800 \end{aligned}$ | $\begin{array}{r} 100 \\ 100 \\ 60 \\ 60 \end{array}$ | $\begin{array}{r} 100 \\ 100 \\ \\ 35 \end{array}$ | $\begin{aligned} & 30-90 \\ & 30-90 \\ & 20-60 \\ & 20-60 \end{aligned}$ | $\begin{aligned} & 200 \\ & 200 \\ & 150 \\ & 150 \end{aligned}$ | $\begin{aligned} & 1.5 \\ & 1.5 \end{aligned}$ | $\begin{aligned} & 150 \\ & 150 \end{aligned}$ | 15 | 40 |
| $\begin{aligned} & \text { 2N697 } \\ & \text { 2N697A } \\ & \text { 2N698 } \\ & \text { 2N699 } \end{aligned}$ | $\begin{aligned} & \text { NPN } \\ & \text { NPN } \\ & \text { NPN } \\ & \text { NPN } \end{aligned}$ | $\begin{aligned} & G P \\ & G P \\ & G P \\ & G P \end{aligned}$ | $\begin{aligned} & \text { 2N697 } \\ & \text { 2N697 } \\ & \text { 2N698 } \\ & \text { 2N699 } \end{aligned}$ | $\begin{aligned} & 600 \\ & 800 \\ & 800 \\ & 600 \end{aligned}$ | $\begin{array}{r} 60 \\ 60 \\ 120 \\ 120 \end{array}$ | 35 | $\begin{aligned} & 40-120 \\ & 40-120 \\ & 20-60 \\ & 40-120 \end{aligned}$ | $\begin{aligned} & 150 \\ & 150 \\ & 150 \\ & 150 \end{aligned}$ | 1.5 1.5 1.2 5 | $\begin{aligned} & 150 \\ & 150 \\ & 150 \\ & 150 \end{aligned}$ | 25 15 35 | 40 50 40 50 |
| $\begin{aligned} & \text { 2N699A } \\ & \text { 2N6994 } \\ & \text { 2N702 } \\ & \text { 2N703 } \end{aligned}$ | $\begin{array}{\|l\|} \hline \text { NPN } \\ \text { NPN } \\ \text { NPN } \\ \text { NPN } \end{array}$ | $\begin{aligned} & G P \\ & G P \\ & G P \\ & G P \end{aligned}$ | $\begin{aligned} & \text { 2N699 } \\ & \text { 2N699 } \\ & \text { 2N2220 } \\ & \text { 2N2221 } \end{aligned}$ | $\begin{aligned} & 800 \\ & 870 \\ & 300 \\ & 300 \end{aligned}$ | $\begin{array}{r} 120 \\ 120 \\ 25 \\ 25 \end{array}$ | $\begin{aligned} & 25 \\ & 25 \end{aligned}$ | $\begin{aligned} & 40.120 \\ & 40-120 \\ & 20-60 \\ & 40-100 \end{aligned}$ | $\begin{array}{r} 150 \\ 150 \\ 10 \\ 10 \end{array}$ | 5 1.2 .5 .5 | $\begin{array}{r} 150 \\ 50 \\ 10 \\ 10 \end{array}$ | $\begin{aligned} & 35 \\ & 35 \end{aligned}$ | 50 60 70 70 |
| $\left\lvert\, \begin{aligned} & \text { 2N706 } \\ & \text { 2N706A } \\ & \text { 2N706B } \\ & \text { 2N706C } \end{aligned}\right.$ | NPN <br> NPN <br> NPN <br> NPN | $\begin{aligned} & s w \\ & s w \\ & s w \\ & s w \end{aligned}$ |  | $\begin{aligned} & 300 \\ & 300 \\ & 300 \\ & 360 \end{aligned}$ | $\begin{aligned} & 25 \\ & 25 \\ & 25 \\ & 40 \end{aligned}$ |  | $\begin{aligned} & 20 \\ & 20-60 \\ & 20-60 \\ & 20-60 \end{aligned}$ | 10 10 10 10 | . 6 | $\begin{aligned} & 10 \\ & 10 \\ & 10 \\ & 10 \end{aligned}$ |  | 200 200 200 200 |
| $\begin{aligned} & \text { 2N707 } \\ & \text { 2N707A } \\ & \text { 2N708 } \\ & \text { 2N708A } \end{aligned}$ | NPN NPN NPN NPN | RF <br> RF <br> SW <br> SW |  | $\begin{aligned} & 300 \\ & 500 \\ & 360 \\ & 360 \end{aligned}$ | $\begin{aligned} & 56 \\ & 70 \\ & 40 \\ & 50 \end{aligned}$ | 40 | $9-$ $9-50$ $30-120$ $40-120$ | 10 10 10 10 | .6 .6 .4 .15 | $\begin{aligned} & 10 \\ & 10 \\ & 10 \\ & 10 \end{aligned}$ |  | 70 300 300 |
| $\begin{array}{\|l} \text { 2N709 } \\ \text { 2N709A } \\ \text { 2N715 } \\ \text { 2N716 } \end{array}$ | NPN <br> NPN <br> NPN <br> NPN | $\begin{aligned} & S W \\ & S W \\ & R F \\ & R F \end{aligned}$ | 2N4875 <br> 2N4875 | $\begin{aligned} & 300 \\ & 300 \\ & 500 \\ & 500 \end{aligned}$ | 15 15 50 70 | 6 6 35 40 | $\begin{aligned} & 20-120 \\ & 30-90 \\ & 10-50 \\ & 10-50 \end{aligned}$ | 10 10 15 15 | .3 .3 1.2 1.2 | $\begin{array}{r} 3 \\ 3 \\ 15 \\ 15 \end{array}$ |  | 600 600 70 70 |
| $\begin{aligned} & \text { 2N717 } \\ & \text { 2N718 } \\ & \text { 2N718A } \\ & \text { 2N719 } \end{aligned}$ | NPN NPN NPN NPN | GP GP GP GP | $\begin{aligned} & \text { 2N717 } \\ & \text { 2N718 } \\ & \text { 2N718A } \\ & \text { 2N719 } \end{aligned}$ | $\begin{aligned} & 400 \\ & 400 \\ & 500 \\ & 400 \end{aligned}$ | $\begin{array}{r} 60 \\ 60 \\ 75 \\ 120 \end{array}$ |  | $\begin{aligned} & 20-60 \\ & 40-120 \\ & 40-120 \\ & 20-60 \end{aligned}$ | $\begin{aligned} & 150 \\ & 150 \\ & 150 \\ & 150 \end{aligned}$ | $\begin{array}{r} 1.5 \\ 1.5 \\ 1.5 \\ 5 \end{array}$ | $\begin{aligned} & 150 \\ & 150 \\ & 150 \\ & 150 \end{aligned}$ | 30 15 | 40 50 60 40 |
| $\begin{array}{\|l} \text { 2N719A } \\ \text { 2N720 } \\ \text { 2N720A } \\ \text { 2N721 } \end{array}$ | NPN <br> NPN <br> NPN <br> PNP | GP GP GP GP | $\begin{aligned} & \text { 2N719A } \\ & \text { 2N720 } \\ & \text { 2N720A } \\ & \text { 2N721 } \end{aligned}$ | $\begin{array}{r} 500 \\ 400 \\ 500 \\ 400 \end{array}$ | $\begin{array}{r} 120 \\ 120 \\ 120 \\ 50 \end{array}$ |  | $\begin{aligned} & 20-60 \\ & 40-120 \\ & 40-120 \\ & 20-45 \end{aligned}$ | $\begin{aligned} & 150 \\ & 150 \\ & 150 \\ & 150 \end{aligned}$ | $\begin{array}{r} 1.2 \\ 5 \\ 5 \\ 1.5 \end{array}$ | $\begin{array}{r} 50 \\ 150 \\ 150 \\ 150 \end{array}$ | 15 35 30 15 | 40 50 50 50 |



TRANSISTOR INTERCHANGEABILITY
MASTER LIST OF REGISTERED TYPES

| TYPE number |  | CLASSHFICATION | $\begin{aligned} & \text { TI } \\ & \text { REPLACEMENT } \\ & \text { OR MEAREST } \\ & \text { EOUNALENT } \end{aligned}$ | I MAXIMUM RATINOS |  |  | EECTRICAL CHARACTERISTICS |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  | $\begin{gathered} \mathrm{PT} \\ \mathrm{~T}_{A}=25^{\circ} \mathrm{C} \\ { }^{{ }^{1} \mathrm{~T} C=25^{\circ} \mathrm{C}} \\ (\mathrm{~mW}) \\ \hline \end{gathered}$ | Vceo <br> (V) | VCEO <br> (V) | MN Max | $\begin{gathered} e \\ \hline(\mathrm{~mA}) \\ \hline \end{gathered}$ |  | $\begin{aligned} & \text { (set) } \\ & \hline \mathbf{I C} \\ & \text { (mA) } \end{aligned}$ | $\begin{gathered} \mathrm{hfo}_{\mathrm{f}} \\ 1 \mathrm{kftz} \\ \text { MiN } \end{gathered}$ | $\begin{gathered} \mathrm{f} \\ \mathrm{MNN} \\ (\mathrm{MHz}) \\ \hline \end{gathered}$ |
| $\begin{aligned} & \text { 2N757 } \\ & \text { 2N757A } \\ & \text { 2N758 } \\ & \text { 2N758A } \end{aligned}$ | NPN <br> NPN <br> NPN <br> NPN | $\begin{aligned} & G P \\ & G P \\ & G P \\ & G P \end{aligned}$ | $\begin{aligned} & \text { 2N2221 } \\ & \text { 2N2221 } \\ & \text { 2N2221 } \\ & \text { 2N2221 } \end{aligned}$ | 500 500 500 500 | 45 60 45 60 | 45 60 45 60 |  |  | 1 1 1 1 | 10 10 10 10 | $\begin{aligned} & 18 \\ & 18 \\ & 18 \\ & 18 \end{aligned}$ |  |
| $\begin{aligned} & \text { 2N7588 } \\ & \text { 2N759 } \\ & \text { 2N759A } \\ & 2 N 7598 \end{aligned}$ | NPN <br> NPN <br> NPN <br> NPN | $\begin{aligned} & \text { GP } \\ & \text { GP } \\ & \text { GP } \\ & \text { GP } \end{aligned}$ | $\begin{aligned} & \text { 2N2221 } \\ & \text { 2N2222 } \\ & \text { 2N2222 } \\ & \text { 2N2222 } \end{aligned}$ | 500 500 500 500 | 60 45 60 60 | 60 45 60 60 | $12$ $25-$ | 1 <br> 1 | .5 1 1 .5 | $\begin{aligned} & 10 \\ & 10 \\ & 10 \\ & 10 \end{aligned}$ | $\begin{aligned} & 18 \\ & 36 \\ & 36 \\ & 36 \end{aligned}$ |  |
| $\begin{aligned} & \text { 2N760 } \\ & 2 N 760 A \\ & 2 N 7608 \\ & 2 N 761 \end{aligned}$ | NPN <br> NPN <br> NPN <br> NPN | $\begin{aligned} & \text { GP } \\ & \text { GP } \\ & G P \\ & G P \end{aligned}$ | $\begin{aligned} & \text { 2N2222 } \\ & \text { 2N2222 } \\ & \text { 2N2222 } \\ & \text { 2N2218A } \end{aligned}$ | 500 500 500 500 | 45 60 60 50 | 45 60 60 30 | 20-55 | 10 | 1 1 .5 1 | 10 10 10 10 | $\begin{aligned} & 76 \\ & 76 \\ & 76 \\ & 19 \end{aligned}$ |  |
| $\left\lvert\, \begin{aligned} & \text { 2N762 } \\ & 2 N 770 \\ & 2 N 771 \\ & 2 N 772 \end{aligned}\right.$ | $\begin{aligned} & \mathrm{NPN} \\ & \mathrm{NPN} \\ & \mathrm{NPN} \\ & \mathrm{NPN} \end{aligned}$ | GP <br> SW <br> SW <br> SW | 2N2218A | $\begin{aligned} & 500 \\ & 150 \\ & 150 \\ & 150 \end{aligned}$ | 50 20 20 25 | 30 15 15 25 | $\begin{aligned} & 45-150 \\ & 12-60 \\ & 30-150 \\ & 20- \end{aligned}$ | 10 20 20 10 | 1 .25 .25 .25 | 10 10 10 10 | 39 | 75 100 75 |
| $\begin{aligned} & \text { 2N773 } \\ & \text { 2N774 } \\ & \text { 2N775 } \\ & \text { 2N776 } \end{aligned}$ | NPN NPN NPN NPN | GP GP GP GP |  | $\begin{aligned} & 150 \\ & 150 \\ & 150 \\ & 150 \end{aligned}$ | 20 20 20 20 | 15 15 15 15 | $4-16$ 7.30 $20-80$ $4-16$ | 1.5 1.5 1.5 1.5 |  |  | 6 11 28 6 |  |
| $\begin{aligned} & \text { 2N777 } \\ & \text { 2N778 } \\ & \text { 2N780 } \\ & \text { 2N783 } \end{aligned}$ | NPN <br> NPN <br> NPN <br> NPN | GP GP GP SW | 2N2220 | $\begin{array}{r} 150 \\ 150 \\ +1 w \\ 300 \end{array}$ | $\begin{aligned} & 20 \\ & 20 \\ & 45 \\ & 40 \end{aligned}$ | $\begin{aligned} & 15 \\ & 15 \end{aligned}$ | $\begin{aligned} & 7-30 \\ & 20-80 \\ & 35.140 \\ & 20-60 \end{aligned}$ | $\begin{array}{r} 1.5 \\ 1.5 \\ .5 \\ 10 \end{array}$ | 1 .25 | $\begin{aligned} & 10 \\ & 10 \end{aligned}$ | 118 | 60 200 |
| $\begin{aligned} & \text { 2N784 } \\ & \text { 2N784A } \\ & \text { 2N789 } \\ & \text { 2N790 } \end{aligned}$ | NPN <br> NPN <br> NPN <br> NPN | sw <br> SW <br> GP <br> GP |  | $\begin{aligned} & 300 \\ & 350 \\ & 150 \\ & 150 \end{aligned}$ | $\begin{aligned} & 30 \\ & 40 \\ & 45 \\ & 45 \end{aligned}$ | $\begin{aligned} & 30 \\ & 30 \end{aligned}$ | $\begin{aligned} & 25- \\ & 25.150 \end{aligned}$ | $\begin{aligned} & 10 \\ & 10 \end{aligned}$ | .19 .65 1 1 | $\begin{array}{r} 10 \\ 100 \\ 5 \\ 5 \end{array}$ | 9 18 | 200 300 |
| $\begin{aligned} & \text { 2N791 } \\ & \text { 2N792 } \\ & \text { 2N793 } \\ & \text { 2NB34 } \end{aligned}$ | NPN <br> NPN <br> NPN <br> NPN | GP GP GP SW |  | 150 150 150 300 | $\begin{aligned} & 45 \\ & 45 \\ & 45 \\ & 40 \end{aligned}$ | $\begin{aligned} & 30 \\ & 30 \\ & 30 \end{aligned}$ | 25- | 10 | 1 1 1 .25 | $\begin{array}{r} 5 \\ 5 \\ 5 \\ 10 \end{array}$ | 18 36 76 | 350 |
| $\begin{aligned} & \text { 2N834A } \\ & \text { 2N835 } \\ & \text { 2N839 } \\ & \text { 2N84O } \end{aligned}$ | NPN NPN NPN NPN | $\begin{aligned} & \text { SW } \\ & \text { SW } \\ & G P \\ & G P \end{aligned}$ | $\begin{aligned} & \text { 2N2222 } \\ & \text { 2N2221A } \end{aligned}$ | $\begin{aligned} & 360 \\ & 300 \\ & 300 \\ & 300 \end{aligned}$ | $\begin{aligned} & 40 \\ & 25 \\ & 45 \\ & 45 \end{aligned}$ | $\begin{aligned} & 20 \\ & 45 \\ & 45 \end{aligned}$ | $\begin{aligned} & 25- \\ & 20- \\ & 15-50 \\ & 30-100 \end{aligned}$ | $\begin{aligned} & 10 \\ & 10 \\ & 10 \\ & 10 \end{aligned}$ | . . .3 2 2 | $\begin{aligned} & 10 \\ & 10 \\ & 10 \\ & 10 \end{aligned}$ | 20 40 | 500 300 30 30 |
| $\begin{aligned} & \text { 2N841 } \\ & \text { 2N842 } \\ & \text { 2N843 } \\ & \text { 2N844 } \end{aligned}$ | NPN <br> NPN <br> NPN <br> NPN | GP GP GP GP | $\begin{aligned} & \text { 2N2222A } \\ & \text { 2N2221 } \\ & \text { 2N2222 } \\ & \text { 2N718A } \end{aligned}$ | $\begin{aligned} & 300 \\ & 300 \\ & 300 \\ & 300 \end{aligned}$ | $\begin{aligned} & 45 \\ & 45 \\ & 45 \\ & 60 \end{aligned}$ | $\begin{aligned} & 45 \\ & 45 \\ & 45 \end{aligned}$ | $\begin{aligned} & 60-400 \\ & 20-55 \\ & 45-150 \\ & 40-120 \end{aligned}$ | $\begin{array}{r} 10 \\ 10 \\ 10 \\ 5 \end{array}$ | 2 1.2 1.2 .8 | $\begin{aligned} & 10 \\ & 10 \\ & 10 \\ & 10 \end{aligned}$ | 80 20 40 | 40 30 40 50 |

## TRANSISTOR INTERCHANGEABILITY MASTER LIST OF REGISTERED TYPES

| TYPE NUMEER |  |  | $\begin{aligned} & \text { II } \\ & \text { REMLACENENT } \\ & \text { OR NBARET } \\ & \text { EOUVARENT } \end{aligned}$ | MAXIMUM RATMES |  |  | EECTICAL CHARACTIEISTICS |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  | $\begin{gathered} P_{T} \\ T_{A}=25^{\circ} \mathrm{C} \\ { }^{\circ} \mathrm{T}_{\mathbf{C}}=25^{\circ} \mathrm{C} \\ (\mathrm{~mW}) \\ \hline \end{gathered}$ | $V_{\text {ceo }}$ $(\mathrm{V})$ | $V_{C E O}$ $(V)$ | Man M | $\begin{gathered} c \\ (\mathrm{~mA}) \end{gathered}$ |  | $\begin{gathered} \text { (set) } \\ (\mathrm{mA}) \end{gathered}$ |  | $\begin{gathered} \text { f } \\ \text { Min } \\ \text { (MHz) } \end{gathered}$ |
| $\begin{aligned} & \text { 2N845 } \\ & \text { 2N847 } \\ & \text { 2N848 } \\ & \text { 2N849 } \end{aligned}$ | NPN <br> NPN <br> NPN <br> NPN | $\begin{aligned} & G P \\ & s w \\ & s w \\ & s w \end{aligned}$ | 2N718A <br> 2N849 | 300 200 200 300 | 100 20 40 25 | 15 25 15 | $\begin{aligned} & 40-120 \\ & 20-60 \end{aligned}$ | $5$ <br> 10 | .8 1.5 1.5 .6 | $\begin{aligned} & 10 \\ & 10 \\ & 10 \\ & 10 \end{aligned}$ |  | $\begin{gathered} 50 \\ \vdots \\ 600 \end{gathered}$ |
| $\begin{aligned} & \text { 2N850 } \\ & \text { 2N851 } \\ & \text { 2N852 } \\ & \text { 2N858 } \end{aligned}$ | NPN <br> NPN <br> NPN <br> PNP | $\begin{aligned} & s w \\ & s w \\ & s w \\ & G P \end{aligned}$ | $\begin{aligned} & \text { 2N850 } \\ & \text { 2N851 } \\ & \text { 2N852 } \\ & \text { 2N2906 } \end{aligned}$ | $\begin{aligned} & 300 \\ & 300 \\ & 300 \\ & 150 \end{aligned}$ | $\begin{aligned} & 25 \\ & 20 \\ & 20 \\ & 40 \end{aligned}$ | $\begin{aligned} & 15 \\ & 12 \\ & 12 \\ & 40 \end{aligned}$ | $\begin{aligned} & 40-120 \\ & 20-60 \\ & 40-120 \\ & 10-60 \end{aligned}$ | $\begin{array}{r} 10 \\ 10 \\ 10 \\ 5 \end{array}$ | .6 <br> .15 | $10$ <br> 5 | 15 | $\begin{array}{r} 600 \\ 300 \\ 300 \\ 5 \end{array}$ |
| $\begin{aligned} & \text { 2N859 } \\ & \text { 2N860 } \\ & \text { 2N861 } \\ & \text { 2N862 } \end{aligned}$ | PNP <br> PNP <br> PNP <br> PNP | $\begin{aligned} & \text { GP } \\ & \text { GP } \\ & \text { GP } \\ & \text { GP } \end{aligned}$ | $\begin{aligned} & \text { 2N2906 } \\ & \text { 2N2906 } \\ & \text { 2N2906 } \\ & \text { 2N2906 } \end{aligned}$ | $\begin{aligned} & 150 \\ & 150 \\ & 150 \\ & 150 \end{aligned}$ | $\begin{aligned} & 40 \\ & 25 \\ & 25 \\ & 15 \end{aligned}$ | $\begin{aligned} & 40 \\ & 25 \\ & 25 \\ & 15 \end{aligned}$ | $\begin{aligned} & 25-100 \\ & 10-40 \\ & 25-75 \\ & 12-48 \end{aligned}$ | 5 5 5 5 | .15 .15 .15 .15 | $\begin{aligned} & 5 \\ & 5 \\ & 5 \\ & 5 \end{aligned}$ | 30 15 30 20 | 6 6.5 7.5 8 |
| $\begin{aligned} & \text { 2N863 } \\ & \text { 2N864 } \\ & \text { 2N864A } \\ & \text { 2N865 } \end{aligned}$ | $\begin{aligned} & \text { PNP } \\ & \text { PNNP } \\ & \text { PNNP } \\ & \text { PNNP } \end{aligned}$ | $\begin{aligned} & \text { GP } \\ & \text { GP } \\ & \text { GP } \\ & \text { GP } \end{aligned}$ | $\begin{aligned} & \text { 2N2906 } \\ & \text { 2N2906 } \\ & \text { 2N2906 } \\ & \text { 2N2906 } \end{aligned}$ | 150 150 300 150 | $\begin{array}{r} 15 \\ 6 \\ 6 \\ 10 \end{array}$ | $\begin{array}{r} 15 \\ 6 \\ 6 \\ 6 \end{array}$ | $\begin{aligned} & 25-100 \\ & 20-100 \\ & 20-250 \\ & 45-125 \end{aligned}$ | $\begin{aligned} & 5 \\ & 5 \\ & 5 \\ & 5 \end{aligned}$ | .15 .1 .1 .1 | $\begin{aligned} & 5 \\ & 5 \\ & 5 \\ & 5 \end{aligned}$ | $\begin{array}{r} 40 \\ 25 \\ 25 \\ 100 \end{array}$ | 10 16 16 24 |
| $\begin{array}{\|l} \text { 2N865A } \\ \text { 2N866 } \\ \text { 2N867 } \\ \text { 2N869 } \end{array}$ | $\begin{array}{\|l} \text { PNP } \\ \text { NPN } \\ \text { NPN } \\ \text { PNP } \end{array}$ | GP GP GP GP | 2N2906 <br> 2N2906 | $\begin{aligned} & 300 \\ & 500 \\ & 500 \\ & 360 \end{aligned}$ | $\begin{aligned} & 10 \\ & 30 \\ & 30 \\ & 25 \end{aligned}$ | $10$ <br> 18 | $\begin{aligned} & 45-400 \\ & 15-45 \\ & 30-90 \\ & 20-120 \end{aligned}$ | $\begin{array}{r} 5 \\ 150 \\ 150 \\ 10 \end{array}$ | $\begin{array}{r} .1 \\ 1.5 \\ 1.5 \\ 1 \end{array}$ | $\begin{array}{r} 5 \\ 150 \\ 150 \\ 10 \end{array}$ | 100 | 24 40 50 100 |
| $\begin{aligned} & \text { 2N869A } \\ & \text { 2N870 } \\ & \text { 2N871 } \\ & \text { 2N902 } \end{aligned}$ | PNP <br> NPN <br> NPN <br> NPN | $\begin{aligned} & \text { GP } \\ & \text { GP } \\ & \text { GP } \\ & \text { GP } \end{aligned}$ | $\begin{aligned} & \text { 2N2906 } \\ & \text { 2N870 } \\ & \text { 2N871 } \\ & \text { 2N2221 } \end{aligned}$ | $\begin{aligned} & 360 \\ & 500 \\ & 500 \\ & 150 \end{aligned}$ | $\begin{array}{r} 25 \\ 100 \\ 100 \\ 45 \end{array}$ | 18 $30$ | $\begin{array}{r} 40-120 \\ 40-120 \\ 100-300 \end{array}$ | $\begin{array}{r} 30 \\ 150 \\ 150 \end{array}$ | .15 1.2 1.2 1 | $\begin{array}{r} 10 \\ 50 \\ 50 \\ 5 \end{array}$ | 30 50 9 | 400 50 60 1 |
| $\begin{aligned} & \text { 2N903 } \\ & \text { 2N904 } \\ & \text { 2N905 } \\ & \text { 2N906 } \end{aligned}$ | NPN <br> NPN <br> NPN <br> NPN | GP <br> GP <br> GP <br> GP | $\begin{aligned} & \text { 2N2221 } \\ & \text { 2N2221 } \\ & \text { 2N2221 } \\ & \text { 2N2221 } \end{aligned}$ | 150 150 150 150 | 45 45 45 45 | 30 30 30 30 |  |  | 1 1 1 1 | $\begin{aligned} & 5 \\ & 5 \\ & 5 \\ & 5 \end{aligned}$ | 18 18 36 76 |  |
| $\begin{aligned} & \text { 2N907 } \\ & \text { 2N908 } \\ & \text { 2N909 } \\ & \text { 2N910 } \end{aligned}$ | NPN <br> NPN <br> NPN <br> NPN | GP <br> GP <br> GP <br> GP | $\begin{aligned} & \text { 2N2221 } \\ & \text { 2N2221 } \\ & \text { 2N2222 } \\ & \text { 2N910 } \end{aligned}$ | $\begin{aligned} & 150 \\ & 150 \\ & 400 \\ & 500 \end{aligned}$ | $\begin{array}{r} 45 \\ 45 \\ 60 \\ 100 \end{array}$ | $\begin{aligned} & 30 \\ & 30 \end{aligned}$ | $\begin{gathered} 20-55 \\ 45-150 \\ 110-350 \\ 75 . \end{gathered}$ | $\begin{aligned} & 10 \\ & 10 \\ & 50 \\ & 10 \end{aligned}$ |  |  | 19 39 40 76 | 12 25 50 60 |
| $\begin{aligned} & \text { 2N911 } \\ & \text { 2N912 } \\ & \text { 2N914 } \\ & \text { 2N914A } \end{aligned}$ | NPN <br> NPN <br> NPN <br> NPN | GP <br> GP <br> SW <br> sw | $\begin{aligned} & \text { 2N911 } \\ & \text { 2N912 } \end{aligned}$ | $\begin{aligned} & 500 \\ & 500 \\ & 360 \\ & 360 \end{aligned}$ | $\begin{array}{r} 100 \\ 100 \\ 40 \\ 40 \end{array}$ |  | $\begin{aligned} & 35- \\ & 15- \\ & 30-120 \\ & 30-120 \end{aligned}$ | $\begin{aligned} & 10 \\ & 10 \\ & 10 \\ & 10 \end{aligned}$ | $\begin{aligned} & .4 \\ & .4 \\ & .7 \\ & .4 \end{aligned}$ | $\begin{array}{r} 10 \\ 10 \\ 200 \\ 200 \end{array}$ | $\begin{aligned} & 36 \\ & 18 \end{aligned}$ | 50 40 300 300 |
| $\begin{aligned} & \text { 2N915 } \\ & \text { 2N916 } \\ & \text { 2N916A } \\ & \text { 2N917 } \end{aligned}$ | NPN <br> NPN <br> NPN <br> NPN | GP <br> GP <br> GP <br> RF | $\begin{aligned} & \text { 2N2222A } \\ & \text { 2N2222A } \\ & \text { 2N2222A } \\ & \text { 2N917 } \end{aligned}$ | $\begin{aligned} & 360 \\ & 360 \\ & 360 \\ & 200 \end{aligned}$ | $\begin{aligned} & 70 \\ & 45 \\ & 45 \\ & 30 \end{aligned}$ | $\begin{aligned} & 50 \\ & 25 \\ & 25 \\ & 15 \end{aligned}$ | $\begin{aligned} & 50-200 \\ & 50-200 \\ & 50-200 \\ & 20-200 \end{aligned}$ | $\begin{array}{r} 10 \\ 10 \\ 10 \\ 3 \end{array}$ | $\begin{aligned} & 1 \\ & .5 \\ & .5 \\ & .5 \end{aligned}$ | $\begin{array}{r} 10 \\ 10 \\ 10 \\ 3 \end{array}$ | 50 50 50 | $\begin{aligned} & 250 \\ & 300 \\ & 300 \\ & 500 \end{aligned}$ |

## TRANSISTOR INTERCHANGEABILITY

 MASTER LIST OF REGISTERED TYPES| TYPE MUMEER |  |  | $\begin{aligned} & \text { TI } \\ & \text { REPLACEMENT } \\ & \text { OR NEAREST } \\ & \text { EOUIVALENT } \end{aligned}$ | MAXIMUM RATINES |  |  | ELECTRICAL CHARACTERISTICS |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  | $\begin{gathered} T_{A}=25^{\circ} \mathrm{C} \\ { }^{*} \mathrm{C}=25^{\circ} \mathrm{C} \\ (\mathrm{~mW}) \end{gathered}$ | VCBO <br> (V) | $\mathbf{V}_{\text {CEO }}$ <br> (V) | HFE | $\begin{gathered} \mathrm{IC} \\ (\mathrm{~mA}) \end{gathered}$ |  | (sal) <br> 1 lC <br> $(\mathrm{mA})$ | $\begin{gathered} h_{f 0} \\ 0 \\ 1 \mathrm{kHz} \\ \text { MIN } \end{gathered}$ | fT <br> MIN <br> (MHz) |
| $\begin{aligned} & \text { 2N917A } \\ & \text { 2N918 } \\ & \text { 2N919 } \\ & \text { 2N920 } \end{aligned}$ | NPN <br> NPN <br> NPN <br> NPN | $\left\lvert\, \begin{aligned} & R F \\ & \text { RF } \\ & S W \\ & S W \end{aligned}\right.$ | $\begin{aligned} & \text { 2N917 } \\ & \text { 2N918 } \end{aligned}$ | $\begin{aligned} & 200 \\ & 200 \\ & 360 \\ & 360 \end{aligned}$ | 30 30 25 25 | 15 15 15 15 | $\begin{aligned} & 20-200 \\ & 20- \\ & 20-60 \\ & 40-120 \end{aligned}$ | 3 3 10 10 | .4 .4 .2 .2 | $\begin{aligned} & 10 \\ & 10 \\ & 10 \\ & 10 \end{aligned}$ |  | $\begin{aligned} & 600 \\ & 600 \\ & 200 \\ & 200 \end{aligned}$ |
| $\begin{aligned} & \text { 2N921 } \\ & \text { 2N922 } \\ & \text { 2N923 } \\ & \text { 2N924 } \end{aligned}$ | $\begin{aligned} & \text { NPN } \\ & \mathbf{N P N} \\ & \text { PNP } \\ & \text { PNP } \end{aligned}$ | $\begin{aligned} & S W \\ & S W \\ & G P \\ & G P \end{aligned}$ | $\begin{aligned} & \text { 2N2906 } \\ & \text { 2N2906 } \end{aligned}$ | 360 360 250 250 | 50 50 40 40 | 20 20 25 25 | $\begin{aligned} & 20-60 \\ & 40-120 \end{aligned}$ | $\begin{aligned} & 10 \\ & 10 \end{aligned}$ | .3 .3 .5 .5 | 10 10 5 5 | $\begin{aligned} & 12 \\ & 24 \end{aligned}$ | $\begin{aligned} & 200 \\ & 200 \end{aligned}$ |
| $\begin{aligned} & \text { 2N925 } \\ & \text { 2N926 } \\ & \text { 2N927 } \\ & \text { 2N928 } \end{aligned}$ | $\begin{aligned} & \text { PNP } \\ & \text { PNP } \\ & \text { PNP } \\ & \text { PNP } \end{aligned}$ | $\begin{aligned} & G P \\ & G P \\ & G P \\ & G P \end{aligned}$ | $\begin{aligned} & \text { 2N2906 } \\ & \text { 2N2906 } \\ & \text { 2N2906 } \\ & \text { 2N2906 } \end{aligned}$ | 250 250 250 250 | 50 50 70 70 | 40 40 60 60 |  |  | .5 .5 .5 .5 | $\begin{aligned} & 5 \\ & 5 \\ & 5 \\ & 5 \end{aligned}$ | $\begin{array}{r} 10 \\ 20 \\ 8 \\ 18 \end{array}$ |  |
| $\begin{aligned} & \text { 2N929 } \\ & \text { 2N929A } \\ & \text { 2N930 } \\ & \text { 2N930A } \end{aligned}$ | NPN <br> NPN <br> NPN <br> NPN | GP <br> GP <br> GP <br> GP | $\begin{aligned} & \text { 2N929 } \\ & \text { 2N930 } \end{aligned}$ | $\begin{aligned} & 300 \\ & 500 \\ & 300 \\ & 500 \end{aligned}$ | $\begin{aligned} & 45 \\ & 60 \\ & 45 \\ & 60 \end{aligned}$ | $\begin{aligned} & 45 \\ & 45 \\ & 45 \\ & 45 \end{aligned}$ | $\begin{array}{r} 40-120 \\ 40-120 \\ 100-300 \\ 100-300 \end{array}$ | $\begin{aligned} & .01 \\ & .01 \\ & .01 \\ & .01 \end{aligned}$ | 1 .5 1 .5 | $\begin{aligned} & 10 \\ & 10 \\ & 10 \\ & 10 \end{aligned}$ | $\begin{array}{r} 60 \\ 60 \\ 150 \\ 150 \end{array}$ | 30 45 30 45 |
| $\begin{aligned} & \text { 2N9308 } \\ & \text { 2N935 } \\ & \text { 2N936 } \\ & \text { 2N937 } \end{aligned}$ | NPN PNP PNP PNP | GP <br> GP <br> GP <br> GP | $\begin{aligned} & \text { 2N2907A } \\ & \text { 2N2907A } \\ & \text { 2N2907A } \end{aligned}$ | $\begin{aligned} & 500 \\ & 250 \\ & 250 \\ & 250 \end{aligned}$ | $\begin{aligned} & 60 \\ & 50 \\ & 50 \\ & 50 \end{aligned}$ | $\begin{aligned} & 45 \\ & 40 \\ & 35 \\ & 30 \end{aligned}$ | $\begin{gathered} 100-300 \\ 9-22 \\ 18-44 \\ 36-88 \end{gathered}$ | . 01 | .5 .3 .5 .6 | $\begin{array}{r} 10 \\ 5 \\ 5 \\ 5 \end{array}$ | 150 | 45 |
| $\begin{aligned} & \text { 2N938 } \\ & \text { 2N939 } \\ & \text { 2N940 } \\ & \text { 2N941 } \end{aligned}$ | PNP PNP PNP PNP | GP <br> GP <br> GP <br> GP | $\begin{aligned} & \text { 2N2907A } \\ & \text { 2N2907A } \\ & \text { 2N2907A } \\ & \text { 2N2907A } \end{aligned}$ | 250 250 250 250 | 40 40 40 25 | 35 35 35 | 10. | 1 | .3 .3 .3 | $\begin{aligned} & 5 \\ & 5 \\ & 5 \end{aligned}$ | 9 18 36 25 | 16 |
| $\left(\begin{array}{l} 2 \mathrm{~N} 942 \\ \text { 2N943 } \\ \text { 2N944 } \\ \text { 2N945 } \end{array}\right.$ | PNP <br> PNP <br> PNP <br> PNP | GP GP GP GP | $\begin{aligned} & \text { 2N2907A } \\ & \text { 2N2907A } \\ & \text { 2N2907A } \\ & \text { 2N2907A } \end{aligned}$ | $\begin{aligned} & 250 \\ & 250 \\ & 250 \\ & 250 \end{aligned}$ | $\begin{aligned} & 25 \\ & 40 \\ & 40 \\ & 50 \end{aligned}$ | $\begin{aligned} & 18 \\ & 18 \\ & 50 \end{aligned}$ | 10 10 10 | $\begin{aligned} & \text { 3UA } \\ & \text { 4UA } \\ & \text { 5UA } \end{aligned}$ |  |  | 25 25 25 25 | 10 |
| $\begin{aligned} & \text { 2N946 } \\ & \text { 2N947 } \\ & \text { 2N956 } \\ & \text { 2N957 } \end{aligned}$ | PNP <br> NPN <br> NPN <br> NPN | GP <br> SW <br> GP <br> GP | 2N2907A <br> 2N956 <br> 2N2221 | $\begin{aligned} & 250 \\ & 360 \\ & 500 \\ & 250 \end{aligned}$ | $\begin{aligned} & 80 \\ & 20 \\ & 75 \\ & 40 \end{aligned}$ | 80 <br> 20 | $\begin{aligned} & 10- \\ & 20- \\ & 100-300 \\ & 45- \end{aligned}$ | $\begin{array}{r} 5 U A \\ 10 \\ 150 \\ 10 \end{array}$ | $\begin{array}{r} .4 \\ 1.5 \\ 1.5 \end{array}$ | $\begin{array}{r} 5 \\ 150 \\ 10 \end{array}$ | 25 50 | 200 70 200 |
| $\begin{aligned} & \text { 2N958 } \\ & \text { 2N959 } \\ & \text { 2N978 } \\ & \text { 2N981 } \end{aligned}$ | NPN <br> NPN <br> PNP <br> NPN | SW SW GP GP | $\begin{aligned} & \text { 2N2906 } \\ & \text { 2N720A } \end{aligned}$ | 250 250 330 500 | 25 25 30 80 | 15 15 20 80 | $20-$ 40 $15-60$ $36-$ | 10 10 150 1 | .2 .2 1.5 3 | $\begin{array}{r} 10 \\ 10 \\ 150 \\ 10 \end{array}$ | 36 | 200 200 40 |
| 2N986 <br> 2N988 <br> 2N989 <br> 2N995 | NPN <br> NPN <br> NPN PNP | GP <br> GP <br> GP <br> SW | $\begin{aligned} & \text { 2N2221 } \\ & \text { 2N2221 } \end{aligned}$ | $\begin{aligned} & 500 \\ & 300 \\ & 300 \\ & 360 \end{aligned}$ | $\begin{array}{r} 100 \\ 20 \\ 20 \\ 20 \end{array}$ | $\begin{aligned} & 10 \\ & 10 \\ & 15 \end{aligned}$ | $20-120$ $20-120$ $35-140$ | 10 10 20 | .5 .5 .2 | 10 10 20 |  | 300 300 100 |

# TRANSISTOR INTERCHANGEABILITY MASTER LIST OF REGISTERED TYPES 

| $\begin{gathered} \text { TYF } \\ \text { MUMER } \end{gathered}$ |  | $\begin{aligned} & \frac{8}{8} \\ & \frac{8}{8} \\ & \frac{8}{8} \\ & 8 \end{aligned}$ | $\begin{aligned} & \text { II } \\ & \text { momacement } \\ & \text { or manest } \\ & \text { EOUVALBNT } \end{aligned}$ | MAXIMUM RATMvos |  |  | BECHECAL CHARACTINTICS |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  | $\begin{gathered} \mathrm{T}_{\mathrm{A}}=25^{\circ} \mathrm{C} \\ { }^{\circ} \mathrm{C}=25^{\circ} \mathrm{C} \\ (\mathrm{~mW}) \end{gathered}$ | VCBO <br> (V) | $V_{C E O}$ <br> (V) | $H^{\text {F }}$ |  | Vels(med) |  |  | $\begin{gathered} \mathbf{F}_{T} \\ \text { MNN } \\ \text { (MNz) } \end{gathered}$ |
|  |  |  |  |  |  |  | MNN M | $\begin{gathered} k \\ \text { (ma) } \end{gathered}$ |  | $\begin{array}{r} \hline \mathbf{l} \\ (\mathrm{mA}) \\ \hline \end{array}$ |  |  |
| $\begin{aligned} & \text { 2N995A } \\ & \text { 2N996 } \\ & \text { 2N997 } \\ & \text { 2N998 } \end{aligned}$ | $\begin{aligned} & \text { PNP } \\ & \text { PNP } \\ & \text { NPN } \\ & \text { NPN } \end{aligned}$ | SW <br> GP <br> DA <br> DA | 2N2906 2N997 2N998 | $\begin{aligned} & 360 \\ & 360 \\ & 500 \\ & 500 \end{aligned}$ | $\begin{array}{r} 20 \\ 15 \\ 75 \\ 100 \end{array}$ | $\begin{aligned} & 15 \\ & 12 \\ & 40 \\ & 60 \end{aligned}$ | $\begin{aligned} & 35-140 \\ & 35- \\ & 7 K-70 K \\ & 1.6 K-8 K \end{aligned}$ | $\begin{array}{r} 20 \\ 20 \\ 100 \\ 10 \end{array}$ | .2 .3 1.6 1.2 | $\begin{array}{r} 20 \\ 60 \\ 100 \\ 50 \end{array}$ | 1000 | 100 100 |
| $\begin{aligned} & \text { 2N999 } \\ & \text { 2N1005 } \\ & \text { 2N1006 } \\ & \text { 2N1024 } \end{aligned}$ | $\begin{aligned} & \text { NPN } \\ & \text { NPN } \\ & \text { NPN } \\ & \text { PN } \end{aligned}$ | DA <br> GP <br> GP <br> SW | $\begin{aligned} & \text { 2N999 } \\ & \text { 2N2217 } \\ & \text { 2N2218 } \\ & \text { 2N3250 } \end{aligned}$ | $\begin{aligned} & 500 \\ & 150 \\ & 150 \\ & 250 \end{aligned}$ | $\begin{aligned} & 60 \\ & 15 \\ & 15 \\ & 18 \end{aligned}$ | 60 15 15 | $\begin{aligned} & 7 K-70 K \\ & 10-25 \\ & 25-150 \end{aligned}$ | $\begin{array}{r} 100 \\ 10 \\ 10 \end{array}$ | 1.6 .6 .6 | $\begin{array}{r} 100 \\ 10 \\ 10 \end{array}$ | 9 |  |
| $\begin{aligned} & \text { 2N1025 } \\ & \text { 2N1026 } \\ & \text { 2N1027 } \\ & \text { 2N1028 } \end{aligned}$ |  | $\begin{aligned} & s w \\ & s w \\ & s w \\ & s w \end{aligned}$ | $\begin{aligned} & \text { 2N3250 } \\ & \text { 2N3250 } \\ & \text { 2N3250 } \\ & \text { 2N3250 } \end{aligned}$ | $\begin{aligned} & 250 \\ & 250 \\ & 250 \\ & 250 \end{aligned}$ | $\begin{aligned} & 40 \\ & 40 \\ & 18 \\ & 12 \end{aligned}$ |  |  |  |  |  | 9 18 18 9 | 7.2 |
| $\begin{aligned} & \text { 2N1034 } \\ & \text { 2N1035 } \\ & \text { 2N1036 } \\ & \text { 2N1037 } \end{aligned}$ | $\begin{aligned} & \text { PNP } \\ & \text { PNP } \\ & \text { PNP } \\ & \text { PNP } \end{aligned}$ | GP <br> GP <br> $G P$ <br> GP |  | 250 250 250 250 | 50 50 50 50 | 40 35 30 35 |  |  | .5 .4 .3 .5 | 8 8 8 8 | 9 18 34 9 |  |
| $\begin{aligned} & \text { 2N1051 } \\ & \text { 2N1052 } \\ & \text { 2N1054 } \\ & 2 N_{1055} \end{aligned}$ | $\begin{aligned} & \text { NPN } \\ & \text { NPN } \\ & \text { NPN } \\ & \text { NPN } \end{aligned}$ | GP <br> $G P$ <br> GP <br> GP | $\begin{aligned} & \text { 2N2218 } \\ & \text { 2N3114 } \\ & \text { 2N3114 } \end{aligned}$ | $\begin{aligned} & 500 \\ & 150 \\ & 600 \\ & 200 \end{aligned}$ | $\begin{array}{r} 40 \\ 200 \\ 125 \\ 100 \end{array}$ | $\begin{array}{r} 40 \\ 115 \\ 100 \end{array}$ | $\begin{aligned} & 25- \\ & 20-80 \\ & 20 \\ & 20-80 \end{aligned}$ | $\begin{array}{r} 50 \\ 200 \\ 200 \\ 50 \end{array}$ | $\begin{aligned} & 3 \\ & 5 \\ & 2 \end{aligned}$ | $\begin{array}{r} 50 \\ 200 \\ 50 \end{array}$ | $\begin{aligned} & 30 \\ & 15 \end{aligned}$ | 80 8 3 |
| $\begin{aligned} & 2 \mathrm{~N} 1060 \\ & 2 \mathrm{~N} 1074 \\ & 2 \mathrm{~N} 1075 \\ & 2 \mathrm{~N} 1076 \end{aligned}$ | NPN <br> NPN <br> NPN <br> NPN | $\begin{aligned} & \text { GP } \\ & \text { GP } \\ & \text { GP } \\ & \text { GP } \end{aligned}$ | $\begin{aligned} & \text { 2N2217 } \\ & \text { 2N2218 } \\ & \text { 2N2218 } \\ & \text { 2N2218 } \end{aligned}$ | 250 250 250 250 | 40 50 50 50 | 40 40 35 30 | 17 | 5 | . 3 | 5 | 9 18 36 |  |
| 2N1077 <br> 2N1082 <br> 2N1103 <br> 2N1104 | NPN <br> NPN <br> NPN <br> NPN | $\begin{aligned} & G P \\ & G P \\ & G P \\ & G P \end{aligned}$ | $\begin{aligned} & \text { 2N2218 } \\ & \text { 2N2221 } \\ & \text { 2N2221 } \\ & \text { 2N2221 } \end{aligned}$ | $\begin{aligned} & 250 \\ & 200 \\ & 125 \\ & 125 \end{aligned}$ | $\begin{aligned} & 50 \\ & 25 \\ & 45 \\ & 45 \end{aligned}$ | 35 35 35 | $\begin{aligned} & 10-50 \\ & 30-65 \\ & 45-150 \end{aligned}$ | $\begin{aligned} & 10 \\ & 10 \\ & 10 \end{aligned}$ | $\begin{array}{r} 1 \\ 1.5 \\ 1.5 \end{array}$ | $\begin{array}{r} 8 \\ 10 \\ 10 \end{array}$ | 9 10 20 40 | 7 |
| 2N1105 <br> 2N1106 <br> 2N1116 <br> 2N1117 | NPN <br> NPN <br> NPN <br> NPN | $\begin{aligned} & \text { GP } \\ & \text { GP } \\ & \text { GP } \\ & \text { GP } \end{aligned}$ | 2N698 <br> 2N698 <br> 2N2192 <br> 2N2193 | $\begin{aligned} & 800 \\ & 800 \\ & 600 \\ & 600 \end{aligned}$ | $\begin{array}{r} 60 \\ 100 \\ 60 \\ 60 \end{array}$ | $\begin{array}{r} 60 \\ 100 \\ 60 \\ 60 \end{array}$ | $\begin{aligned} & 12-36 \\ & 12-36 \\ & 40-150 \\ & 40-150 \end{aligned}$ | $\begin{aligned} & 200 \\ & 200 \\ & 500 \\ & 200 \end{aligned}$ | 5 5 5 4 | $\begin{aligned} & 200 \\ & 200 \\ & 500 \\ & 200 \end{aligned}$ |  | 6 4 |
| 2N1118 <br> 2N1118A <br> 2N1119 <br> 2N1131 | $\begin{aligned} & \text { PNP } \\ & \text { PNP } \\ & \text { PNP } \\ & \text { PNP } \end{aligned}$ | $\begin{aligned} & \text { SW } \\ & \text { SW } \\ & \text { GP } \\ & \text { GP } \end{aligned}$ | $\begin{aligned} & \text { 2N3250 } \\ & \text { 2N3250 } \\ & \text { 2N1131 } \end{aligned}$ | $\begin{aligned} & 150 \\ & 150 \\ & 150 \\ & 600 \end{aligned}$ | $\begin{aligned} & 25 \\ & 25 \\ & 10 \\ & 50 \end{aligned}$ | 35 | 2515. 20-45 | $\begin{array}{r} 15 \\ 15 \\ 150 \end{array}$ | $\begin{aligned} & .15 \\ & 1.5 \end{aligned}$ | $\begin{array}{r} 5 \\ 150 \end{array}$ | $\begin{aligned} & 15 \\ & 15 \\ & 15 \end{aligned}$ | 8 8 7.2 50 |
| 2N1131A <br> 2N1132 <br> 2N1132A <br> 2N11328 | $\begin{aligned} & \text { PNP } \\ & \mathbf{P N P} \\ & \mathbf{N N P} \\ & \text { PNP } \end{aligned}$ | $\begin{aligned} & G P \\ & G P \\ & G P \\ & G P \end{aligned}$ | 2N1131 <br> 2N1132 <br> 2N1132 <br> 2N1132 | $\begin{aligned} & 600 \\ & 600 \\ & 600 \\ & 600 \end{aligned}$ | $\begin{aligned} & 60 \\ & 50 \\ & 60 \\ & 70 \end{aligned}$ | $\begin{aligned} & 40 \\ & 35 \\ & 40 \\ & 45 \end{aligned}$ | $\begin{aligned} & 20-45 \\ & 30-90 \\ & 30-90 \\ & 30-90 \end{aligned}$ | $\begin{aligned} & 150 \\ & 150 \\ & 150 \\ & 150 \end{aligned}$ | $\begin{aligned} & 1.5 \\ & 1.5 \\ & 1.5 \\ & 1.5 \end{aligned}$ | $\begin{aligned} & 150 \\ & 150 \\ & 150 \\ & 150 \end{aligned}$ | $\begin{aligned} & 15 \\ & 25 \\ & 25 \\ & 25 \end{aligned}$ | 50 60 60 60 |

## TRANSISTOR INTERCHANGEABILITY MASTER LIST OF REGISTERED TYPES

| TYPK NUME思 |  | $\begin{aligned} & 8 \\ & \frac{8}{8} \\ & \frac{8}{8} \\ & 8 \end{aligned}$ | 7 <br> replacement OR NEAREST ERUMYALENT | MAXXMUM RATmas |  |  | EPCTRICAL CHARACTEISTICS |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  | $\begin{gathered} T_{A}=25^{\circ} \mathrm{C} \\ { }^{T_{C}} \mathrm{C}=25^{\circ} \mathrm{C} \\ (\mathrm{~mW}) \end{gathered}$ | Veno <br> (V) | Vcro <br> (V) | hri  <br> MIN  <br> $(\mathrm{MAX})$  |  | $\begin{gathered} \text { hfe } \\ 1 \mathrm{kHz} \\ \text { MiN } \end{gathered}$ | $\begin{array}{c\|} \hline \text { f } \\ \text { Man } \\ (\mathrm{MHAz}) \\ \hline \end{array}$ |
| $\left\lvert\, \begin{aligned} & 2 N 1135 \\ & 2 N 1135 A \\ & 2 N 1139 \\ & 2 N 1149 \end{aligned}\right.$ | $\begin{aligned} & \text { PNP } \\ & \text { PNP } \\ & \text { NPN } \\ & \text { NPN } \end{aligned}$ | $\begin{aligned} & G P \\ & G P \\ & G P \\ & G P \end{aligned}$ | $\begin{aligned} & \text { 2N2904 } \\ & \text { 2N2904 } \\ & \text { 2N2218 } \\ & \text { 2N1149 } \end{aligned}$ | 100 100 100 150 | 12 12 15 45 | 12 12 15 | $\begin{array}{cr}20-200 & 10 \\ 9-20 & 1\end{array}$ | . 710 |  | $\begin{gathered} 5.6 \\ 5.6 \\ 100 \end{gathered}$ |
| $\left\{\begin{array}{l} 2 N i 150 \\ 2 N: 151 \\ 2 N 1152 \\ 2 N \\| 153 \end{array}\right.$ | NPN NPN NPN NPN | $\begin{aligned} & G P \\ & G P \\ & G P \\ & G P \end{aligned}$ | 2N1150 <br> 2N1151 <br> 2N1152 <br> 2N1153 | $\begin{aligned} & 150 \\ & 150 \\ & 150 \\ & 150 \end{aligned}$ | $\begin{aligned} & 45 \\ & 45 \\ & 45 \\ & 45 \end{aligned}$ |  | $\begin{array}{ll}18-40 & 1 \\ 18-90 & 1 \\ 36-90 & 1 \\ 76-333 & 1\end{array}$ |  |  |  |
| $\begin{aligned} & 2 N 1154 \\ & 2 N 1155 \\ & 2 N 1156 \\ & 2 N 1196 \end{aligned}$ | $\begin{aligned} & \text { NPN } \\ & \text { NPN } \\ & \text { NPN } \\ & \text { PNP } \end{aligned}$ | $\begin{aligned} & G P \\ & G P \\ & G P \\ & G P \end{aligned}$ | 2N1154 <br> 2N1155 <br> 2N1156 | $\begin{aligned} & 750 \\ & 750 \\ & 750 \\ & 350 \end{aligned}$ | $\begin{array}{r} 50 \\ 80 \\ 120 \\ 70 \end{array}$ | 70 | $9-$ 5 <br> 9. 5 <br> 9. 5 <br> $5-30$ 2 |  |  |  |
| $\begin{aligned} & 2 N 1197 \\ & 2 N 1199 \\ & 2 N 1199 A \\ & 2 N 1200 \end{aligned}$ | PNP <br> NPN <br> NPN <br> NPN | $\begin{aligned} & \text { GP } \\ & \text { SW } \\ & \text { SW } \\ & \text { RF } \end{aligned}$ |  | $\begin{aligned} & 350 \\ & 150 \\ & 150 \\ & 100 \end{aligned}$ | $\begin{aligned} & 70 \\ & 20 \\ & 20 \\ & 20 \end{aligned}$ | $\begin{aligned} & 70 \\ & 15 \\ & 15 \\ & 15 \end{aligned}$ | $\begin{array}{cr}5-30 \\ 12-60 & 2 \\ 12-60 & 20 \\ 7-200 & 20 \\ \end{array}$ | $\begin{array}{ll} .25 & 10 \\ .25 & 10 \end{array}$ | 9 | 75 75 |
| $\begin{aligned} & \text { 2N1201 } \\ & \text { 2N1219 } \\ & \text { 2N1220 } \\ & \text { 2N1221 } \end{aligned}$ | NPN PNP PNP PNP | RF SW SW SW | $\begin{aligned} & \text { 2N3250 } \\ & \text { 2N3250 } \\ & \text { 2N3250 } \end{aligned}$ | 100 250 250 250 | 20 30 30 30 | $\begin{aligned} & 15 \\ & 25 \\ & 25 \\ & 25 \end{aligned}$ | $\begin{array}{cr}7.200 & 1.5 \\ 18 . & 5 \\ 9 . & 5\end{array}$ |  | $\begin{gathered} 9 \\ 18 \end{gathered}$ |  |
| $\begin{aligned} & \text { 2N1222 } \\ & \text { 2N1223 } \\ & \text { 2N1228 } \\ & \text { 2N1229 } \end{aligned}$ | $\begin{array}{\|l} \text { PNP } \\ \text { PNP } \\ \text { PNP } \\ \text { PNP } \end{array}$ | sW <br> SW <br> GP <br> GP | 2N3250 <br> 2N3250 <br> 2N2904 <br> 2N2904 | 250 250 400 400 | 30 40 15 15 | 25 40 15 15 |  | .2 10 <br> .2 10 | 9 6 14 28 |  |
| $\begin{aligned} & \text { 2N1230 } \\ & \text { 2N1231 } \\ & \text { 2N1232 } \\ & \text { 2N1233 } \end{aligned}$ | PNP <br> PNP PNP PNP | GP <br> GP <br> GP <br> GP | $\begin{aligned} & \text { 2N2904 } \\ & \text { 2N2904 } \\ & \text { 2N2905A } \\ & \text { 2N2905A } \end{aligned}$ | 400 400 400 400 | 35 35 60 60 | 35 35 60 60 |  | .2 10 <br> .2 10 <br> .2 10 <br> .2 10 | 14 28 14 28 |  |
| $\begin{aligned} & 2 N 1234 \\ & 2 N 1238 \\ & 2 N 1239 \\ & 2 N 1240 \end{aligned}$ | PNP <br> PNP <br> PNP <br> PNP | GP <br> SW <br> SW <br> SW | 2N3494 | 400 16 16 16 | 110 15 15 35 | 110 15 15 35 |  | .2 10 <br> .2 10 <br> .2 10 <br> .2 10 | 14 14 28 14 |  |
| $\begin{aligned} & 2 \mathrm{~N} 1241 \\ & 2 \mathrm{~N} 1242 \\ & 2 \mathrm{~N} 1243 \\ & 2 \mathrm{~N} 1244 \end{aligned}$ | PNP PNP PNP PNP | $\begin{aligned} & s w \\ & s w \\ & S W \\ & s w \end{aligned}$ |  | 16 16 16 16 | 35 60 60 110 | 35 60 60 110 |  | .2 10 <br> .2 10 <br> .2 10 <br> .2 10 | 28 14 28 14 |  |
| $\begin{aligned} & \text { 2N1247 } \\ & \text { 2N1248 } \\ & \text { 2N1249 } \\ & \text { 2N1252 } \end{aligned}$ | NPN <br> NPN <br> NPN <br> NPN | GP <br> GP <br> GP <br> SW | $\begin{aligned} & \text { 2N2222 } \\ & \text { 2N2222 } \\ & \text { 2N2222 } \\ & \text { 2N2537 } \end{aligned}$ | $\begin{array}{r} 30 \\ 30 \\ 30 \\ 600 \end{array}$ | $\begin{array}{r} 6 \\ 6 \\ 6 \\ 30 \end{array}$ | $\begin{aligned} & 6 \\ & 6 \\ & 6 \end{aligned}$ | $15-$ 5 UA <br> $15-$ .02 <br> $20-$ .03 <br> $15-45$ 150 | 1.5150 |  | 40 |

## TRANSISTOR INTERCHANGEABILITY MASTER LIST OF REGISTERED TYPES

| TYPE NUMEE | $\begin{aligned} & \frac{\xi}{3} \\ & \frac{8}{2} \end{aligned}$ | 88888 |  | MAXIMUM RATINOS |  |  | EMcIRICAL CHARACTEISTICS |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  | $\begin{gathered} \mathrm{r}_{\mathrm{A}}=25^{\circ} \mathrm{C} \\ { }^{{ }^{\circ} \mathrm{T} \mathrm{C}=25^{\circ} \mathrm{C}} \\ (\mathrm{~mW}) \end{gathered}$ | Veno <br> (V) | Veso <br> (V) |  |  | Ver (mat) |  | $\begin{gathered} h_{10} \\ 1 \mathrm{kdtz} \\ \text { MiN } \end{gathered}$ | $\begin{gathered} \mathrm{T} \\ \text { MiN } \\ \text { (MNz) } \end{gathered}$ |
|  |  |  |  |  |  |  | MIN MAXIC <br>  <br>  <br>  |  | $\begin{array}{\|lr\|} \hline \max & \mathrm{IC} \\ \mathrm{IV}) & (\mathrm{ma}) \\ \hline \end{array}$ |  |  |  |
| $\begin{aligned} & \text { 2N1252A } \\ & \text { 2N1253 } \\ & \text { 2N1253A } \\ & \text { 2N1254 } \end{aligned}$ | NPN | SW | 2N2537 | 800 | 60 | 30 | 15-45 | 150 | 1.5 | 150 |  | 40 |
|  | NPN | SW | 2N2537 | 600 | 30 |  | 30-90 | 150 | 1.5 | 150 |  | 50 |
|  | NPN | SW | 2N2537 | 800 | 60 | 30 | 30-90 | 150 | 1.5 | 150 |  | 50 |
|  | PNP | GP | 2N1131 | 275 | 30 | 30 | 25-50 | 10 | . 3 | 10 |  | 30 |
| $\begin{aligned} & 2 \mathrm{~N} 1255 \\ & 2 \mathrm{~N} 1256 \\ & 2 \mathrm{~N} 1257 \\ & 2 \mathrm{~N} 1258 \end{aligned}$ | PNP | GP | 2N1132 | 275 | 30 | 30 | 40-80 | 10 | . 3 | 10 |  | 50 |
|  | PNP | GP | 2N1131 | 275 | 40 | 40 | 25-50 | 10 | . 3 | 10 |  | 30 |
|  | PNP | GP | 2N1132 | 275 | 40 | 40 | 40-80 | 10 | . 3 | 10 |  | 50 |
|  | PNP | GP | 2N2905 | 275 | 30 | 30 | 75-150 | 10 | . 6 | 10 |  | 50 |
| $\begin{aligned} & \text { 2N1259 } \\ & \text { 2N1267 } \\ & \text { 2N1268 } \\ & \text { 2N1269 } \end{aligned}$ | PNP | GP | 2N2904 | 275 |  | 50 | 25-100 | 10 | . 3 | 10 |  | 40 |
|  | NPN | RF |  | 150 | 20 | 15 | $4-16$ | 1.5 |  |  | 6 |  |
|  | NPN | RF |  | 150 | 20 | 15 | 7-30 | 1.5 |  |  | 11 |  |
|  | NPN | RF |  | 150 | 20 | 15 | 20-80 | 1.5 |  |  | 28 |  |
| $\begin{aligned} & 2 \mathrm{~N} 1270 \\ & 2 \mathrm{~N} 1271 \\ & 2 \mathrm{~N} 1272 \\ & 2 \mathrm{~N} 1275 \end{aligned}$ | NPN | RF |  | 150 | 20 | 15 | 4-16 | 1.5 |  |  | 6 |  |
|  | NPN | RF |  | 150 | 20 | 15 | 7.30 | 1.5 |  |  | 11 |  |
|  | NPN | RF |  | 150 | 20 | 15 | 20-80 | 1.5 |  |  | 28 |  |
|  | PNP | GP |  | 250 | 100 | 80 | 9-25 | 1 | . 3 | 5 |  |  |
| $\left\lvert\, \begin{aligned} & \text { 2N1276 } \\ & \text { 2N1277 } \\ & \text { 2N1278 } \\ & \text { 2N1279 } \end{aligned}\right.$ |  |  |  |  |  |  |  |  | 1 | 5 | 9 |  |
|  | NPN | GP |  | 150 | 40 | 30 |  |  | 1 | 5 | 18 |  |
|  | NPN | GP |  | 150 | 40 | 30 |  |  | 1 | 5 | 37 |  |
|  | NPN | GP |  | 150 | 40 | 30 |  |  |  | 5 | 76 |  |
| $\begin{aligned} & \text { 2N1335 } \\ & \text { 2N1336 } \\ & \text { 2N1337 } \\ & \text { 2N1338 } \end{aligned}$ | NPN |  |  | 800 | 120 | 45 | 10-150 | 30 |  |  |  | 70 |
|  | NPN | $G P$ |  | 800 | 120 | 45 | 10-150 | 30 |  |  |  | 70 |
|  | NPN | GP |  | 800 | 120 | 45 | 10-150 | 30 |  |  |  | 70 |
|  | NPN | GP |  | 800 | 80 | 25 | $10-150$ | 30 |  |  |  | 70 |
| $\begin{aligned} & 2 \mathrm{~N} 1339 \\ & 2 \mathrm{~N} 1340 \\ & 2 \mathrm{~N} 1341 \\ & 2 \mathrm{~N} 1342 \end{aligned}$ | NPN | GP |  | 800 | 120 | 50 | 10-150 | 30 |  |  |  |  |
|  | MPN | GP |  | 800 | 120 | 50 | 10-150 | 30 |  |  |  | 70 |
|  | NPN | GP |  | 800 | 120 | 50 | 10-150 | 30 |  |  |  | 70 |
|  | NPN | GP |  | 800 | 150 | 65 | 10-150 | 30 |  |  |  | 70 |
| $\begin{aligned} & 2 N 1386 \\ & 2 N 1387 \\ & 2 N 1388 \\ & 2 N 1389 \end{aligned}$ | NPN | GP | 2N2222 | 300 | 25 | 25 | 30-90 | 10 |  |  |  |  |
|  | NPN | GP | 2N2222 | 300 | 30 | 30 | 20-40 | 10 |  | 5 |  |  |
|  | NPN | GP | 2N2222 | 300 | 45 | 25 | 15-55 | 10 |  |  | 30 |  |
|  | NPN | GP | 2N2222 | 300 | 50 | 50 |  |  |  | 5 |  | 24 |
| $\begin{aligned} & 2 N 1390 \\ & 2 N 1409 \\ & 2 N 1409 A \\ & 2 N 1410 \end{aligned}$ | NPN | GP | 2N2222 | 300 | 20 |  | 30.150 | 10 |  |  | 10 |  |
|  | NPN | SW | 2N2537 | 600 | 30 | 25 | 15-45 | 150 |  |  |  | 200 |
|  | NPN | SW | 2N2537 | 800 | 30 | 25 | 15-45 | 150 |  |  |  | 200 |
|  | NPN | SW | 2N2537 | 600 | 45 | 30 | 30-90 | 150 |  |  |  | 130 |
| $\begin{array}{\|l} \text { 2N1410A } \\ \text { 2N1417 } \\ \text { 2N1418 } \\ \text { 2N1420 } \end{array}$ | NPN | Sw | 2N2537 | 800 | 30 | 30 | 30.90 | 150 |  |  |  | 130 |
|  | NPN | GP | 2N2218 | 150 | 15 | 15 |  |  |  |  | 30 |  |
|  | NPN | GP | 2N2218 | 150 | 30 | 30 |  |  |  |  | 30 |  |
|  | NPN | GP | 2N1420 | 600 | 60 |  | 100-300 | 150 | 1.5 | 150 |  | 50 |

## TRANSISTOR INTERCHANGEABILITY MASTER LIST OF REGISTERED TYPES

| $\begin{aligned} & \text { TYPE } \\ & \text { NUMBER } \end{aligned}$ |  | $\begin{aligned} & \mathbf{7} \\ & \frac{2}{3} \\ & 5 \\ & 5 \\ & 5 \end{aligned}$ | $\begin{aligned} & \text { TI } \\ & \text { RERLACEMENT } \\ & \text { OR MGAREST } \\ & \text { EOUYALENT } \end{aligned}$ | MAXIMUM RATENOS |  |  | ELECTICAL CHARACTIEMSTICS |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  | $\begin{gathered} \mathrm{P}_{\mathrm{T}} \\ \mathrm{r}_{\mathrm{A}}=25^{\circ} \mathrm{C} \\ { }^{+} \mathrm{T}_{\mathrm{C}}=25^{\circ} \mathrm{C} \\ (\mathrm{~mW}) \end{gathered}$ | Veso <br> (V) | Vceo(v) | hpe |  | Vces(eat) |  |  |  |
|  |  |  |  |  |  |  | MIN Ma | $\begin{gathered} c \\ (m A) \end{gathered}$ | MaX <br> (V) | $\begin{array}{r} 1 c \\ (\mathrm{ma}) \\ \hline \end{array}$ |  |  |
| $\begin{aligned} & \text { 2N1420A } \\ & \text { 2N1428 } \\ & \text { 2N1429 } \\ & \text { 2N1439 } \end{aligned}$ | NFN PNP PNP PNP | GP <br> GP <br> GP <br> GP | 2N1420 <br> 2N2904 <br> 2N2907A | 800 100 100 400 | 60 6 6 50 | $\begin{array}{r} 6 \\ 6 \\ 50 \end{array}$ | $\begin{aligned} & 100-300 \\ & 12 . \\ & 12 . \end{aligned}$ | $\begin{array}{r} 150 \\ 5 \\ 5 \end{array}$ | $\begin{array}{r} 1.5 \\ .1 \\ .1 \\ .25 \end{array}$ | $\begin{array}{r} 150 \\ 5 \\ 5 \\ 5 \\ \hline \end{array}$ | 25 25 9 | $\begin{aligned} & 60 \\ & 16 \\ & 16 \end{aligned}$ |
| 2N1440 <br> 2N1441 <br> 2N1442 <br> 2N1443 | PNP <br> PNP <br> PNP <br> PNP | GP <br> GP <br> GP <br> GP | $\begin{aligned} & \text { 2N2907A } \\ & \text { 2N2907A } \\ & \text { 2N2907A } \\ & \text { 2N2907 } \end{aligned}$ | 400 400 400 400 | 60 50 50 50 | 50 35 30 15 |  |  | .25 .25 .25 .25 | 5 5 5 5 | 9 18 30 50 |  |
| 2N1444 <br> 2N1469 <br> 2N1472 <br> 2N1474 | NPN PNP NPN PNP | $\begin{aligned} & G P \\ & G P \\ & S W \\ & G P \end{aligned}$ | 2N2906 <br> 2N2906A | $\begin{aligned} & 500 \\ & 250 \\ & 150 \\ & 250 \end{aligned}$ | $\begin{aligned} & 60 \\ & 40 \\ & 25 \\ & 60 \end{aligned}$ | 20 <br> 25 | $20$ $20$ | $250$ | 1.5 <br> .25 | 250 <br> 10 | $\begin{aligned} & 36 \\ & 12 \end{aligned}$ | 75 |
| $\begin{aligned} & \text { 2N1474A } \\ & \text { 2N1475 } \\ & \text { 2N1476 } \\ & \text { 2N1477 } \end{aligned}$ | $\begin{aligned} & \text { PNP } \\ & \text { PNP } \\ & \text { PNP } \\ & \text { PNP } \end{aligned}$ | $\begin{aligned} & G P \\ & G P \\ & G P \\ & G P \end{aligned}$ | $\begin{aligned} & \text { 2N2906A } \\ & \text { 2N2906A } \\ & \text { 2N3495 } \\ & \text { 2N3495 } \end{aligned}$ | $\begin{aligned} & 250 \\ & 250 \\ & 250 \\ & 250 \end{aligned}$ | $\begin{array}{r} 60 \\ 60 \\ 100 \\ 100 \end{array}$ |  |  |  |  |  | 18 36 12 30 |  |
| $\begin{aligned} & 2 \mathrm{~N} 1491 \\ & 2 \mathrm{~N} 1492 \\ & 2 \mathrm{~N} 1493 \\ & 2 \mathrm{~N} 1507 \end{aligned}$ | NPN <br> NPN <br> NPN <br> NPN | $\begin{aligned} & G P \\ & G P \\ & G P \\ & G P \end{aligned}$ | $\begin{aligned} & \text { 2N2218 } \\ & \text { 2N2192 } \\ & \text { 2N5059 } \\ & \text { 2N1507 } \end{aligned}$ | *3W <br> *3W <br> *3W <br> 600 | $\begin{array}{r} 30 \\ 60 \\ 100 \\ 60 \end{array}$ |  | 100-300 | 150 | 1.5 | 150 | 15 15 15 | 50 |
| $\left\lvert\, \begin{aligned} & 2 N 1508 \\ & 2 N 1509 \\ & 2 N 1528 \\ & 2 N 1564 \end{aligned}\right.$ | NPN NFN NPN NPN | $\begin{aligned} & \text { GP } \\ & \text { GP } \\ & \text { GP } \\ & \text { GP } \end{aligned}$ | $\begin{aligned} & \text { 2N2102 } \\ & \text { 2N2102 } \\ & \text { 2N2218 } \\ & \text { 2N2218 } \end{aligned}$ | $\begin{aligned} & 1 w \\ & 1 w \\ & 150 \\ & 600 \end{aligned}$ | $\begin{array}{r} 100 \\ 60 \\ 25 \\ 80 \end{array}$ | $\begin{aligned} & 55 \\ & 35 \\ & 60 \end{aligned}$ | $\begin{aligned} & 20-60 \\ & 20-60 \\ & 15-50 \end{aligned}$ | $\begin{array}{r} 600 \\ 600 \\ 5 \end{array}$ | $\begin{array}{r} 3.6 \\ 3.6 \\ 1 \end{array}$ | $\begin{array}{r} 600 \\ 600 \\ \\ 10 \end{array}$ | 10 20 | 50 50 |
| $\begin{aligned} & \text { 2N1 565 } \\ & \text { 2N1566 } \\ & \text { 2N1572 } \\ & \text { 2N1573 } \end{aligned}$ | $\begin{aligned} & \text { NPN } \\ & \text { NPN } \\ & \text { NPN } \\ & \text { NPN } \end{aligned}$ | $\begin{aligned} & G P \\ & G P \\ & G P \\ & G P \end{aligned}$ | $\begin{aligned} & \text { 2N2218 } \\ & \text { 2N1566 } \\ & \text { 2N698 } \\ & \text { 2N1893 } \end{aligned}$ | $\begin{aligned} & 600 \\ & 600 \\ & 600 \\ & 600 \end{aligned}$ | $\begin{array}{r} 60 \\ 80 \\ 125 \\ 125 \end{array}$ | $\begin{aligned} & 30 \\ & 60 \\ & 80 \\ & 80 \end{aligned}$ | $\begin{aligned} & 30-100 \\ & 60-200 \\ & 15-50 \\ & 30-100 \end{aligned}$ | 5 5 5 5 | 1 1 1 1 | $\begin{aligned} & 10 \\ & 10 \\ & 10 \\ & 10 \end{aligned}$ | 40 80 20 40 |  |
| $\left\lvert\, \begin{aligned} & \text { 2N1574 } \\ & \text { 2N1586 } \\ & \text { 2N1587 } \\ & \text { 2N1588 } \end{aligned}\right.$ | $\begin{aligned} & \text { NPN } \\ & \text { NPN } \\ & \text { NPN } \\ & \text { NPN } \end{aligned}$ | GP GP GP GP | 2N1890 | $\begin{aligned} & 600 \\ & 125 \\ & 125 \\ & 125 \end{aligned}$ | $\begin{array}{r} 125 \\ 15 \\ 30 \\ 60 \end{array}$ | 80 10 20 40 | $\begin{gathered} 60-200 \\ 5-27 \\ 5-27 \\ 5-27 \end{gathered}$ | 5 1 1 1 | 1 1.5 1.5 1.5 | 10 5 5 5 | 80 9 9 9 |  |
| $\begin{aligned} & \text { 2N1589 } \\ & \text { 2N1590 } \\ & \text { 2N1591 } \\ & \text { 2N1592 } \end{aligned}$ | $\begin{aligned} & \text { NPN } \\ & \text { NPN } \\ & \text { NPN } \\ & \text { NPN } \end{aligned}$ | GP <br> GP <br> GP <br> GP |  | $\begin{aligned} & 125 \\ & 125 \\ & 125 \\ & 125 \end{aligned}$ | $\begin{aligned} & 15 \\ & 30 \\ & 60 \\ & 15 \end{aligned}$ | $\begin{aligned} & 10 \\ & 20 \\ & 40 \\ & 10 \end{aligned}$ | $\begin{aligned} & 20-75 \\ & 20-75 \\ & 20-75 \\ & 40-210 \end{aligned}$ | 1 1 1 | 1.5 1.5 1.5 1.5 | $\begin{aligned} & 5 \\ & 5 \\ & 5 \\ & 5 \end{aligned}$ | 25 25 25 70 |  |
| 2N1593 <br> 2N1594 <br> 2N1606 <br> 2N1607 | $\begin{aligned} & \text { NPN } \\ & \text { NPN } \\ & P N P \\ & \text { PNP } \end{aligned}$ | GP <br> GP <br> SW <br> SW |  | $\begin{aligned} & 125 \\ & 125 \\ & 100 \\ & 100 \end{aligned}$ | $\begin{aligned} & 30 \\ & 60 \\ & 10 \\ & 10 \end{aligned}$ | 20 40 | $\begin{gathered} 40-210 \\ 40-210 \\ 6-30 \\ 6-30 \end{gathered}$ | 1 1 15 15 | 1.5 1.5 .15 .15 | 5 5 5 5 | 70 | 7.2 10 |

## TRANSISTOR INTERCHANGEABILITY MASTER LIST OF REGISTERED TYPES

| TYPE NUMEER | 忘$\frac{8}{8}$8 |  | 11 <br> REPLACEMENT <br> OR NEAREST EQUIVALENT | MAXIMUM RATINGS |  |  | EECTRICAL CHARACTERISTICS |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  | $\begin{gathered} \mathrm{P}_{\boldsymbol{T}} \\ \mathrm{T}_{A}=25^{\circ} \mathrm{C} \\ { }^{{ }^{\circ} \mathrm{T}^{\prime} \mathrm{C}=25^{\circ} \mathrm{C}} \\ (\mathrm{~mW}) \end{gathered}$ | VCBO <br> (V) | Vceo <br> (V) | MN M | $\begin{gathered} c \\ (\mathrm{ma}) \end{gathered}$ | VC <br> MAX <br> $(V)$ | $\begin{aligned} & (\mathrm{sen}) \\ & \hline \text { IC } \\ & \hline(\mathrm{mA}) \end{aligned}$ |  |  |
| $\begin{aligned} & \text { 2N1608 } \\ & \text { 2N1613 } \\ & \text { 2N1613A } \\ & 2 N 16138 \end{aligned}$ | PNP <br> NPN <br> NPN <br> NPN | SW <br> GP <br> GP <br> GP | $\begin{aligned} & \text { 2N1613 } \\ & \text { 2N1613 } \\ & \text { 2N2243 } \end{aligned}$ | $\begin{aligned} & 100 \\ & 800 \\ & 1 W \\ & 1 W \end{aligned}$ | $\begin{array}{r} 10 \\ 75 \\ 75 \\ 120 \end{array}$ |  | $\begin{gathered} 6-30 \\ 40-120 \\ 40-120 \\ 40-120 \end{gathered}$ | $\begin{array}{r} 15 \\ 150 \\ 150 \\ 150 \end{array}$ | $\begin{array}{r} .15 \\ 1.5 \\ 1 \\ .2 \end{array}$ | $\begin{array}{r} 5 \\ 150 \\ 150 \\ 150 \end{array}$ | $\begin{aligned} & 30 \\ & 30 \\ & 30 \end{aligned}$ | 25 60 60 60 |
| $\begin{aligned} & \text { 2N1615 } \\ & \text { 2N1623 } \\ & \text { 2N1640 } \\ & \text { 2N1641 } \end{aligned}$ | NPN <br> PNP <br> PNP <br> PNP | GP <br> GP <br> SW <br> SW | 715101 <br> 2N2904 | 600 250 250 250 | 100 50 30 30 | 100 20 | 25. $9-40$ $6-$ 10 | 5 1 .1 .1 | 5 . | 50 |  | 2 |
| 2N1642 <br> 2N1643 <br> 2N1644 <br> 2N1654 | $\begin{aligned} & \text { PNP } \\ & \text { PNP } \\ & \text { NPN } \\ & \text { PNP } \end{aligned}$ | sw <br> SW <br> GP <br> GP | $\begin{aligned} & \text { 2N2218 } \\ & \text { 2N3495 } \end{aligned}$ | $\begin{array}{r} 250 \\ 250 \\ * 2 w \\ 250 \end{array}$ | $\begin{array}{r} 30 \\ 25 \\ 60 \\ 100 \end{array}$ | 80 | $\begin{aligned} & 15- \\ & 10-25 \\ & 40-120 \\ & 20-45 \end{aligned}$ | $\begin{array}{r} .1 \\ .1 \\ 150 \\ 1 \end{array}$ | 1.5 .3 | 150 |  | 50 |
| 2N1655 <br> 2N1656 <br> 2N1663 <br> 2N1671 | $\begin{aligned} & \text { PNP } \\ & \text { PNP } \\ & \text { NPN } \\ & \text { P-N } \end{aligned}$ | $\begin{aligned} & \text { GP } \\ & \text { GP } \\ & 5 W \\ & U J \end{aligned}$ | $\begin{aligned} & \text { 2N3495 } \\ & \text { 2N3495 } \\ & \text { 2N1671 } \end{aligned}$ | $\begin{gathered} 250 \\ 250 \\ 150 \\ \text { SEE UNIU } \end{gathered}$ | $\begin{gathered} 125 \\ 125 \\ 20 \\ \text { UNCTION } \end{gathered}$ | $\begin{array}{r} 100 \\ 100 \\ 15 \\ \text { NTERCH } \end{array}$ | $\begin{gathered} 10-20 \\ 20-45 \\ 30-150 \\ \text { ANGEABILIT } \end{gathered}$ | $\begin{array}{r} 1 \\ 1 \\ 20 \end{array}$ | .3 .3 .25 | 5 5 10 |  | 100 |
| $\begin{aligned} & \text { 2N1671A } \\ & \text { 2N1671B } \\ & \text { 2N1674 } \\ & \text { 2N1676 } \end{aligned}$ | $\begin{aligned} & \text { P-N } \\ & \mathbf{P - N} \\ & \mathbf{N P N} \\ & \text { PNNP } \end{aligned}$ | $\begin{aligned} & U J \\ & U J \\ & G P \\ & S W \end{aligned}$ | $\begin{aligned} & \text { 2N1671A } \\ & \text { 2N1671B } \\ & \text { 2N2218 } \end{aligned}$ | SEE UNIJ SEE UNIJ 200 100 | UNCTION UNCTION <br> 45 <br> 4.5 | INTERCH INTERCH 45 | ANGEABHITT ANGEABLIT |  | 1.5 .1 | $\begin{aligned} & 5 \\ & 5 \end{aligned}$ | 50 | 20 16 |
| 2N1677 <br> 2N1679 <br> 2N1680 <br> 2N1682 | PNP <br> NPN <br> NPN <br> NPN | SW <br> GP GP <br> SW | 2N2102 2N2102 2N2537 | $\begin{aligned} & 100 \\ & 1 w \\ & 1 w \\ & 500 \end{aligned}$ | $\begin{array}{r} 4.5 \\ 100 \\ 60 \\ 25 \end{array}$ | $\begin{aligned} & 55 \\ & 35 \end{aligned}$ | $\begin{aligned} & 40-120 \\ & 40-120 \\ & 20- \end{aligned}$ | $\begin{array}{r} 600 \\ 600 \\ 10 \end{array}$ | .1 3.6 3.6 .6 | $\begin{array}{r} 5 \\ 600 \\ 600 \\ 10 \end{array}$ | 25 | 16 50 50 200 |
| $\begin{aligned} & \text { 2N1700 } \\ & \text { 2N1704 } \\ & \text { 2N1708 } \\ & \text { 2N1708A } \end{aligned}$ | NPN <br> NPN <br> NPN <br> NPN | GP <br> GP <br> SW <br> SW | $\begin{aligned} & \text { 2N2102 } \\ & \text { 2N2218 } \end{aligned}$ | $\begin{array}{r} 5 \mathrm{~W} \\ 150 \\ * 1 \mathrm{~W} \\ 300 \end{array}$ | $\begin{aligned} & 60 \\ & 45 \\ & 25 \\ & 40 \end{aligned}$ | $\begin{aligned} & 45 \\ & 12 \end{aligned}$ | $\begin{aligned} & 20-80 \\ & 50-200 \\ & 20- \\ & 30-120 \end{aligned}$ | $\begin{array}{r} 100 \\ 1 \\ 10 \\ 10 \end{array}$ | $\begin{gathered} 12.5 \\ 1 \\ .22 \\ .22 \end{gathered}$ | $\begin{aligned} & 2.5 \\ & 10 \\ & 10 \\ & 10 \end{aligned}$ | 4 | $\begin{aligned} & 200 \\ & 300 \end{aligned}$ |
| $\begin{aligned} & \text { 2N1711 } \\ & \text { 2N171 IA } \\ & \text { 2N171 1B } \\ & \text { 2N1763 } \end{aligned}$ | NPN <br> NPN <br> NPN <br> NPN | GP <br> GP <br> GP <br> SW | 2N1711 <br> 2N1711 <br> 2N1711 <br> 2N2537 | $\begin{aligned} & 800 \\ & 1 W \\ & 1 w \\ & 300 \end{aligned}$ | $\begin{array}{r} 75 \\ 75 \\ 120 \\ 40 \end{array}$ | 25 | $\begin{aligned} & 100-300 \\ & 100-300 \\ & 100-300 \end{aligned}$ | $\begin{aligned} & 150 \\ & 150 \\ & 150 \end{aligned}$ | $\begin{array}{r} 1.5 \\ 1 \\ .2 \\ 1.5 \end{array}$ | $\begin{array}{r} 150 \\ 150 \\ 150 \\ 10 \end{array}$ | $\begin{aligned} & \mathbf{5 0} \\ & \mathbf{5 0} \\ & \mathbf{5 0} \end{aligned}$ | 70 70 70 |
| $\begin{aligned} & \text { 2N1764 } \\ & \text { 2N1837 } \\ & \text { 2N1837A } \\ & \text { 2N1837B } \end{aligned}$ | NPN <br> NPN <br> NPN <br> NPN | SW <br> GP <br> GP <br> GP | $\begin{aligned} & \text { 2N2537 } \\ & \text { 2N2218 } \\ & \text { 2N2218 } \\ & \text { 2N2218 } \end{aligned}$ | $\begin{aligned} & 300 \\ & 800 \\ & 800 \\ & 800 \end{aligned}$ | $\begin{aligned} & 20 \\ & 80 \\ & 80 \\ & 80 \end{aligned}$ | $\begin{aligned} & 15 \\ & 30 \\ & 30 \\ & 30 \end{aligned}$ | 40-120 40-120 40-120 | $\begin{aligned} & 150 \\ & 150 \\ & 150 \end{aligned}$ | $\begin{array}{r} 1.5 \\ .8 \\ .8 \\ .8 \end{array}$ | $\begin{array}{r} 10 \\ 150 \\ 150 \\ 150 \end{array}$ |  | 140 140 140 |
| $\begin{aligned} & \text { 2N1838 } \\ & \text { 2N1839 } \\ & \text { 2N1840 } \\ & \text { 2N1889 } \end{aligned}$ | NPN <br> NPN <br> NPN <br> NPN | GP <br> GP <br> GP <br> GP | $\begin{aligned} & \text { 2N2218 } \\ & \text { 2N2217 } \\ & \text { 2N2218 } \\ & \text { 2N1889 } \end{aligned}$ | 600 <br> 600 <br> 800 <br> 800 | $\begin{array}{r} 45 \\ 45 \\ 25 \\ 100 \end{array}$ | $\begin{aligned} & 20 \\ & 20 \\ & 15 \end{aligned}$ | $\begin{aligned} & 40-150 \\ & 12-50 \\ & 10-100 \\ & 40-120 \end{aligned}$ | $\begin{aligned} & 100 \\ & 100 \\ & 150 \\ & 150 \end{aligned}$ | 1.4 <br> 1.4 <br> 1.4 <br> 5 | $\begin{aligned} & 100 \\ & 150 \\ & 150 \\ & 150 \end{aligned}$ | 30 | 90 90 90 50 |

TRANSISTOR INTERCHANGEABILITY
MASTER LIST OF REGISTERED TYPES

| TYPE NUMEER |  | $\begin{aligned} & \text { 名 } \\ & \frac{3}{3} \\ & \frac{1}{5} \\ & 3 \end{aligned}$ |  | MAXIMUM RATINOS |  |  | ELECIRICAL CMARACTERISTICS |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  | $\begin{gathered} \mathrm{PY} \\ \mathrm{~T}_{\mathrm{A}}=25^{\circ} \mathrm{C} \\ { }^{{ }^{\mathrm{T}} \mathrm{C}=25^{\circ} \mathrm{C}} \\ (\mathrm{~mW}) \\ \hline \end{gathered}$ | $\mathbf{V C B O}$ <br> (V) | Vceo <br> (V) | MFE | $\begin{gathered} \mathrm{IC} \\ (\mathrm{~mA}) \end{gathered}$ | MaX <br> (V) | (ICl) (ma) | $\begin{gathered} \text { Mfo } \\ 1 \mathrm{kdtz} \\ \text { MNY } \end{gathered}$ |  |
| 2N1890 <br> 2N1893 <br> 2N1917 <br> 2N1918 | NPN NPN PNP PNP | $\begin{aligned} & \text { GP } \\ & \text { GP } \\ & S W \\ & S W \end{aligned}$ | $\begin{aligned} & \text { 2N1890 } \\ & \text { 2N1893 } \end{aligned}$ | $\begin{aligned} & 800 \\ & 800 \\ & 250 \\ & 250 \end{aligned}$ | $\begin{array}{r} 100 \\ 120 \\ 25 \\ 25 \end{array}$ | $\begin{aligned} & 8 \\ & 8 \end{aligned}$ | $\begin{array}{r} 100-300 \\ 40-120 \end{array}$ | $\begin{aligned} & 150 \\ & 150 \end{aligned}$ | $\begin{aligned} & 5 \\ & 5 \end{aligned}$ | $\begin{aligned} & 150 \\ & 150 \end{aligned}$ | $\begin{aligned} & 50 \\ & 30 \\ & 25 \\ & 25 \end{aligned}$ | 60 50 16 10 |
| $\begin{aligned} & \text { 2N1919 } \\ & \text { 2N1920 } \\ & \text { 2N1921 } \\ & \text { 2N1922 } \end{aligned}$ | $\begin{aligned} & \text { PNP } \\ & \text { PNP } \\ & \text { PNP } \\ & \text { PNP } \end{aligned}$ | $\begin{aligned} & \text { sw } \\ & \text { sw } \\ & \text { Sw } \\ & \text { sw } \end{aligned}$ |  | 250 250 250 250 | 40 40 50 80 | 18 18 50 80 |  |  |  |  |  |  |
| $\begin{aligned} & 2 \mathrm{~N} 1923 \\ & 2 \mathrm{~N} 1941 \\ & 2 \mathrm{~N} 1943 \\ & 2 \mathrm{~N} 1944 \end{aligned}$ | NPN NPN NPN NPN | GP <br> GP <br> GP <br> GP | $\begin{aligned} & \text { 2N2243 } \\ & \text { 2N2219A } \\ & \text { 2N2192 } \\ & \text { 2N2219A } \end{aligned}$ | $\begin{aligned} & 750 \\ & 600 \\ & 800 \\ & 600 \end{aligned}$ | $\begin{aligned} & 85 \\ & 45 \\ & 60 \\ & 20 \end{aligned}$ | $\begin{aligned} & 85 \\ & 60 \end{aligned}$ | $\begin{gathered} 4-90 \\ 30-150 \\ 30-90 \\ 150-450 \end{gathered}$ | $\begin{array}{r} 10 \\ 200 \\ 1 \end{array}$ | $\begin{array}{r} 7 \\ 1.5 \\ 5 \end{array}$ | $\begin{array}{r} 20 \\ 5 \\ 200 \end{array}$ | $\begin{array}{r} 28 \\ 40 \\ 12 \\ 100 \end{array}$ | $\begin{aligned} & 60 \\ & 60 \end{aligned}$ |
| $\begin{aligned} & \text { 2N1945 } \\ & \text { 2N1946 } \\ & \text { 2N1947 } \\ & \text { 2N1948 } \end{aligned}$ | $\left\lvert\, \begin{aligned} & \mathbf{N P N} \\ & \mathbf{N P N} \\ & \mathbf{N P N} \\ & \mathbf{N P N} \end{aligned}\right.$ | GP GP <br> GP <br> GP | $\begin{aligned} & \text { 2N2219A } \\ & \text { 2N2219A } \end{aligned}$ | $\begin{aligned} & 600 \\ & 600 \\ & 600 \\ & 600 \end{aligned}$ | $\begin{aligned} & 30 \\ & 40 \\ & 20 \\ & 30 \end{aligned}$ |  | $\begin{aligned} & 150-450 \\ & 150-450 \\ & 500-800 \\ & 500-800 \end{aligned}$ | $\begin{array}{r} 1 \\ 1 \\ 100 \\ 100 \end{array}$ |  |  | $\begin{aligned} & 100 \\ & 100 \\ & 100 \\ & 100 \end{aligned}$ | 60 60 60 60 |
| $\begin{aligned} & \text { 2N1949 } \\ & \text { 2N1950 } \\ & \text { 2N1951 } \\ & \text { 2N1952 } \end{aligned}$ | NPN <br> NPN <br> NPN <br> NPN | GP <br> GP <br> GP <br> GP |  | $\begin{aligned} & 600 \\ & 600 \\ & 600 \\ & 600 \end{aligned}$ | $\begin{aligned} & 40 \\ & 20 \\ & 30 \\ & 40 \end{aligned}$ |  | $\begin{aligned} & 500-800 \\ & 250-500 \\ & 250-500 \\ & 250-500 \end{aligned}$ | 100 100 100 100 |  |  | $\begin{array}{r} 100 \\ 75 \\ 75 \\ 75 \end{array}$ | 60 60 60 60 |
| $\begin{aligned} & 2 \mathrm{~N} 1953 \\ & 2 \mathrm{~N} 1958 \\ & 2 \mathrm{~N} 1958 \mathrm{~A} \\ & 2 \mathrm{~N} 1959 \end{aligned}$ | NPN <br> NPN <br> NPN <br> NPN | $\begin{aligned} & G P \\ & S W \\ & S W \\ & S W \end{aligned}$ | $\begin{aligned} & \text { 2N2537 } \\ & \text { 2N2537 } \end{aligned}$ | $\begin{aligned} & 600 \\ & 600 \\ & 600 \\ & 600 \end{aligned}$ | $\begin{aligned} & 20 \\ & 60 \\ & 60 \\ & 60 \end{aligned}$ |  | $\begin{aligned} & 15-150 \\ & 20-60 \\ & 20-60 \\ & 40-120 \end{aligned}$ | $\begin{array}{r} 10 \\ 150 \\ 150 \\ 150 \end{array}$ | .45 .45 .45 | $\begin{aligned} & 150 \\ & 150 \\ & 150 \end{aligned}$ | 28 | 40 100 100 |
| $\begin{aligned} & \text { 2N1959A } \\ & \text { 2N1962 } \\ & \text { 2N1963 } \\ & \text { 2N1964 } \end{aligned}$ | NPN NPN NPN NPN | $\begin{aligned} & s w \\ & s w \\ & s w \\ & s w \end{aligned}$ | $\begin{aligned} & \text { 2N2537 } \\ & \text { 2N2537 } \\ & \text { 2N2537 } \\ & \text { 2N2539 } \end{aligned}$ | $\begin{aligned} & 600 \\ & 400 \\ & 400 \\ & 400 \end{aligned}$ | $\begin{aligned} & 60 \\ & 40 \\ & 30 \\ & 60 \end{aligned}$ |  | $\begin{aligned} & 40-120 \\ & 20-60 \\ & 25- \\ & 20-60 \end{aligned}$ | 150 10 10 150 | .45 .25 .16 .45 | $\begin{array}{r} 150 \\ 10 \\ 10 \\ 150 \end{array}$ |  | 100 200 200 100 |
| 2N1965 <br> 2 N 1972 <br> 2N1973 <br> 2N1974 | NPN <br> NPN <br> NPN <br> NPN | SW <br> GP <br> GP <br> GP | $\begin{aligned} & \text { 2N2539 } \\ & \text { 2N2219 } \\ & \text { 2N1973 } \\ & \text { 2N1974 } \end{aligned}$ | $\begin{aligned} & 400 \\ & 600 \\ & 800 \\ & 800 \end{aligned}$ | $\begin{array}{r} 60 \\ 60 \\ 100 \\ 100 \end{array}$ |  | $\begin{aligned} & 40-120 \\ & 110-350 \\ & 75- \\ & 35- \end{aligned}$ | $\begin{array}{r} 150 \\ 50 \\ 10 \\ 10 \end{array}$ | $\begin{array}{r} 45 \\ 2 \\ 1.2 \\ 1.2 \end{array}$ | 150 50 50 50 | 40 76 36 | 100 50 60 50 |
| 2N1975 <br> 2N1983 <br> 2N1984 <br> 2N1985 | NPN <br> NPN <br> NPN <br> NPN | GP <br> GP <br> GP <br> GP | $\begin{aligned} & \text { 2N1975 } \\ & \text { 2N2218 } \\ & \text { 2N2217 } \\ & \text { 2N2217 } \end{aligned}$ | $\begin{aligned} & 800 \\ & 600 \\ & 600 \\ & 600 \end{aligned}$ | 100 50 50 50 | $\begin{aligned} & 25 \\ & 25 \\ & 25 \end{aligned}$ | 15 | 10 | 1.2 | 50 | 18 70 35 15 | 40 40 40 40 |
| 2N1986 <br> 2N1987 <br> 2N1988 <br> 2N1989 | NPN <br> NPN <br> NPN <br> NPN | GP GP GP GP | $\begin{aligned} & \text { 2N2219 } \\ & \text { 2N2217 } \\ & \text { 2N2218A } \\ & \text { 2N2217 } \end{aligned}$ | $\begin{aligned} & 600 \\ & 600 \\ & 600 \\ & 600 \end{aligned}$ | $\begin{array}{r} 50 \\ 50 \\ 100 \\ 100 \end{array}$ | $\begin{aligned} & 25 \\ & 25 \\ & 45 \\ & 45 \end{aligned}$ | $\begin{aligned} & 60-210 \\ & 20-80 \\ & 35-120 \\ & 20-60 \end{aligned}$ | $\begin{array}{r} 150 \\ 150 \\ 30 \\ 30 \end{array}$ | 2 | $\begin{aligned} & 30 \\ & 30 \end{aligned}$ | 20 10 | 40 <br> 40 <br> 40 <br> 40 |

# TRANSISTOR INTERCHANGEABILITY MASTER LIST OF REGISTERED TYPES 

| TYFEMUMES: | $\begin{aligned} & E \\ & \frac{5}{5} \end{aligned}$ |  | $\begin{gathered} \text { TI } \\ \text { REPLCEMENT } \\ \text { OH NEAREST } \\ \text { EQUVALENT } \end{gathered}$ | MAXIMUM RATENOS |  |  | EXCTICAL CHANACTERSTICS |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  | $\begin{gathered} \mathbf{P}_{\mathbf{T}} \\ \mathbf{T}_{\mathrm{A}}=25^{\circ} \mathrm{C} \\ { }^{*} \mathrm{~T}_{\mathrm{C}}=25^{\circ} \mathrm{C} \\ (\mathrm{~mW}) \\ \hline \end{gathered}$ | $\mathbf{V}_{\text {CEO }}$ <br> (V) | Vceo | hre |  | VCE(sel) |  | $\begin{gathered} \mathrm{h}_{0} \\ 0 \\ 1 \mathrm{k}+\mathrm{mz} \\ \mathrm{MN} \end{gathered}$ | $\begin{gathered} \text { F } \\ \text { Min } \\ \text { (MNBI } \end{gathered}$ |
|  |  |  |  | $\begin{gathered} { }^{*} \mathrm{~T} \mathrm{C}=25^{\circ} \mathrm{C} \\ (\mathrm{~mW}) \\ \hline \end{gathered}$ |  |  | MIN MAXIC <br> $(\mathrm{mA})$ |  | Max IC <br> (V) (ma) |  |  |  |
| 2N1991 | PNP | GP | $\begin{aligned} & \text { 2N2904 } \\ & \text { 2N2221 } \end{aligned}$ | 600 | 30 | 20 | $\begin{aligned} & 15-60 \\ & 30-120 \end{aligned}$ | $\begin{array}{r} 150 \\ 1 \end{array}$ | 1.5.25 | $\begin{array}{r} 150 \\ 10 \end{array}$ |  | 40300 |
| 2N1992 | NPN | GP |  | 350 | 15 | 15 |  |  |  |  |  |  |
| 2N2002 | PNP | SW |  | 250 | 30 | 5 |  |  |  |  |  |  |
| 2N2003 | PNP | SW |  |  |  | 5 |  |  |  |  |  |  |
|  | PNP | SW |  | 250 | 50 | 15 | 12. | 1 |  |  | 15 |  |
| 2N2005 2N2006 | PNP | SW |  | 250 | 50 | 15 |  |  |  |  |  |  |  |
| 2N2007 | PNP | SW |  | 250 250 | 60 60 | 35 35 |  |  |  |  |  |  |  |
| 2N2008 | NPN | GP | 2N3114 | 800 | 175 | 110 | 30.90 | 10 | 2.5 | 25 | 20 | 40 |
| 2N2017 | NPN | GP | 2N2270 | 1w | 60 | 60 | 50.200 | 200 |  |  | 30 |  |
| 2N2038 | NPN | GP | 2N2217 | 600 | 45 | 45 | 12-36 | 200 | 6 | 200 |  | 2 |
| 2N2039 | NPN | GP | 2N698 | 600 | 75 | 75 | 12-36 | 200 | 6 | 200 |  | 2 |
| 2N2040 | NPN | GP | 2N2218 | 600 | 45 | 45 | 30-90 | 200 | 6 | 200 |  | 2 |
| 2N2041 | NPN | GP | 2N1893 | 600 | 75 | 75 | 30-90 | 200 | 6 | 200 |  | 2 |
| 2N2049 | NPN | GP | 2N2219A | 800 | 75 |  | 100-300 | 150 | . 4 | 10 | 75 | 50 |
| 2N2060 | NPN | DU | 2N2060 | 500 | 100 |  | 50-150 | 10 | 1.2 | 50 | 50 | 60 |
|  | NPN | DU | 2N2060 | 500 | 100 | 60 | 50-150 | 10 | . 6 | 50 | 50 |  |
| 2N2060B | NPN | DU | 2N2060 | 500 | 100 |  |  |  |  |  |  | 60 |
| 2N2086 | NPN | SW |  | 600 | 120 |  | 20. | 150 | . 7 | 150 |  | 150 |
| 2N2087 | NPN | SW |  | 600 | 120 |  | 40.120 | 150 | . 5 | 150 |  | 150 |
|  | NPN | GP | 2N2102 | *5W | 120 | 65 | 35. | 10 | . 5 | 150 | 35 |  |
| 2N2102A | NPN | GP | 2N2102A | -5W | 120 | 65 | 40-120 | 150 | . 3 | 150 | 30 |  |
| 2N2104 | PNP | SW | 2N2904 | 800 | 50 | 35 | 25-80 | 150 | 1.5 | 150 |  | 60 |
|  |  | SW | 2N2904 | 800 | 50 | 35 | 15-40 | 150 | 1.5 | 150 |  | 50 |
|  | NPN | GP | 2N696 | 1w | 60 |  | 12-36 | 200 | 5 | 200 |  |  |
| 2N2107 | NPN | GP | 2N697 | IW | 60 |  | 30-90 | 200 |  | 200 |  |  |
| \|2N2108 | NPN | GP | 2N1711 | 1w | 60 |  | 75-200 | 200 |  | 200 |  |  |
|  | P-N | UJ | 2N2160 | SEE UNUU | NCTION | INTERCH | VGEABLITY |  |  |  |  |  |
|  |  | sw | 2N2222 | 200 | 55 | 35 | 60-160 | 10 | 1.5 | 10 | 75 |  |
| 2N2162 | PNP | sw | 2N2946 | 150 | 30 | 30 |  |  |  |  |  | 14 |
| 2N2163 | PNP | SW | 2N2945 | 150 | 15 | 15 |  |  |  |  |  | 14 |
| 2N2164 | PNP | SW | 2N2944 | 150 |  | 8 |  |  |  |  |  | 24 |
| 2N2165 | PNP | SW | 2N2946 | 150 | 30 | 30 |  |  |  |  |  | 10 |
| 2N2166 | PNP | SW | 2N2945 | 150 | 15 | 15 |  |  |  |  |  | 10 |
| 2N2167 | PNP | SW | 2N2944 | 150 | 12 | 8 |  |  |  |  |  | 16 |
| 2N2175 | PNP | GP |  | 100 |  | 6 | 30. | . 02 |  |  |  | 10 |
| 2N2176 |  |  |  | 100 | 6 | 6 | 30. | . 02 |  |  |  | 10 |
| 2N2177 | PNP | GP |  | 100 | 6 | 6 | 15. | 5UA |  |  | 50 |  |
| 2N2178 | PNP | GP |  | 100 | 6 | 6 | 15. | 5UA |  |  | 50 |  |
| 2N2181 | PNP | SW | 2N2945 |  |  |  |  | 5 |  |  |  | 6 |

TRANSISTOR INTERCHANGEABILITY MASTER LIST OF REGISTERED TYPES

| TYPE NUMPER |  | $\begin{aligned} & \text { Z } \\ & \frac{1}{k} \\ & \mathbf{S} \\ & \frac{1}{5} \\ & \frac{3}{4} \end{aligned}$ | $\begin{gathered} \text { TI } \\ \text { REPLACEMENT } \\ \text { OR NBAREST } \\ \text { EQUNALENT } \end{gathered}$ | MAXIMUM RATINOS |  |  | EIECTRICAL CHARACTERISTICS |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  | $\begin{gathered} P_{T} \\ T_{A}=25^{\circ} \mathrm{C} \\ { }^{*} \mathrm{~T}_{\mathrm{C}}=25^{\circ} \mathrm{C} \\ (\mathrm{~mW}) \end{gathered}$ | VCBO (V) | $V_{C E O}$ <br> (V) | hre | $\begin{gathered} \text { lc } \\ (\mathrm{mA}) \end{gathered}$ | $\mathbf{V C E}_{\text {( }}$ <br> MAX <br> $(\mathrm{V})$ | sat) <br> (mA) | $\begin{gathered} \mathrm{hfo}_{6} \\ 1 \mathrm{kfzz} \\ \text { MN } \end{gathered}$ | $\begin{array}{c\|} \hline \boldsymbol{T} \\ \text { MIN } \\ (M \mathrm{Mz}) \end{array}$ |
| $\begin{aligned} & \text { 2N2182 } \\ & \text { 2N2183 } \\ & \text { 2N2184 } \\ & \text { 2N2185 } \end{aligned}$ | PNP <br> PNP <br> PNP <br> PNP | $\begin{aligned} & s w \\ & s w \\ & s w \\ & s w \end{aligned}$ | $\begin{aligned} & \text { 2N2945 } \\ & \text { 2N2944 } \\ & \text { 2N2944 } \\ & \text { 2N2946 } \end{aligned}$ | 150 150 150 150 | 25 15 15 30 | $\begin{aligned} & 25 \\ & 10 \\ & 10 \\ & 30 \end{aligned}$ | 10 10 10 | 5 5 5 |  |  |  | 6 6 6 6.5 |
| $\begin{aligned} & \text { 2N2186 } \\ & \text { 2N2187 } \\ & \text { 2N2192 } \\ & \text { 2N2192A } \end{aligned}$ | PNP <br> PNP <br> NPN <br> NPN | $\begin{aligned} & S W \\ & S W \\ & G P \\ & G P \end{aligned}$ | $\begin{aligned} & \text { 2N2946 } \\ & \text { 2N2946 } \\ & \text { 2N2192 } \\ & \text { 2N2192A } \end{aligned}$ | $\begin{aligned} & 150 \\ & 150 \\ & 800 \\ & 800 \end{aligned}$ | $\begin{aligned} & 30 \\ & 30 \\ & 60 \\ & 60 \end{aligned}$ | $\begin{aligned} & 30 \\ & 30 \\ & 40 \\ & 40 \end{aligned}$ | $\begin{aligned} & 100-300 \\ & 100-300 \end{aligned}$ | $\begin{aligned} & 150 \\ & 150 \end{aligned}$ | . 35 | $\begin{aligned} & 150 \\ & 150 \end{aligned}$ |  | 6.5 6.5 50 50 |
| $\begin{aligned} & \text { 2N2192B } \\ & \text { 2N2193 } \\ & \text { 2N2193A } \\ & \text { 2N2193B } \end{aligned}$ | NPN NPN NPN NPN | $\begin{aligned} & G P \\ & G P \\ & G P \\ & G P \end{aligned}$ | $\begin{aligned} & \text { 2N2192A } \\ & \text { 2N2193 } \\ & \text { 2N2193A } \\ & \text { 2N2193A } \end{aligned}$ | $\begin{aligned} & 800 \\ & 800 \\ & 800 \\ & 800 \end{aligned}$ | 60 80 80 80 | 40 50 50 50 | $\begin{array}{r} 100-300 \\ 40-120 \\ 40-120 \\ 40-120 \end{array}$ | 150 150 150 150 | .18 .35 .25 .18 | 150 150 150 150 |  | 50 50 |
| $\begin{aligned} & \text { 2N2194 } \\ & \text { 2N2194A } \\ & \text { 2N2194B } \\ & \text { 2N2195 } \end{aligned}$ | NPN NPN <br> NPN <br> NPN | $\begin{aligned} & \text { GP } \\ & \text { GP } \\ & \text { GP } \\ & \text { GP } \end{aligned}$ | $\begin{aligned} & \text { 2N2194 } \\ & \text { 2N2194A } \\ & \text { 2N2194A } \\ & \text { 2N2243 } \end{aligned}$ | $\begin{aligned} & 800 \\ & 800 \\ & 800 \\ & 800 \end{aligned}$ | 60 60 60 45 | 40 40 40 25 | $20-60$ $20-60$ $20-60$ $20-$ | 150 150 150 150 | .35 .25 .18 .35 | 150 150 150 150 |  | 50 50 |
| $\begin{aligned} & \text { 2N2195A } \\ & \text { 2N2195B } \\ & \text { 2N2198 } \\ & \text { 2N2205 } \end{aligned}$ | $\begin{aligned} & \text { NPN } \\ & \mathbf{N P N} \\ & \mathbf{N P N} \\ & \mathbf{N P N} \end{aligned}$ | GP <br> GP <br> GP <br> SW | $\begin{aligned} & \text { 2N2243 } \\ & \text { 2N2243 } \\ & \text { 2N2102 } \end{aligned}$ | $\begin{array}{r}800 \\ 800 \\ * \\ * \\ * \\ \hline 1 W\end{array}$ | 45 45 80 25 | 25 25 80 12 | $20-$ 20. $35-55$ $20-$ | 150 150 100 10 | .25 .18 6 .22 | $\begin{array}{r} 150 \\ 150 \\ 200 \\ 10 \end{array}$ |  | 4 |
| $\begin{aligned} & \text { 2N2214 } \\ & \text { 2N2216 } \\ & \text { 2N2217 } \\ & \text { 2N2218 } \end{aligned}$ | NPN <br> PNP <br> NPN <br> NPN | SW <br> SW <br> GP <br> GP | $\begin{aligned} & \text { 2N2217 } \\ & \text { 2N2218 } \end{aligned}$ | $\begin{array}{r} 250 \\ +3 W \\ 800 \\ 800 \end{array}$ | 25 150 60 60 | 15 100 30 30 | $\begin{aligned} & 25- \\ & 25-120 \\ & 20-60 \\ & 40-120 \end{aligned}$ | 10 50 150 150 | .2 5 4 .4 | 10 50 150 150 |  | 200 50 250 250 |
| $\begin{aligned} & \text { 2N2218A } \\ & \text { 2N2219 } \\ & \text { 2N2219A } \\ & \text { 2N2220 } \end{aligned}$ | NPN <br> NPN <br> NPN <br> NPN | GP GP GP GP | $\begin{aligned} & \text { 2N2218A } \\ & \text { 2N2219 } \\ & \text { 2N2219A } \\ & \text { 2N2220 } \end{aligned}$ | $\begin{aligned} & 800 \\ & 800 \\ & 800 \\ & 500 \end{aligned}$ | $\begin{aligned} & 75 \\ & 60 \\ & 75 \\ & 60 \end{aligned}$ | $\begin{aligned} & 40 \\ & 30 \\ & 40 \\ & 30 \end{aligned}$ | $\begin{gathered} 40-120 \\ 100-300 \\ 100-300 \\ 20-60 \end{gathered}$ | $\begin{aligned} & 150 \\ & 150 \\ & 150 \\ & 150 \end{aligned}$ | $\begin{aligned} & .3 \\ & .4 \\ & .3 \\ & .4 \end{aligned}$ | $\begin{aligned} & 150 \\ & 150 \\ & 150 \\ & 150 \end{aligned}$ | 30 50 | 250 250 300 250 |
| $\begin{aligned} & \text { 2N2221 } \\ & \text { 2N2221A } \\ & \text { 2N2222 } \\ & \text { 2N2222A } \end{aligned}$ | NPN <br> NPN <br> NPN <br> NPN | GP GP GP GP | $\begin{aligned} & \text { 2N2221 } \\ & \text { 2N2221A } \\ & \text { 2N2222 } \\ & \text { 2N2222A } \end{aligned}$ | $\begin{aligned} & 500 \\ & 500 \\ & 500 \\ & 500 \end{aligned}$ | $\begin{aligned} & 60 \\ & 75 \\ & 60 \\ & 75 \end{aligned}$ | $\begin{aligned} & 30 \\ & 40 \\ & 30 \\ & 40 \end{aligned}$ | $\begin{array}{r} 40-120 \\ 40-120 \\ 100-300 \\ 100-300 \end{array}$ | $\begin{aligned} & 150 \\ & 150 \\ & 150 \\ & 150 \end{aligned}$ | .4 .3 .4 .3 | $\begin{aligned} & 150 \\ & 150 \\ & 150 \\ & 150 \end{aligned}$ | 30 50 | 250 250 250 300 |
| $\begin{aligned} & \text { 2N2222B } \\ & \text { 2N2223 } \\ & \text { 2N2223A } \\ & \text { 2N222A } \end{aligned}$ | NPN <br> NPN <br> NPN <br> NPN | GP <br> DU <br> DU <br> GP | $\begin{aligned} & \text { 2N2222B } \\ & \text { 2N2223 } \\ & \text { 2N2223A } \\ & \text { 2N2218A } \end{aligned}$ | $\begin{aligned} & 500 \\ & 500 \\ & 500 \\ & 800 \end{aligned}$ | $\begin{array}{r} 75 \\ 100 \\ 100 \\ 65 \end{array}$ | $40$ <br> 40 | $\begin{array}{r} 100-300 \\ 50-200 \\ 50-200 \\ 35-115 \end{array}$ | 150 10 10 10 | $\begin{array}{r} .3 \\ 1.2 \\ 1.2 \\ .4 \end{array}$ | $\begin{array}{r} 150 \\ \quad 50 \\ 50 \\ 150 \end{array}$ | 50 40 40 | 300 50 50 250 |
| $\begin{aligned} & \text { 2N2236 } \\ & \text { 2N2237 } \\ & \text { 2N2239 } \\ & \text { 2N2240 } \end{aligned}$ | NPN <br> NPN <br> NPN <br> NPN | GP <br> GP <br> GP <br> GP | $\begin{aligned} & \text { 2N2218 } \\ & \text { 2N2218 } \\ & \text { 2N2218 } \end{aligned}$ | $\begin{aligned} & 575 \\ & 575 \\ & 1 W \\ & 600 \end{aligned}$ | $\begin{aligned} & 40 \\ & 40 \\ & 60 \\ & 25 \end{aligned}$ | $\begin{aligned} & 20 \\ & 20 \\ & 20 \end{aligned}$ | $\begin{aligned} & 15-60 \\ & 40-125 \\ & 30-200 \\ & 40-100 \end{aligned}$ | $\begin{array}{r} 100 \\ 100 \\ 200 \\ 1 \end{array}$ | .25 .25 3 1 | 100 100 200 50 |  | 50 50 |

# TRANSISTOR INTERCHANGEABILITY MASTER LIST OF REGISTERED TYPES 

| TY/ mumate | $\begin{aligned} & E \\ & \frac{E}{2} \\ & 8 \end{aligned}$ | $\begin{aligned} & \frac{8}{8} \\ & \frac{8}{2} \\ & 8 \\ & 8 \end{aligned}$ |  | MAXPMUM RATNVOS |  |  | ELCDRLCAL CHARACTEASTICS |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  | $\left\{\begin{array}{c} \mathrm{T}_{A}=25^{\circ} \mathrm{C} \\ { }^{{ }^{\circ} \mathrm{C}=25^{\circ} \mathrm{C}} \\ (\mathrm{~mW}) \end{array}\right.$ | Veso <br> (V) | Veso <br> (V) | $h_{\text {Fe }}$ |  | Vex(sat) |  |  | $\begin{gathered} \text { T } \\ \text { MNN } \\ \text { (MHz) } \end{gathered}$ |
|  |  |  |  |  |  |  | $\operatorname{min~Max}$ | $\begin{gathered} \hline \boldsymbol{L} \\ (\mathrm{mA}) \end{gathered}$ | max <br> (V) | - k <br> (mA) |  |  |
| $\begin{aligned} & \text { 2N2241 } \\ & \text { 2N2242 } \\ & \text { 2N2243 } \\ & \text { 2N2243A } \end{aligned}$ | NPN <br> NFN <br> NPN <br> NPN | GP <br> SW <br> GP <br> GP | $\begin{aligned} & \text { 2N2219A } \\ & \text { 2N2243 } \\ & \text { 2N22434 } \end{aligned}$ | $\begin{aligned} & 600 \\ & 360 \\ & 800 \\ & 800 \end{aligned}$ | $\begin{array}{r} 25 \\ 40 \\ 120 \\ 120 \end{array}$ | $\begin{aligned} & 20 \\ & 15 \\ & 60 \\ & 80 \end{aligned}$ | $\begin{array}{r} 100-200 \\ 40-120 \\ 40-120 \\ 40-120 \end{array}$ | $\begin{array}{r} 1 \\ 10 \\ 150 \\ 150 \end{array}$ | 1 .7 .35 .25 | 50 100 150 150 |  | 50 250 50 50 |
| $\begin{aligned} & \text { 2N2244 } \\ & \text { 2N2245 } \\ & \text { 2N2246 } \\ & \text { 2N2247 } \end{aligned}$ | NPN <br> NPN <br> NPN <br> NPN | GP <br> GP <br> GP <br> GP | $\begin{aligned} & \text { 2N2220 } \\ & \text { 2N2220 } \\ & \text { 2N2220 } \\ & \text { 2N2220 } \end{aligned}$ | $\begin{aligned} & 500 \\ & 500 \\ & 500 \\ & 500 \end{aligned}$ | 20 20 20 45 | $\begin{aligned} & 20 \\ & 20 \\ & 20 \\ & 45 \end{aligned}$ | $\begin{array}{r} 5-15 \\ 10-30 \\ 5-15 \\ 5-15 \end{array}$ | $\begin{aligned} & 2 U A \\ & 2 U A \\ & 2 U A \\ & 2 U A \end{aligned}$ | .2 .2 .2 .2 | 1 1 1 1 | 40 80 40 40 | 60 60 60 60 |
| $\begin{aligned} & \text { 2N2248 } \\ & \text { 2N2249 } \\ & \text { 2N2250 } \\ & \text { 2N2251 } \end{aligned}$ | NPN NPN NPN NPN | GP <br> G <br> © <br> GP | $\begin{aligned} & \text { 2N2220 } \\ & \text { 2N2221 } \\ & \text { 2N2220 } \\ & \text { 2N2220 } \end{aligned}$ | $\begin{aligned} & 500 \\ & 500 \\ & 500 \\ & 500 \end{aligned}$ | $\begin{aligned} & 45 \\ & 45 \\ & 25 \\ & 25 \end{aligned}$ | $\begin{aligned} & 45 \\ & 45 \\ & 20 \\ & 20 \end{aligned}$ | $\begin{array}{r} 10-30 \\ 20-60 \\ 5-15 \\ 10-30 \end{array}$ | $\begin{aligned} & 2 \mathrm{UA} \\ & 2 \mathrm{UA} \\ & 2 \mathrm{UA} \\ & 2 \mathrm{UA} \end{aligned}$ | .2 .2 .2 .2 | $\begin{aligned} & 1 \\ & 1 \\ & 1 \\ & 1 \end{aligned}$ | $\begin{array}{r} 80 \\ 150 \\ 40 \\ 80 \end{array}$ | 60 60 60 60 |
| $\begin{aligned} & \text { 2N2252 } \\ & \text { 2N2253 } \\ & \text { 2N22S4 } \\ & \text { 2N2255 } \end{aligned}$ | NPN <br> NPN <br> NPN <br> NPN | GP GP ©P GP | $\begin{aligned} & \text { 2N2221 } \\ & \text { 2N2220 } \\ & \text { 2N2220 } \\ & \text { 2N2221 } \end{aligned}$ | $\begin{aligned} & 500 \\ & 500 \\ & 500 \\ & 500 \end{aligned}$ | 25 45 45 45 | $\begin{aligned} & 20 \\ & 50 \\ & 50 \\ & 50 \end{aligned}$ | $\begin{array}{r} 20-60 \\ 5-15 \\ 10-30 \\ 20-60 \end{array}$ | $\begin{aligned} & 2 U A \\ & 2 U A \\ & 2 U A \\ & 2 U A \end{aligned}$ | .2 .2 .2 .2 | $\begin{aligned} & 1 \\ & 1 \\ & 1 \\ & 1 \end{aligned}$ | $\begin{array}{r} 150 \\ 40 \\ 80 \\ 150 \end{array}$ | 60 60 60 60 |
| $\begin{aligned} & \text { 2N2256 } \\ & \text { 2N2257 } \\ & \text { 2N2270 } \\ & \text { 2N2272 } \end{aligned}$ | NPN <br> NPN <br> NRN <br> NPN | SW <br> SW <br> GP <br> GP | $\begin{aligned} & \text { 2N2270 } \\ & \text { 2N929 } \end{aligned}$ | $\begin{array}{r} 300 \\ 300 \\ -5 w \\ 360 \end{array}$ | $\begin{array}{r} 7 \\ 7 \\ 60 \\ 40 \end{array}$ | 45 | $\begin{aligned} & 17- \\ & 40- \\ & 30- \\ & 80-240 \end{aligned}$ | $\begin{array}{r} 10 \\ 10 \\ 1 \\ 10 \end{array}$ | $.9$ | $\begin{aligned} & 150 \\ & 200 \end{aligned}$ | 50 |  |
| $\begin{aligned} & \text { 2N2274 } \\ & \text { 2N2275 } \\ & \text { 2N2275 } \\ & \text { 2N2277 } \end{aligned}$ |  | $\left\lvert\, \begin{aligned} & \text { sw } \\ & \text { sw } \\ & \text { sw } \\ & \text { sw } \end{aligned}\right.$ | $\begin{aligned} & \text { 2N2946 } \\ & \text { 2N2946 } \\ & \text { 2N2944 } \\ & \text { 2N2944 } \end{aligned}$ | 150 150 150 150 | 25 25 15 15 | 25 25 10 10 | 10 10 10 10 | 5 5 5 5 |  |  |  | 6 6 6 6 |
| 2N2278 <br> 2N2279 <br> 2N22s0 <br> 2N2297 | $\begin{aligned} & \text { PNP } \\ & \mathbf{N N P} \\ & P N P \\ & N P N \end{aligned}$ | $\begin{aligned} & \text { SW } \\ & \text { SW } \\ & \text { SW } \\ & \text { GP } \end{aligned}$ | 2N2945 <br> 2N2945 <br> 2N2944 <br> 2N3036 | $\begin{aligned} & 150 \\ & 150 \\ & 150 \\ & 800 \end{aligned}$ | 15 15 10 80 | $\begin{array}{r} 15 \\ 15 \\ 6 \\ 35 \end{array}$ | 40.120 | 150 | . 1 | $\begin{array}{r} 5 \\ 150 \end{array}$ |  | 7.6 7.6 16 60 |
| $\begin{aligned} & \text { 2N2303 } \\ & \text { 2N2307 } \\ & \text { 2N2309 } \\ & \text { 2N2310 } \end{aligned}$ | $\begin{aligned} & \text { PNP } \\ & \text { P-N } \\ & \text { NPN } \\ & \text { NPN } \end{aligned}$ | $\begin{aligned} & G P \\ & U J \\ & G P \\ & G P \end{aligned}$ | 2N2303 <br> 2N2218 | $\begin{aligned} & 600 \\ & \text { SEE UNLUU } \\ & 600 \\ & 350 \end{aligned}$ | 30 JNCTION 30 60 | $\begin{array}{c\|}  \\ \text { ITERCH } \\ 30 \\ 60 \end{array}$ | $\begin{gathered} 75-200 \\ \text { ANGEAMLITY } \\ 25-125 \\ 12-36 \end{gathered}$ | $\begin{array}{r} 150 \\ 5 T \\ .2 \\ 200 \end{array}$ | 1.5 <br> 5 | $\begin{aligned} & 150 \\ & 200 \end{aligned}$ | 40 | 60 |
| $\begin{aligned} & \text { 2N2311 } \\ & \text { 2N2312 } \\ & \text { 2N2313 } \\ & \text { 2N2314 } \end{aligned}$ | NPN <br> NPN NPN NPN | GP <br> GP <br> GP <br> GP |  | $\begin{aligned} & 350 \\ & 350 \\ & 350 \\ & 350 \end{aligned}$ | $\begin{array}{r} 100 \\ 60 \\ 100 \\ 60 \end{array}$ | $\begin{array}{r} 100 \\ 60 \\ 100 \end{array}$ | $\begin{aligned} & 12-36 \\ & 30-90 \\ & 30-90 \\ & 20-60 \end{aligned}$ | $\begin{aligned} & 200 \\ & 200 \\ & 200 \\ & 150 \end{aligned}$ | $\begin{aligned} & 5 \\ & 5 \\ & 5 \\ & 5 \end{aligned}$ | $\begin{aligned} & 200 \\ & 200 \\ & 200 \\ & 150 \end{aligned}$ | 15 | 40 |
| $\begin{aligned} & \text { 2N2315 } \\ & \text { 2N2316 } \\ & \text { 2N2317 } \\ & \text { 2N2318 } \end{aligned}$ | NHN <br> NPN <br> NPN <br> NPN | GP <br> $\boldsymbol{G P}$ <br> GP <br> SW |  | $\begin{aligned} & 350 \\ & \mathbf{3 5 0} \\ & 350 \\ & \mathbf{3 6 0} \end{aligned}$ | $\begin{array}{r} 60 \\ 120 \\ 75 \\ 30 \end{array}$ |  | $\begin{aligned} & 40.120 \\ & 40.120 \\ & 40.120 \\ & 15 . \end{aligned}$ | $\begin{array}{r} 150 \\ 150 \\ 150 \\ .1 \end{array}$ | $\begin{array}{r} 1.5 \\ 5 \\ 1.5 \\ .35 \end{array}$ | $\begin{array}{r} 150 \\ 150 \\ 150 \\ 20 \end{array}$ | $\begin{aligned} & \mathbf{2 5} \\ & 30 \\ & 30 \end{aligned}$ | $\begin{array}{r} 50 \\ 50 \\ 60 \\ 300 \end{array}$ |

## TRANSISTOR INTERCHANGEABILITY

MASTER LIST OF REGISTERED TYPES

| TYPM NUMEN: |  | $\begin{aligned} & 8 \\ & \frac{8}{3} \\ & 8 \end{aligned}$ | $\begin{aligned} & \text { I } \\ & \text { RIPLACMANT } \\ & \text { OR NLANBS } \\ & \text { ROUNALBNT } \end{aligned}$ | MAXIMUM ( ATMVOS |  |  | CTETILCAL CHARACTEASTICS |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  | $\begin{gathered} T_{A}=2 \theta^{\circ} \mathrm{C} \\ { }^{-1} \mathrm{C}=28^{\circ} \mathrm{C} \\ (\mathrm{~mW}) \end{gathered}$ | $v_{\mathrm{ClO}}$ (V) | Vero <br> (V) | MIN MAX | $\begin{gathered} \hline \mathbf{I C} \\ (\mathrm{ma}) \\ \hline \end{gathered}$ |  | + $\begin{array}{r} 16 \\ (\mathrm{ma}) \\ \hline \end{array}$ |  |  |
| $\begin{aligned} & \text { 2N2319 } \\ & \text { 2N2320 } \\ & \text { 2N2330 } \\ & \text { 2N2331 } \end{aligned}$ | NPN <br> NPN <br> NPN <br> NPN | $\begin{aligned} & \text { sw } \\ & \text { sw } \\ & \text { sw } \\ & \text { sw } \end{aligned}$ | 2N2432 | $\begin{aligned} & 300 \\ & 600 \\ & 800 \\ & 500 \end{aligned}$ | $\begin{aligned} & 30 \\ & 30 \\ & 30 \\ & 30 \end{aligned}$ | $\begin{aligned} & 20 \\ & 20 \end{aligned}$ | 13. <br> 15- <br> 50. <br> 50. | $\begin{aligned} & .1 \\ & .1 \\ & 10 \\ & 10 \end{aligned}$ | . 35 | $\begin{aligned} & 20 \\ & 20 \end{aligned}$ |  | $\begin{aligned} & 300 \\ & 300 \\ & 100 \\ & 100 \end{aligned}$ |
| $\begin{aligned} & \text { 2N2332 } \\ & \text { 2N2333 } \\ & \text { 2N2334 } \\ & \text { 2N233s } \end{aligned}$ | $\begin{aligned} & \text { PNP } \\ & \text { PNP } \\ & \text { PNP } \\ & \text { PNP } \end{aligned}$ | $\begin{aligned} & s w \\ & s w \\ & s w \\ & s w \end{aligned}$ |  | 150 150 150 150 | 15 15 30 30 | 15 5 15 15 |  |  |  |  |  |  |
| $\begin{aligned} & \text { 2N2336 } \\ & \text { 2N2337 } \\ & \text { 2N2349 } \\ & \text { 2N2350 } \end{aligned}$ | $\begin{aligned} & \text { PNP } \\ & \text { PNP } \\ & \text { NPN } \\ & \text { NPN } \end{aligned}$ | sW SW GP GP | $\begin{aligned} & \text { 2N929 } \\ & \text { 2N2222A } \end{aligned}$ | $\begin{aligned} & 150 \\ & 150 \\ & 150 \\ & 400 \end{aligned}$ | $\begin{aligned} & 50 \\ & 50 \\ & 40 \\ & 60 \end{aligned}$ | $\begin{aligned} & 35 \\ & 35 \\ & 24 \\ & 40 \end{aligned}$ | $\begin{aligned} & 120-250 \\ & 100-300 \end{aligned}$ | $\begin{array}{r} 10 \\ 150 \end{array}$ | $\begin{aligned} & 1.5 \\ & .35 \end{aligned}$ | $\begin{array}{r} 10 \\ 150 \end{array}$ | 60 | 250 |
| $\begin{aligned} & \text { 2N2350A } \\ & \text { 2N2351 } \\ & \text { 2N2351A } \\ & \text { 2N2352 } \end{aligned}$ | NPN NPN NPN NPN | GP GP GP GP | $\begin{aligned} & \text { 2N2222A } \\ & \text { 2N2193 } \\ & \text { 2N2193 } \\ & \text { 2N2194 } \end{aligned}$ | $\begin{array}{r} 400 \\ 400 \\ 400 \\ 400 \end{array}$ | $\begin{aligned} & 60 \\ & 80 \\ & 80 \\ & 60 \end{aligned}$ | $\begin{aligned} & 40 \\ & 50 \\ & 50 \\ & 40 \end{aligned}$ | $\begin{array}{r} 100-300 \\ 40-120 \\ 40-120 \\ 20-60 \end{array}$ | $\begin{aligned} & 150 \\ & 150 \\ & 150 \\ & 150 \end{aligned}$ | .25 .35 .25 .35 | $\begin{aligned} & 150 \\ & 150 \\ & 150 \\ & 150 \end{aligned}$ |  | 250 250 250 250 |
| $\begin{aligned} & \text { 2N2352A } \\ & \text { 2N2353 } \\ & \text { 2N2353A } \\ & \text { 2N2356 } \end{aligned}$ | NPN <br> NPN <br> NPN <br> NPN | GP <br> GP <br> GP <br> SW | 2N2194 2N2221 2N2221 | $\begin{aligned} & 400 \\ & 400 \\ & 400 \\ & 600 \end{aligned}$ | $\begin{aligned} & 60 \\ & 45 \\ & 45 \\ & 25 \end{aligned}$ | $\begin{array}{r} 40 \\ 25 \\ 25 \\ 7 \end{array}$ | $\begin{aligned} & 20-60 \\ & 20- \\ & 20- \end{aligned}$ | $\begin{aligned} & 150 \\ & 150 \\ & 150 \end{aligned}$ | .25 .35 .25 | $\begin{aligned} & 150 \\ & 150 \\ & 150 \end{aligned}$ |  | 250 250 250 50 |
| $\begin{aligned} & \text { 2N2356A } \\ & \text { 2N2364 } \\ & \text { 2N2364A } \\ & \text { 2N2368 } \end{aligned}$ | NPN <br> NPN <br> NPN <br> NPN | $\begin{aligned} & s w \\ & s w \\ & s w \\ & s w \end{aligned}$ |  | $\begin{aligned} & 600 \\ & 400 \\ & 400 \\ & 360 \end{aligned}$ | $\begin{array}{r} 25 \\ 120 \\ 120 \\ 40 \end{array}$ | $\begin{array}{r} 7 \\ 80 \\ 80 \end{array}$ | $\begin{aligned} & 40-120 \\ & 40-120 \\ & 20-60 \end{aligned}$ | $\begin{array}{r} 150 \\ 150 \\ 10 \end{array}$ | .35 .25 .25 | $\begin{array}{r} 150 \\ 150 \\ 10 \end{array}$ |  | 50 50 50 400 |
| $\begin{aligned} & \text { 2N2369 } \\ & \text { 2N2369A } \\ & \text { 2N2370 } \\ & \text { 2N2371 } \end{aligned}$ | NPN <br> NPN <br> PNP <br> PNP | SW <br> SW <br> GP <br> GP |  | $\begin{aligned} & 390 \\ & 360 \\ & 200 \\ & 200 \end{aligned}$ | $\begin{aligned} & 40 \\ & 40 \\ & 15 \\ & 15 \end{aligned}$ | $\begin{aligned} & 15 \\ & 15 \end{aligned}$ | $\begin{aligned} & 40-120 \\ & 40-120 \\ & 15 . \\ & 20 . \end{aligned}$ | $\begin{array}{r} 10 \\ 10 \\ 250 \\ 250 \end{array}$ | .25 .35 | 10 10 | 15 20 | 500 500 |
| $\begin{aligned} & \text { 2N2372 } \\ & \text { 2N2373 } \\ & \text { 2N2377 } \\ & \text { 2N2378 } \end{aligned}$ | PNP PNP PNP PNP | GP GP SW SW | $\begin{aligned} & \text { 2N3798 } \\ & \text { 2N3798 } \end{aligned}$ | $\begin{aligned} & 150 \\ & 150 \\ & 150 \\ & 150 \end{aligned}$ | 15 15 25 10 | 15 15 25 10 | $15-$ 20. 10.100 15. | $\begin{array}{r} 25 U \\ 25 U \\ 5 \\ 15 \end{array}$ |  |  | 15 20 15 | 8 <br> 7.2 |
| $\begin{aligned} & \text { 2N2380 } \\ & \text { 2N2380A } \\ & \text { 2N2386 } \\ & \text { 2N2386A } \end{aligned}$ | NPN NPN PCH PCH | GP <br> GP <br> FE <br> FE | $\begin{aligned} & \text { 2N2193 } \\ & \text { 2N2193 } \\ & \text { 2N2386 } \\ & \text { 2N2386A } \end{aligned}$ | $\begin{aligned} & 600 \\ & 600 \\ & \text { SEE FET } \\ & \text { SEE FET } \end{aligned}$ | $\begin{array}{r} 80 \\ 80 \\ \text { INTERCH } \\ \text { INTERCH } \end{array}$ | $\begin{array}{r} 40 \\ 40 \\ \text { IANGEABM } \\ \text { HNGEABM } \end{array}$ | $\begin{array}{\|l} 20-120 \\ 20-120 \\ \text { LITY LIST } \\ \text { LITY LIST } \end{array}$ | $\begin{aligned} & 150 \\ & 150 \end{aligned}$ | $\begin{aligned} & 1.3 \\ & 1.3 \end{aligned}$ | $\begin{aligned} & 150 \\ & 150 \end{aligned}$ |  | 100 100 |
| $\begin{aligned} & \text { 2N2387 } \\ & \text { 2N2388 } \\ & \text { 2N2389 } \\ & \text { 2N2390 } \end{aligned}$ | NPN <br> NPN <br> NPN <br> NPN | GP GP GP GP | $\begin{aligned} & \text { 2N2387 } \\ & \text { 2N2388 } \\ & \text { 2N2389 } \\ & \text { 2N2390 } \end{aligned}$ | $\begin{aligned} & 300 \\ & 300 \\ & 450 \\ & 450 \end{aligned}$ | $\begin{aligned} & 45 \\ & 45 \\ & 75 \\ & 75 \end{aligned}$ | $\begin{aligned} & 45 \\ & 45 \end{aligned}$ | $\begin{array}{r} 40-120 \\ 100-300 \\ 40.120 \\ 100-300 \end{array}$ | $\begin{aligned} & .01 \\ & .01 \\ & 150 \\ & 150 \end{aligned}$ | $\begin{array}{r} 1 \\ 1 \\ 1.5 \\ 1.5 \end{array}$ | $\begin{array}{r} 10 \\ 10 \\ 150 \\ 150 \end{array}$ | 60 150 30 50 |   <br> 0 30 <br> 00  <br> 00  <br>  70 |

## TRANSISTOR INTERCHANGEABILITY MASTER LIST OF REGISTERED TYPES

| MYM | $8$ |  |  | Maximum ratives |  |  | Escmical Chanactursice |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  |  |  | hri |  | $\mathrm{V}_{\text {cli(men) }}$ |  | $\begin{gathered} h_{6} \\ 1 \text { kets } \\ \text { MN } \end{gathered}$ |  |
|  |  |  |  |  |  |  |  | $\begin{gathered} \hline \mathbf{I C} \\ (m A) \\ \hline \end{gathered}$ | $\begin{aligned} & \max \\ & (\mathrm{V}) \\ & \hline \end{aligned}$ | $\begin{array}{ll} 1 \\ \text { It } \\ (\mathrm{mA}) \end{array}$ |  |  |
| $\left\lvert\, \begin{aligned} & \text { 2N2391 } \\ & \text { 2N2392 } \\ & \text { 2N2393 } \\ & \text { 2N2394 } \end{aligned}\right.$ | $\begin{aligned} & \text { PNP } \\ & \text { NP } \\ & \text { NNP } \\ & \text { PNP } \end{aligned}$ | $\begin{aligned} & G P \\ & G P \\ & G P \\ & G P \\ & G P \end{aligned}$ | $\begin{aligned} & \text { 2N2393 } \\ & \text { 2N2394 } \end{aligned}$ | 300 300 450 450 | 25 25 50 50 | $\begin{aligned} & 20 \\ & 20 \\ & 35 \\ & 35 \end{aligned}$ | 15-45 <br> $30-90$ <br> 20-45 <br> 30-90 | $\begin{array}{r} 10 \\ 10 \\ 150 \\ 150 \end{array}$ | $\begin{array}{r} .6 \\ .6 \\ 1.5 \\ 1.5 \end{array}$ | $\begin{array}{r} 10 \\ 10 \\ 150 \\ 150 \end{array}$ | $\begin{aligned} & 15 \\ & 90 \\ & 15 \\ & 25 \end{aligned}$ | 140 140 50 60 |
| $\begin{aligned} & \text { 2N2395 } \\ & \text { 2N2396 } \\ & \text { 2N2397 } \\ & \text { 2N2403 } \end{aligned}$ | $\begin{aligned} & \text { NPN } \\ & \text { NPN } \\ & \text { NFN } \\ & \text { NFN } \end{aligned}$ | GP GP SW SW | $\begin{aligned} & \text { 2N239s } \\ & \text { 2N2396 } \end{aligned}$ | 450 450 300 $1 W$ | 60 60 35 60 | $\begin{aligned} & 40 \\ & 40 \\ & 15 \\ & 60 \end{aligned}$ | $\begin{aligned} & 20-60 \\ & 40.120 \\ & 25-120 \\ & 20-60 \end{aligned}$ | 150 150 10 600 | 1 1 .3 1.5 | 150 150 10 600 |  | 40 50 200 147 |
| $\begin{aligned} & \text { 2N2404 } \\ & \text { 2N2405 } \\ & \text { 2N2410 } \\ & \text { 2N2411 } \end{aligned}$ | $\begin{aligned} & \text { NPN } \\ & \text { N N } \\ & \text { NPN } \\ & \text { PNP } \end{aligned}$ | $\begin{aligned} & \text { SW } \\ & \text { GP } \\ & \text { SW } \\ & \text { SW } \end{aligned}$ | $\begin{aligned} & \text { 2N1893 } \\ & \text { 2N2410 } \end{aligned}$ | $\begin{aligned} & 1 w \\ & .5 w \\ & 800 \\ & 300 \end{aligned}$ | 60 120 60 25 | $\begin{aligned} & 60 \\ & 90 \\ & 30 \\ & 20 \end{aligned}$ | 40-120 40-200 30-120 20-60 | $\begin{array}{r} 600 \\ 150 \\ 10 \\ 10 \end{array}$ | $\begin{array}{r} 1.5 \\ .5 \\ .2 \end{array}$ | 600 <br> 150 <br> 10 | 50 | 147 200 140 |
| 2N2412 <br> 2N2413 <br> 2N2414 <br> 2N2417 | $\begin{aligned} & \text { PNP } \\ & \text { NPN } \\ & \text { NPN } \\ & \text { P-N } \end{aligned}$ | $\begin{aligned} & \text { sw } \\ & \text { Gp } \\ & \text { Du } \\ & u J \end{aligned}$ | 2N2221 2N2060 2N489 | $\begin{gathered} 300 \\ 300 \\ 500 \\ \text { sEE UNI. } \end{gathered}$ | $\begin{gathered} 25 \\ 40 \\ 60 \\ \text { IUNCTION } \end{gathered}$ | $\begin{aligned} & 20 \\ & 18 \end{aligned}$ | $\begin{aligned} & 40.120 \\ & 30.120 \\ & 50-250 \end{aligned}$ <br> ANGEABITT | $\begin{aligned} & 10 \\ & 10 \\ & 10 \end{aligned}$ | $\begin{array}{r}.2 \\ .4 \\ \hline 1.2\end{array}$ | $\begin{aligned} & 10 \\ & 10 \\ & 50 \end{aligned}$ | 50 | 140 300 50 |
| 2N2417A <br> 2N2417B <br> 2N2418 <br> 2N2418A | $\begin{aligned} & P \cdot N \\ & P \cdot N \\ & P \cdot N \\ & P \cdot N \end{aligned}$ | $\left\lvert\, \begin{aligned} & u J \\ & u J \\ & u J \\ & u J \\ & u J \end{aligned}\right.$ |  | SEE UNUUNCTION INTERCHANGEABHITY LIST SEE UNUUNCTION INTERCHANGEABLTTY LIST SEE UNIUUNCTION INTERCHANGEABLITY UST SEE UNIUUNCTION INTERCHANGEABLITY LST |  |  |  |  |  |  |  |  |
| 2N2418B <br> 2N2419 <br> 2N2419A <br> 2N2A198 | $\begin{aligned} & P-N \\ & P-N \\ & P-N \\ & P-N \end{aligned}$ | $\begin{array}{\|l\|} \hline u J \\ u J \\ u J \\ u J \\ u J \end{array}$ | 2N4908 2N491 2N491A 2N491B | SEE UNIJUNCTION INTERCHANGEAELITY LIST SEE UNIJUNCTION INTERCHANGEABLITY LIST SEE UNIUUNCTION INTERCHANGEABHITY LIST SEE UNIJUNCTION INTERCHANGEABLLTY UST |  |  |  |  |  |  |  |  |
|  | $\begin{aligned} & P \cdot N \\ & P \cdot N \\ & P \cdot N \\ & P-N \\ & \hline \end{aligned}$ | $\begin{aligned} & u \\ & u \\ & u \\ & u \\ & u J \\ & u J \\ & u J \end{aligned}$ | $\begin{aligned} & \text { 2N492 } \\ & \text { 2N492A } \\ & \text { 2N4923 } \\ & \text { 2N493 } \end{aligned}$ | SEE UNLUNCTION INTERCHANGEABILTY LIST SEE UNIUUNCTION INTERCHANGEABLLTY LIST SEE UNIJUNCTION INTERCHANGEAEHLTY LIST SEE UNIUUNCTION INTERCHANGEABLITY UST |  |  |  |  |  |  |  |  |
|  | $\begin{aligned} & \text { P-N } \\ & P-N \\ & P-N \\ & P N P N \end{aligned}$ | $\begin{aligned} & \text { us } \\ & \text { uJ } \\ & \text { us } \\ & \text { sw } \end{aligned}$ | $\begin{aligned} & \text { 2N493A } \\ & \text { 2N493B } \end{aligned}$ | SEE UNUUNCTION INTERCHANGEABHLTY UST SEE UNIJUNCTION NTTERCHANGEABLLTY LUST SEE UNIUUNCTION INTERCHANGEABLUTY LIST |  |  |  |  | . 3 | 15 |  |  |
| $\begin{aligned} & \text { 2N2425 } \\ & \text { 2N2427 } \\ & \text { 2N2432 } \\ & \text { 2N2432A } \end{aligned}$ | PNP <br> NPN <br> NPN <br> NPN | $\begin{aligned} & s w \\ & s w \\ & s w \\ & s w \end{aligned}$ | $\begin{array}{\|l} \text { 2N2432 } \\ \text { 2N2432A } \end{array}$ | $\begin{aligned} & 375 \\ & 500 \\ & 300 \\ & 300 \end{aligned}$ | 50 40 30 45 | $\begin{aligned} & 10 \\ & 40 \\ & 30 \\ & 45 \end{aligned}$ | $25-110$ $20-60$ 50 $50-$ | 5 .01 1 1 | $\begin{array}{r} .3 \\ .15 \\ .15 \end{array}$ | $\begin{aligned} & 15 \\ & 10 \\ & 10 \end{aligned}$ | 40 | 50 <br> 20 <br> 20 |
| 2N2433 2N2434 2N2435 | NPN <br> NPN <br> NPN <br> NPN | $\begin{aligned} & s w \\ & s w \\ & s w \\ & s w \end{aligned}$ |  | $\begin{aligned} & 500 \\ & 500 \\ & 500 \\ & 500 \end{aligned}$ | $\begin{array}{r} 75 \\ 75 \\ 720 \\ 120 \end{array}$ | $\begin{aligned} & 45 \\ & 45 \\ & 80 \\ & 80 \end{aligned}$ | $\begin{array}{r} 40-120 \\ 100-300 \\ 40-120 \\ 100-300 \end{array}$ | $\begin{aligned} & 150 \\ & 150 \\ & 150 \\ & 150 \end{aligned}$ | $\begin{array}{r} 1.5 \\ 1.5 \\ 3 \\ 3 \end{array}$ | $\begin{aligned} & 150 \\ & 150 \\ & 150 \\ & 150 \end{aligned}$ | 30 50 30 50 | 80 90 80 90 |

## TRANSISTOR INTERCHANGEABILITY MASTER LIST OF REGISTERED TYPES

| TYFE NUMEER | $\frac{3}{8}$ | $\begin{aligned} & \frac{8}{8} \\ & \frac{8}{3} \\ & \frac{8}{8} \\ & 8 \end{aligned}$ | 7 <br> REPLACEMENT OR NEAREST ECUIVALENT | MAXIMUM RATMES |  |  | ELCMRKAL CHARACTERSTICS |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  | $\begin{gathered} \mathrm{PT}_{\mathrm{T}} \\ \mathrm{~T}_{\mathrm{A}}=25^{\circ} \mathrm{C} \\ { }^{\mathrm{T}_{\mathrm{C}}=25^{\circ} \mathrm{C}} \\ (\mathrm{~mW}) \\ \hline \end{gathered}$ | $V_{C B O}$ (V) | Vceo <br> (V) | $\square$ | $\begin{gathered} \hline \mathrm{lc} \\ (\mathrm{~mA}) \\ \hline \end{gathered}$ | VCE! <br> MAX <br> (V) | $\begin{gathered} (\operatorname{set}) \\ \hline L C \\ (\mathrm{~mA}) \\ \hline \end{gathered}$ |  | $\begin{gathered} \mathrm{T} \\ \mathrm{MmN} \\ (\mathrm{MHz}) \\ \hline \end{gathered}$ |
| $\begin{aligned} & \text { 2N2437 } \\ & \text { 2N2438 } \\ & \text { 2N2439 } \\ & \text { 2N2440 } \end{aligned}$ | NPN <br> NPN <br> NPN <br> NPN | $\begin{aligned} & s w \\ & s w \\ & s w \\ & G P \end{aligned}$ | 2N2102 | $\begin{aligned} & 500 \\ & 500 \\ & 500 \\ & 300 \end{aligned}$ | $\begin{aligned} & 100 \\ & 100 \\ & 100 \\ & 120 \end{aligned}$ | $\begin{aligned} & 75 \\ & 75 \\ & 75 \\ & 80 \end{aligned}$ | $\begin{gathered} 15- \\ 35- \\ 75- \\ 100-300 \end{gathered}$ | $\begin{array}{r} 10 \\ 10 \\ 10 \\ 150 \end{array}$ | .2 .4 .4 .4 | $\begin{aligned} & 10 \\ & 50 \\ & 50 \\ & 50 \end{aligned}$ | $\begin{aligned} & 18 \\ & 36 \\ & 76 \\ & 50 \end{aligned}$ | 70 80 90 90 |
| $\left\lvert\, \begin{aligned} & \text { 2N2443 } \\ & \text { 2N2452 } \\ & \text { 2N2453 } \\ & \text { 2N2453A } \end{aligned}\right.$ | $\begin{aligned} & \text { NPN } \\ & \text { NPN } \\ & \text { NPN } \\ & \text { NPN } \end{aligned}$ | GP GP DU DU | $\begin{aligned} & \text { 2N2102 } \\ & \text { 2N2453 } \\ & \text { 2N2453 } \end{aligned}$ | $\begin{aligned} & 800 \\ & 500 \\ & 500 \\ & 500 \end{aligned}$ | $\begin{array}{r} 120 \\ 100 \\ 60 \\ 80 \end{array}$ | 100 30 50 | $\begin{array}{r} 50-150 \\ 150-600 \\ 150-600 \end{array}$ | $\begin{gathered} 50 \\ 1 \\ 1 \end{gathered}$ | 1.2 <br> 1 | $\begin{gathered} 50 \\ 5 \\ 5 \end{gathered}$ | $\begin{array}{r} 45 \\ 150 \\ 150 \end{array}$ | $\begin{aligned} & 50 \\ & 60 \\ & 60 \end{aligned}$ |
| $\begin{aligned} & \text { 2N2459 } \\ & \text { 2N2460 } \\ & \text { 2N2461 } \\ & \text { 2N2462 } \end{aligned}$ | $\begin{aligned} & \text { NPN } \\ & \text { NPN } \\ & \text { NPN } \\ & \text { NPN } \end{aligned}$ | GP <br> GP <br> GP <br> GP |  | $\begin{aligned} & 400 \\ & 400 \\ & 400 \\ & 400 \end{aligned}$ | $\begin{aligned} & 100 \\ & 100 \\ & 100 \\ & 100 \end{aligned}$ | 60 60 60 60 | $\begin{aligned} & 10- \\ & 20- \\ & 40- \\ & 60- \end{aligned}$ | $\begin{aligned} & .1 \\ & .1 \\ & .1 \\ & .1 \end{aligned}$ | $\begin{aligned} & .3 \\ & .3 \\ & .3 \\ & .3 \end{aligned}$ | $\begin{aligned} & 10 \\ & 10 \\ & 10 \\ & 10 \end{aligned}$ | $\begin{array}{r} 40 \\ 70 \\ 115 \\ 160 \end{array}$ | $\begin{aligned} & 100 \\ & 120 \\ & 140 \\ & 160 \end{aligned}$ |
| $\begin{aligned} & \text { 2N2463 } \\ & \text { 2N2464 } \\ & \text { 2N2465 } \\ & \text { 2N2466 } \end{aligned}$ | NPN <br> NPN <br> NPN <br> NPN | GP GP GP GP |  | $\begin{aligned} & 500 \\ & 500 \\ & 500 \\ & 500 \end{aligned}$ | $\begin{aligned} & 100 \\ & 100 \\ & 100 \\ & 100 \end{aligned}$ | $\begin{aligned} & 60 \\ & 60 \\ & 60 \\ & 60 \end{aligned}$ | $\begin{aligned} & 10- \\ & 20- \\ & 40- \\ & 60- \end{aligned}$ | $\begin{aligned} & .1 \\ & .1 \\ & .1 \\ & .1 \end{aligned}$ | $\begin{aligned} & .3 \\ & .3 \\ & .3 \\ & .3 \end{aligned}$ | $\begin{aligned} & 10 \\ & 10 \\ & 10 \\ & 10 \end{aligned}$ | $\begin{array}{r} 40 \\ 70 \\ 115 \\ 160 \end{array}$ | $\begin{aligned} & 100 \\ & 120 \\ & 140 \\ & 160 \end{aligned}$ |
| $\begin{aligned} & \text { 2N2475 } \\ & \text { 2N2476 } \\ & \text { 2N2477 } \\ & \text { 2N2478 } \end{aligned}$ | NPN NPN NPN NPN | $\begin{aligned} & s W \\ & S W \\ & S W \\ & G P \end{aligned}$ | 2N2218 | $\begin{gathered} 300 \\ +2 W \\ \cdot 2 W \\ 600 \end{gathered}$ | $\begin{array}{r} 15 \\ 60 \\ 60 \\ 120 \end{array}$ | $\begin{array}{r} 6 \\ 20 \\ 20 \\ 40 \end{array}$ | $\begin{aligned} & 20- \\ & 20- \\ & 40- \\ & 30- \end{aligned}$ | $\begin{array}{r} 50 \\ 150 \\ 150 \\ 150 \end{array}$ | .4 .4 . | 150 150 150 |  | 600 250 250 200 |
| $\begin{aligned} & \text { 2N2479 } \\ & \text { 2N2480 } \\ & \text { 2N2480A } \\ & \text { 2N2481 } \end{aligned}$ | NPN <br> NPN <br> NPN <br> NPN | GP <br> DU <br> DU <br> SW | 2N2218 <br> 2N2060 <br> 2N2060 | $\begin{aligned} & 600 \\ & 300 \\ & 300 \\ & 400 \end{aligned}$ | $\begin{aligned} & 80 \\ & 75 \\ & 80 \\ & 40 \end{aligned}$ | $\begin{aligned} & 40 \\ & 40 \\ & 40 \\ & 15 \end{aligned}$ | $\begin{aligned} & 30-120 \\ & 30-350 \\ & 50-200 \\ & 40-120 \end{aligned}$ | $\begin{array}{r} 150 \\ 1 \\ 1 \\ 10 \end{array}$ | .85 1.3 1.2 .25 | 150 50 50 10 | $\begin{aligned} & 60 \\ & 50 \end{aligned}$ | 150 50 50 300 |
| $\begin{aligned} & \text { 2N2483 } \\ & \text { 2N2484 } \\ & \text { 2N2484A } \\ & \text { 2N2497 } \end{aligned}$ | NPN NPN NPN PCH | GP <br> GP <br> GP <br> FE | $\begin{aligned} & \text { 2N2483 } \\ & \text { 2N2484 } \\ & \text { 2N2484 } \\ & \text { 2N2497 } \end{aligned}$ | $\begin{gathered} 360 \\ 360 \\ 360 \\ \text { SEE FET } \end{gathered}$ | $\begin{array}{r} 60 \\ 60 \\ 60 \\ \text { WTERCH } \end{array}$ | $\begin{array}{r} 60 \\ 60 \\ 60 \end{array}$ | $\begin{array}{r} 40-120 \\ 100-500 \\ 100-500 \end{array}$ <br> ITY LST | $\begin{aligned} & .01 \\ & .01 \\ & .01 \end{aligned}$ | .35 .35 .35 | $\begin{aligned} & 1 \\ & 1 \\ & 1 \end{aligned}$ | 80 150 150 | 12 15 60 |
| $\begin{aligned} & \text { 2N2498 } \\ & \text { 2N2499 } \\ & \text { 2N2500 } \\ & \text { 2N2501 } \end{aligned}$ | PCH <br> PCH <br> PCH <br> NPN | FE <br> FE <br> FE <br> SW | $\begin{aligned} & \text { 2N2498 } \\ & \text { 2N2499 } \\ & \text { 2N2500 } \\ & \text { 2N2537 } \end{aligned}$ | SEE FET <br> SEE FET <br> SEE FET <br> 360 | INTERCH INTERC INTERCH 40 | ANGEABIL ANGEABH ANGEABIL 20 | ITY LIST ITY LIST ITY LIST $50-150$ | 10 |  |  |  | 350 |
| $\begin{aligned} & \text { 2N2509 } \\ & \text { 2N2510 } \\ & \text { 2N2511 } \\ & \text { 2N2514 } \end{aligned}$ | NPN NPN NPN NPN | GP GP GP GP | 2N3117 | $\begin{aligned} & 400 \\ & 400 \\ & 400 \\ & 400 \end{aligned}$ | $\begin{array}{r} 125 \\ 100 \\ 80 \\ 80 \end{array}$ | 80 65 50 60 | $\begin{gathered} 25- \\ 150-500 \\ 240-750 \\ 15-50 \end{gathered}$ | .01 10 10 5 | 1 1 1 .5 | $\begin{array}{r} 5 \\ 5 \\ 5 \\ 10 \end{array}$ | 20 | ( 45 |
| $\begin{aligned} & \text { 2N2515 } \\ & \text { 2N2516 } \\ & \text { 2N2517 } \\ & \text { 2N2518 } \end{aligned}$ | NPN NPN NPN NPN | GP GP GP GP |  | $\begin{array}{r} 400 \\ 400 \\ 400 \\ 400 \end{array}$ | $\begin{array}{r} 80 \\ 80 \\ 125 \\ 125 \end{array}$ | 60 60 80 80 | $\begin{aligned} & 30-100 \\ & 60-200 \\ & 15-50 \\ & 30-100 \end{aligned}$ | 5 5 5 5 | .5 .5 .5 .5 | 10 10 10 10 | 40 60 20 40 | 60  <br> 100  <br> 0 30 |

## TRANSISTOR INTERCHANGEABILITY MASTER LIST OF REGISTERED TYPES

| TYPE NUMBER | $\frac{2}{8}$$\frac{8}{8}$$\frac{8}{8}$ | $Z$8$\frac{8}{8}$$\frac{1}{2}$8 | $\begin{gathered} \text { n } \\ \text { REMLACEMENT } \\ \text { OR NEAREST } \\ \text { ECUYALENT } \end{gathered}$ | MAXIMUM RATENES |  |  | EECTRICAL CHARACTERISTICS |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  | $\begin{gathered} P_{T} \\ T_{A}=25^{\circ} \mathrm{C} \\ { }^{\circ} \mathrm{T}_{\mathrm{C}}=25^{\circ} \mathrm{C} \\ (\mathrm{~mW}) \end{gathered}$ | VCBO <br> (V) | Vceo <br> (V) | hfe |  | $\mathbf{V C E}_{\text {(sed) }}$ |  | $\begin{gathered} \mathrm{h}_{\mathrm{fe}} \\ 1 \mathrm{kdtz} \\ \text { MEN } \end{gathered}$ | $\begin{gathered} \mathbf{f}_{\mathrm{T}} \\ \mathrm{MH} \\ \hline \mathrm{MHz} \end{gathered}$ |
|  |  |  |  |  |  |  | $\text { MIN MAX } \begin{gathered} \mathrm{IC} \\ (\mathrm{~mA}) \\ \hline \end{gathered}$ |  | $\begin{array}{\|lr\|} \hline M A X & \mathbf{C} \\ (V) & (\mathrm{mA}) \\ \hline \end{array}$ |  |  |  |
| 2N2519 <br> 2N2520 | NPN | GP |  | 400 |  | 80 | 60-200 | 5 | . 5 | 10 | 80183676 | 100 |
| 2N2520 | NPN | GP |  | 400 | 60 | 60 | 12. | 1 | . 5 | 10 |  |  |
| $\begin{array}{\|l\|l\|} \text { 2N2521 } \\ \text { 2N2522 } \end{array}$ | NPN | GP |  | 400 | 60 | 60 | 25- | 1 | . 5 | 10 |  |  |
|  |  | GP |  | 400 | 60 | 60 | 50. | 1 | . 5 | 10 |  |  |
| 2N2523 | NPN | GP | $\begin{aligned} & \text { 2N929 } \\ & \text { 2N930 } \end{aligned}$ | 400 | 60 | 45 | 40-120 | . 01 | . 5 | 10 | 60 | 45 |
| 2N2524 | NPN | GP |  | 400 | 60 | 45 | 100-300 | . 01 | . 5 | 10 | 150 |  |
| 2N2529 | NPN | GP |  | 150 | 45 | 40 | 10-20 | 1 | 2 | 10 | 12 |  |
| 2N2530 | NPN | GP |  | 150 | 45 | 40 | 12-35 | 1 | 2 | 10 | 18 |  |
| 2N2531 | NPN | GP |  | 150 | 45 | 40 | 20-80 | 1 | 2 | 10 | 36 |  |
| 2N2532 | NPN | GP |  | 150 | 45 | 40 | 45.185 | 1 | 2 | 10 | 76 |  |
| 2N2533 | NPN | GP |  | 150 | 45 | 40 | 20-55 | 10 | 1.5 | 10 | 19 |  |
| 2N2534 | NPN | GP |  | 150 | 45 | 40 | 45-150 | 10 | 1.5 | 10 | 39 |  |
| 2N2537 | NPN | SW | 2N2537 | 800 | 60 | 30 | 50-150 | 150 | . 45 | 150 |  | 250 |
| 2N2538 | NPN | SW | 2N2538 | 800 | 60 | 30 | 100.300 | 150 |  | 150 |  | 250 |
| 2N2539 | NPN | sw | 2N2539 | 500 | 60 | 30 | 50.150 | 150 | . 45 | 150 |  | 250 |
| 2N2540 | NPN | SW | 2N2540 | 500 | 60 | 30 | 100-300 | 150 | . 45 | 150 |  | 250 |
| 2N2551 | PNP | GP |  |  |  | 150 | 15-45 | 100 | 1.2 | 100 |  |  |
| 2N2569 | NPN | SW |  | 300 | 20 | 5 | 50. | . 1 |  |  |  | 100 |
| 2N2570 | NPN | SW |  | 300 | 20 | 5 | 50 | . 1 |  |  |  | 100 |
| 2N2571 | NPN | SW |  | 300 | 20 | 15 | 50. | 100 |  |  |  | 100 |
| 2N2572 | NPN | SW | 2N2586 | 300 | 20 | 15 | $\begin{aligned} & 50- \\ & 120-360 \\ & 10- \\ & 20- \end{aligned}$ | $\begin{array}{r} 100 \\ .01 \\ .1 \\ .1 \end{array}$ | .5.4.4 |  | 1504070 | 5070 |
| 2N2586 | NPN | GP |  | 300 | 60 | 45 |  |  |  | 10 |  |  |
| 2N2590 | PNP | GP |  | 400 | 100 | 60 |  |  |  | 10 |  |  |
| 2N2591 | PNP | GP |  | 400 | 100 | 60 |  |  |  | 10 |  |  |
| 2N2592 2N2593 |  |  | $\begin{aligned} & \text { 2N3036 } \\ & \text { 2N3496 } \end{aligned}$ | 400 | 100 | 60 | $\begin{aligned} & 40- \\ & 60- \\ & 50-150 \\ & 15-60 \end{aligned}$ | $\begin{array}{r} .1 \\ .1 \\ 100 \\ 5 \end{array}$ | .4.41.5 | 10 | $\begin{array}{r} 115 \\ 160 \\ 15 \\ 20 \end{array}$ | 901104030 |
| 2N2593 2N2594 | PNP | GP |  | 400 | 100 | 60 |  |  |  | 10 |  |  |
| 2N2594 | NPN | GP |  | ${ }^{\circ} 5 \mathrm{~W}$ | 80 |  |  |  |  | 200 |  |  |
| 2N2595 | PNP | GP |  | 400 | 80 | 60 |  |  |  | 10 |  |  |
| $\begin{aligned} & \text { 2N2596 } \\ & \text { 2N2597 } \\ & \text { 2N2598 } \\ & \text { 2N2599 } \end{aligned}$ | PNP <br> PNP <br> PNP <br> PNP | $\begin{aligned} & \text { GP } \\ & \text { GP } \\ & \text { GP } \\ & \text { GP } \end{aligned}$ | 2N3496 <br> 2N3496 <br> 2N3497 <br> 2N3497 | 400 | 80 | 60 | $\begin{aligned} & 30-120 \\ & 60-240 \\ & 15-60 \\ & 30-120 \end{aligned}$ | $\begin{aligned} & 5 \\ & 5 \\ & 5 \\ & 5 \end{aligned}$ | .5.5.5.5 | 10 | 40802040 | 40603040 |
|  |  |  |  | 400 | 80 | 60 |  |  |  | 10 |  |  |
|  |  |  |  | 400 | 125 | 80 |  |  |  | 10 |  |  |
|  |  |  |  | 400 | 125 | 80 |  |  |  | 10 |  |  |
| $\begin{aligned} & \text { 2N2599A } \\ & \text { 2N2600 } \\ & \text { 2N2600A } \\ & \text { 2N2601 } \end{aligned}$ | $\begin{array}{\|l\|} \text { PNP } \\ \text { PNP } \\ \text { PNP } \\ \text { PNP } \end{array}$ | $\begin{aligned} & G P \\ & G P \\ & G P \\ & G P \end{aligned}$ | 2N3497 <br> 2N3497 <br> 2N3497 <br> 2N3798 | 400 | 125 | 100 | $\begin{aligned} & 30-120 \\ & 60-240 \\ & 60-240 \\ & 12- \end{aligned}$ | $\begin{aligned} & 5 \\ & 5 \\ & 5 \\ & 1 \end{aligned}$ | $\begin{aligned} & .5 \\ & .5 \\ & .5 \\ & .5 \end{aligned}$ | 10 | 40808018 | 40606020 |
|  |  |  |  | 400 | 125 | 80 |  |  |  | 10 |  |  |
|  |  |  |  | 400 | 125 | 100 |  |  |  | 10 |  |  |
|  |  |  |  | 400 | 60 | 60 |  |  |  | 10 |  |  |
| $\begin{aligned} & \text { 2N2602 } \\ & \text { 2N2603 } \\ & \text { 2N2604 } \\ & \text { 2N2605 } \end{aligned}$ | PNP <br> PNP <br> PNP <br> PNP | GP <br> GP <br> GP <br> GP | 2N3798 <br> 2N3799 <br> 2N2604 <br> 2N2605 | 400 | 60 | 60 | $\begin{array}{r} 25- \\ 50- \\ 40 \\ 100 \end{array}$ | 1 |  | 10 | 36 |  |
|  |  |  |  | 400 | 60 | 60 |  | 1 | . 5 | 10 | 76 | 60 |
|  |  |  |  | 400 | 60 | 45 |  | . 01 | . 5 | 10 | 60 | 30 |
|  |  |  |  | 400 | 60 | 45 |  | . 01 | . 5 | 10 | 150 | 30 |

## TRANSISTOR INTERCHANGEABILITY MASTER LIST OF REGISTERED TYPES

| TYPE NUMEE | $\begin{aligned} & E \\ & \frac{2}{8} \\ & \frac{8}{8} \end{aligned}$ | $\begin{aligned} & \frac{z}{0} \\ & \frac{2}{3} \\ & \frac{3}{6} \\ & 3 \end{aligned}$ | $\begin{aligned} & \text { II } \\ & \text { REPLACEMENT } \\ & \text { OR NBAREST } \\ & \text { EOUVALENT } \end{aligned}$ | maximum ratavas |  |  | ELECRICAL CHARACIEMSTICS |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  | $\begin{gathered} \mathrm{T}_{A}=25^{\circ} \mathrm{C} \\ { }^{{ }^{\circ} \mathrm{T}} \mathrm{C}=25^{\circ} \mathrm{C} \\ (\mathrm{~mW}) \\ \hline \end{gathered}$ | VeBo <br> (V) | Vceo <br> (V) | MN MAX | $\begin{gathered} c \\ \hline(\mathrm{~mA}) \end{gathered}$ |  | Ic (ma) | $\begin{gathered} \mathrm{hfo}_{\mathrm{o}} \\ 1 \mathrm{kHtz} \\ \text { MNN } \end{gathered}$ |  |
| $\begin{aligned} & \text { 2N2605A } \\ & \text { 2N2606 } \\ & \text { 2N2607 } \\ & \text { 2N2608 } \end{aligned}$ | $\begin{aligned} & \text { PNP } \\ & \text { PCH } \\ & \text { PCH } \\ & P C H \end{aligned}$ | $\begin{aligned} & \text { GP } \\ & \text { FE } \\ & \text { FE } \\ & \text { FE } \end{aligned}$ | 2N3799 2N2608 | SEE FET MTERCHANGEABLLITY UST <br> SEE FET INTERCHANGEABILITY LIST <br> SEE FET INTERCHANGEABHLITY LIST |  |  |  |  | . 25 | 10 | 200 | 45 |
| $\begin{aligned} & \text { 2N2609 } \\ & \text { 2N2610 } \\ & \text { 2N2615 } \\ & \text { 2N2616 } \end{aligned}$ | $\begin{aligned} & \text { PCH } \\ & \text { NPN } \\ & \text { NPN } \\ & \text { NPN } \end{aligned}$ | $\begin{aligned} & F E \\ & G P \\ & R F \\ & R F \end{aligned}$ | $\begin{aligned} & \text { 2N2609 } \\ & \text { 2N918 } \\ & \text { 2N918 } \end{aligned}$ | $\begin{aligned} & \text { SEE FET II } \\ & 150 \\ & 300 \\ & 300 \end{aligned}$ | NTERCH 45 30 30 | $\begin{gathered} \text { NGEABIL } \\ 40 \\ 15 \\ 15 \end{gathered}$ | $\begin{aligned} & \text { IY LIST } \\ & 20-200 \\ & 20-200 \end{aligned}$ | 3 3 | 1 .5 .4 | 5 3 10 | 9 | 500 600 |
| $\begin{aligned} & \text { 2N2617 } \\ & \text { 2N2618 } \\ & \text { 2N2631 } \\ & \text { 2N2639 } \end{aligned}$ | $\begin{aligned} & \text { PNP } \\ & \text { NPN } \\ & \text { NPN } \\ & \text { NPN } \end{aligned}$ | GP <br> GP <br> GP <br> DU | $\begin{aligned} & \text { 2N2219 } \\ & \text { 2N2639 } \end{aligned}$ | 250 600 $.8 W$ 300 | 25 <br> 60 <br> 45 | 40 80 45 | $\begin{aligned} & 15-80 \\ & 25- \\ & 8- \\ & 50-300 \end{aligned}$ | 20 10 200 .01 | 1 | 10 | $\begin{aligned} & 25 \\ & 30 \\ & 65 \end{aligned}$ | $\begin{array}{r} 200 \\ 35 \end{array}$ |
| $\begin{aligned} & \text { 2N2640 } \\ & \text { 2N2641 } \\ & \text { 2N2642 } \\ & \text { 2N2643 } \end{aligned}$ | NPN <br> NPN <br> NPN <br> NPN | DU <br> DU <br> DU <br> DU | $\begin{aligned} & \text { 2N2640 } \\ & \text { 2N2641 } \\ & \text { 2N2642 } \\ & \text { 2N2643 } \end{aligned}$ | $\begin{aligned} & 300 \\ & 300 \\ & 300 \\ & 300 \end{aligned}$ | 45 45 45 45 | 45 45 45 45 | $\begin{array}{r} 50-300 \\ 50-300 \\ 100-300 \\ 100-300 \end{array}$ | .01 .01 .01 .01 | 1 1 1 1 | $\begin{aligned} & 10 \\ & 10 \\ & 10 \\ & 10 \end{aligned}$ | 65 65 130 130 | 35 35 35 35 |
| $\begin{aligned} & \text { 2N2644 } \\ & \text { 2N2645 } \\ & \text { 2N2646 } \\ & \text { 2N2647 } \end{aligned}$ | NPN <br> NPN <br> P-N <br> P-N | $\begin{aligned} & \text { DU } \\ & \text { GP } \\ & \text { UJ } \\ & \text { UJ } \end{aligned}$ | $\begin{aligned} & \text { 2N2644 } \\ & \text { 2N2222A } \\ & \text { 2N2646 } \\ & \text { 2N2647 } \end{aligned}$ | SEE UNIJUNCTION INTERCHANGEABILTY LIST SEE UNLUUNCTION INTERCHANGEABILTY LIST |  |  |  |  | 1 .4 | $\begin{aligned} & 10 \\ & 10 \end{aligned}$ | 130 75 | 35 50 |
| $\begin{aligned} & \text { 2N2651 } \\ & \text { 2N2652 } \\ & \text { 2N2652A } \\ & \text { 2N2656 } \end{aligned}$ | NPN <br> NPN <br> NPN <br> NPN | SW <br> DU <br> DU <br> GP | $\begin{aligned} & \text { 2N2223A } \\ & \text { 2N2223A } \\ & \text { 2N2222 } \end{aligned}$ | 360 300 300 360 | 40 100 100 25 | 20 60 60 15 | $\begin{aligned} & 25- \\ & 50-200 \\ & 50-200 \\ & 40-160 \end{aligned}$ | 10 1 1 .1 | .25 1.2 1.2 .5 | 10 50 50 10 | 50 50 | 350 60 60 250 |
| 2N2673 <br> 2N2674 <br> 2N2675 <br> 2N2676 | NPN <br> NPN <br> NPN <br> NPN | GP GP GP GP | 2N2222A | $\begin{aligned} & 250 \\ & 250 \\ & 250 \\ & 250 \end{aligned}$ | 60 60 60 60 | $\begin{aligned} & 45 \\ & 45 \\ & 45 \\ & 45 \end{aligned}$ | $\begin{aligned} & 8-22 \\ & 12-40 \\ & 22-76 \\ & 45-290 \end{aligned}$ | 1 1 1 1 | 1.5 1.5 1.5 1.5 | $\begin{aligned} & 5 \\ & 5 \\ & 5 \\ & 5 \end{aligned}$ | 9 18 37 76 |  |
| $\begin{aligned} & \text { 2N2677 } \\ & \text { 2N2678 } \\ & \text { 2N2692 } \\ & \text { 2N2693 } \end{aligned}$ | NPN <br> NPM <br> NPN <br> NPN | $\begin{aligned} & \text { GP } \\ & \text { GP } \\ & \text { GP } \\ & \text { GP } \end{aligned}$ | $\begin{aligned} & \text { 2N2220 } \\ & \text { 2N2221 } \\ & \text { 2N2483 } \\ & \text { 2N2483 } \end{aligned}$ | 250 250 300 300 | 45 45 45 45 | 35 35 30 30 | $20-55$ $45-150$ $90-360$ 40 | 1 1 .1 .01 | 1.5 1.5 .12 .12 | 5 5 .1 .1 | 19 39 | 42 |
| $\begin{aligned} & \text { 2N2694 } \\ & \text { 2N2695 } \\ & \text { 2N2708 } \\ & \text { 2N2709 } \end{aligned}$ | NPN PNP NPN PNP | GP <br> GP <br> RF <br> GP | $\begin{aligned} & \text { 2N929 } \\ & \text { 2N3485 } \\ & \text { 2N918 } \end{aligned}$ | 300 360 200 240 | 45 25 35 50 | 20 25 20 35 | 20 $30-130$ $30-200$ $10-22$ | .01 50 2 .2 | .12 .25 .4 | $\begin{array}{r} .1 \\ 50 \end{array}$ | 25 30 | 42 <br> 100 |
| $\begin{aligned} & \text { 2N2710 } \\ & \text { 2N2711 } \\ & \text { 2N2712 } \\ & \text { 2N2713 } \end{aligned}$ | NPN NPN NPN NPN | SW RF RF GP | 2N3705 | 360 200 200 360 | 40 18 18 18 | 20 18 18 18 | $40-$ $30-90$ $75-225$ $30-90$ | 10 2 2 2 | $.25$ $.3$ | $10$ $50$ |  | 500 |

# TRANSISTOR INTERCHANGEABILITY <br> MASTER LIST OF REGISTERED TYPES 



## TRANSISTOR INTERCHANGEABILITY <br> MASTER LIST OF REGISTERED TYPES

| TYPE NUMBER | $\frac{\xi}{2}$ <br> $\frac{8}{8}$ | $\begin{aligned} & \frac{Z}{6} \\ & \frac{1}{6} \\ & \frac{3}{2} \\ & \frac{12}{S} \\ & \frac{5}{3} \end{aligned}$ |  | MAXIMUM RATMVGS |  |  | EECTRICAL CHARACTERISTICS |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  | $\begin{gathered} \mathrm{T}_{A}=25^{\circ} \mathrm{C} \\ { }^{{ }^{\mathrm{T}} \mathrm{C}=25^{\circ} \mathrm{C}} \\ (\mathrm{~mW}) \end{gathered}$ | Veso <br> (V) | VeEO <br> (V) | HfE | $\begin{gathered} \text { Ic } \\ (\mathrm{mA}) \\ \hline \end{gathered}$ | Vce <br> MAX <br> (V) | $\begin{array}{cc} \text { (sat) } \\ \hline \mathbf{I C} \\ (\mathrm{mA}) \\ \hline \end{array}$ | $\begin{gathered} h_{f e} \\ 1 \mathrm{kHz} \\ \mathrm{MWN} \end{gathered}$ |  |
| 2N2845 <br> 2N2846 <br> 2N2847 <br> 2N2048 | NPN NPN NPN NPN | $\left\lvert\, \begin{aligned} & s w \\ & s w \\ & s w \\ & s w \end{aligned}\right.$ | $\begin{aligned} & \text { 2N2539 } \\ & \text { 2N2537 } \\ & \text { 2N2539 } \\ & \text { 2N2537 } \end{aligned}$ | $\begin{aligned} & 360 \\ & 800 \\ & 360 \\ & 800 \end{aligned}$ | 60 60 60 60 | 30 30 20 20 | $30-120$ $30-120$ $40-140$ $40-140$ | 150 150 150 150 | .4 .4 .4 .4 | 150 150 150 150 |  | $\begin{aligned} & 250 \\ & 250 \\ & 250 \\ & 250 \end{aligned}$ |
| $\begin{aligned} & \text { 2N2849 } \\ & \text { 2N2850 } \\ & \text { 2N2851 } \\ & \text { 2N2852 } \end{aligned}$ | NPN NPN NPN NPN | $\begin{aligned} & \text { SW } \\ & \text { SW } \\ & \text { SW } \\ & 5 W \end{aligned}$ |  | $\begin{aligned} & 850 \\ & 850 \\ & 850 \\ & 850 \end{aligned}$ | $\begin{aligned} & 100 \\ & 100 \\ & 100 \\ & 100 \end{aligned}$ | $\begin{aligned} & 80 \\ & 80 \\ & 80 \\ & 80 \end{aligned}$ | $\begin{gathered} 100-300 \\ 40-120 \\ 40-120 \\ 20-60 \end{gathered}$ | $\begin{aligned} & 1 A \\ & 1 A \\ & 1 A \\ & 1 A \end{aligned}$ | .4 .25 .4 .4 | $\begin{aligned} & \text { 1A } \\ & \text { 1A } \\ & \text { 1A } \\ & \text { 1A } \end{aligned}$ |  | 30 30 30 30 |
| $\begin{aligned} & \text { 2N2853 } \\ & \text { 2N2854 } \\ & \text { 2N2855 } \\ & \text { 2N2856 } \end{aligned}$ | NPN NPN NPN NPN | $\begin{aligned} & s w \\ & s w \\ & s w \\ & s w \end{aligned}$ |  | $\begin{aligned} & 850 \\ & 850 \\ & 850 \\ & 850 \end{aligned}$ | 60 60 60 60 | 40 40 40 40 | $\begin{aligned} & 40- \\ & 100-300 \\ & 40-120 \\ & 20-60 \end{aligned}$ | 14 14 14 14 | 1.5 .4 .4 .4 | $\begin{aligned} & \text { 5A } \\ & \text { 1A } \\ & \text { 1A } \\ & 1 \mathrm{~A} \end{aligned}$ |  | 30 30 30 30 |
| $\begin{aligned} & \text { 2N2857 } \\ & \text { 2N2858 } \\ & \text { 2N2859 } \\ & \text { 2N2861 } \end{aligned}$ | NPN <br> NPN <br> NPN <br> PNP | $\begin{aligned} & \text { RF } \\ & \text { GP } \\ & \text { GP } \\ & \text { GP } \end{aligned}$ | $\begin{aligned} & \text { 2N3572 } \\ & \text { 2N3036 } \\ & \text { 2N2861 } \end{aligned}$ | $\begin{aligned} & 200 \\ & 600 \\ & 600 \\ & 300 \end{aligned}$ | $\begin{array}{r} 30 \\ 100 \\ 120 \\ 25 \end{array}$ | $\begin{array}{r} 15 \\ 80 \\ 100 \\ 20 \end{array}$ | $\begin{aligned} & 30-150 \\ & 20-60 \\ & 20-60 \\ & 30-120 \end{aligned}$ | $\begin{aligned} & 3 \\ & 1 \mathrm{~A} \\ & 1 \mathrm{~A} \\ & .01 \end{aligned}$ | .3 .3 .2 | $\begin{aligned} & 1 A \\ & 1 A \\ & 10 \end{aligned}$ | $\begin{aligned} & 50 \\ & 50 \end{aligned}$ | 10 1 1 60 |
| $\begin{aligned} & \text { 2N2882 } \\ & \text { 2N2883 } \\ & \text { 2N2864 } \\ & \text { 2N2865 } \end{aligned}$ | PNP NPN NPN NPN | $\begin{aligned} & \text { GP } \\ & \text { GP } \\ & \text { GP } \\ & \text { RF } \end{aligned}$ | 2N2862 <br> 2N2219 <br> 2N2219 <br> 2N3572 | $\begin{aligned} & 300 \\ & 800 \\ & 800 \\ & 200 \end{aligned}$ | 25 60 60 25 | 20 25 25 13 | $\begin{aligned} & 12-120 \\ & 30-200 \\ & 30-200 \\ & 20-200 \end{aligned}$ | .01 200 200 4 | .2 1 1 .4 | $\begin{array}{r} 10 \\ 500 \\ 500 \\ 10 \end{array}$ | $\begin{aligned} & 25 \\ & 20 \end{aligned}$ | 45 150 150 600 |
| $\begin{aligned} & \text { 2N2868 } \\ & \text { 2N2871 } \\ & \text { 2N2872 } \\ & \text { 2N2883 } \end{aligned}$ | NPN PNP PNP NPN | RF SW SW RF | $\begin{aligned} & \text { 2N899 } \\ & \text { 2N2883 } \end{aligned}$ | $\begin{aligned} & 800 \\ & 400 \\ & 400 \\ & 800 \end{aligned}$ | $\begin{array}{r} 60 \\ 60 \\ 110 \\ 40 \end{array}$ | $\begin{array}{r} 40 \\ 60 \\ 110 \\ 20 \end{array}$ | $\begin{aligned} & 40.120 \\ & 15- \\ & 15 . \\ & 20 . \end{aligned}$ | $\begin{array}{r} 150 \\ 1 \\ 1 \\ 100 \end{array}$ | $.25$ $.5$ | $\begin{aligned} & 150 \\ & 100 \end{aligned}$ |  | 50 .2 .2 400 |
| $\left\lvert\, \begin{aligned} & \text { 2N2884 } \\ & \text { 2N2885 } \\ & \text { 2N2886 } \\ & \text { 2N2890 } \end{aligned}\right.$ | NPN <br> NPN <br> NPN <br> NPN | RF SW GP GP | $\begin{aligned} & \text { 2N2884 } \\ & \text { 2N2219 } \\ & \text { 2N3036 } \end{aligned}$ | $\begin{aligned} & 800 \\ & 150 \\ & 800 \\ & 800 \end{aligned}$ | $\begin{array}{r} 40 \\ 40 \\ 50 \\ 100 \end{array}$ | 20 15 40 80 | 20 $30-120$ 22.45 $30-90$ | 100 10 5 14 | .5 .4 1.2 .5 | $\begin{array}{r} 100 \\ 10 \\ 8 \\ 14 \end{array}$ | 30 | $\begin{array}{r} 400 \\ 300 \\ 30 \end{array}$ |
| $\begin{array}{\|l} \text { 2N2891 } \\ \text { 2N2894 } \\ \text { 2N2894A } \\ \text { 2N2895 } \end{array}$ | NPN PNP <br> PNP <br> NPN | GP <br> SW <br> SW <br> GP | $\begin{aligned} & \text { 2N3036 } \\ & \text { 2N2894 } \\ & \text { 2N2894 } \\ & \text { 2N870 } \end{aligned}$ | $\begin{aligned} & 800 \\ & 360 \\ & 360 \\ & 500 \end{aligned}$ | $\begin{array}{r} 100 \\ 12 \\ 12 \\ 120 \end{array}$ | $\begin{aligned} & 80 \\ & 12 \\ & 65 \end{aligned}$ | $\begin{aligned} & 50-150 \\ & 40-150 \\ & 40- \\ & 40-120 \end{aligned}$ | $\begin{array}{r} 14 \\ 30 \\ 30 \\ 150 \end{array}$ | $\begin{array}{r} .5 \\ .15 \\ .6 \end{array}$ | $1 A$ 10 150 | 50 $50$ | 30 400 800 120 |
| 2N2896 <br> 2N2897 <br> 2N2898 <br> 2N2899 | NPN <br> NPN <br> NPN <br> NPN | GP GP GP GP | $\begin{aligned} & \text { 2N720 } \\ & \text { 2N956 } \end{aligned}$ | $\begin{aligned} & 500 \\ & 500 \\ & 500 \\ & 500 \end{aligned}$ | $\begin{array}{r} 140 \\ 60 \\ 120 \\ 140 \end{array}$ | $\begin{aligned} & 90 \\ & 45 \\ & 65 \\ & 90 \end{aligned}$ | $\begin{aligned} & 60-200 \\ & 50-200 \\ & 40-120 \\ & 60-200 \end{aligned}$ | $\begin{aligned} & 150 \\ & 150 \\ & 150 \\ & 150 \end{aligned}$ | $\begin{gathered} .6 \\ 1 \\ .6 \\ .6 \end{gathered}$ | $\begin{aligned} & 150 \\ & 150 \\ & 150 \\ & 150 \end{aligned}$ | 50 50 50 50 | 120 120 120 120 |
| $\begin{aligned} & \text { 2N2900 } \\ & \text { 2N2901 } \\ & \text { 2N2903 } \\ & \text { 2N2903A } \end{aligned}$ | NPN <br> NPN <br> NPN <br> NPN | GP SW DU DU | $\begin{aligned} & \text { 2N2917 } \\ & \text { 2N2915 } \end{aligned}$ | $\begin{aligned} & 500 \\ & 360 \\ & 200 \\ & 200 \end{aligned}$ | $\begin{aligned} & 60 \\ & 20 \\ & 60 \\ & 60 \end{aligned}$ | $\begin{aligned} & 45 \\ & 10 \\ & 30 \\ & 30 \end{aligned}$ | $\begin{aligned} & 50-200 \\ & 30- \\ & 125-625 \\ & 125-625 \end{aligned}$ | $\begin{array}{r} 150 \\ 10 \\ 1 \\ 1 \end{array}$ | $\begin{array}{r} 1 \\ .15 \\ 1 \\ 1 \end{array}$ | 150 10 5 5 | $\begin{gathered} 50 \\ 150 \\ 150 \end{gathered}$ | 120 <br> 300 <br> 60 <br> 60 |

## TRANSISTOR INTERCHANGEABILITY MASTER LIST OF REGISTERED TYPES

| TMF Numere: |  | $\begin{aligned} & \frac{8}{8} \\ & \frac{8}{8} \\ & 8 \end{aligned}$ |  | MAXIMUM RATINOS |  |  | CIECRICAL CHARACTEISTICS |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  | $\begin{array}{ccc} \mathrm{T}_{A}=25^{\circ} \mathrm{C} & \mathrm{VCBO} & \mathrm{VCBO}_{\mathrm{C}} \\ { }^{-T_{C}}=25^{\circ} \mathrm{C} & & \\ (\mathrm{~mW}) & (\mathrm{V}) & (\mathrm{V}) \end{array}$ |  |  | $h_{\text {F }}$ |  | $V_{\text {ce }}$ (ent) |  |  |  |
|  |  |  |  |  |  |  | MIN Ma | $\begin{gathered} c \\ (\mathrm{~mA}) \end{gathered}$ |  | $\begin{aligned} & 1 c \\ & (\mathrm{~mA}) \end{aligned}$ |  |  |
| 2N2904 <br> 2N2904A <br> 2N2905 <br> 2N29054 |  | GP <br> GP <br> GP <br> GP | $\begin{aligned} & \text { 2N2904 } \\ & \text { 2N2904A } \\ & \text { 2N2905 } \\ & \text { 2N2905A } \end{aligned}$ | $\begin{aligned} & 600 \\ & 600 \\ & 600 \\ & 600 \end{aligned}$ | $\begin{aligned} & 60 \\ & 60 \\ & 60 \\ & 60 \end{aligned}$ | $\begin{aligned} & 40 \\ & 60 \\ & 40 \\ & 60 \end{aligned}$ | $\begin{array}{r} 40-120 \\ 40-120 \\ 100-300 \\ 100-300 \end{array}$ | $\begin{aligned} & 150 \\ & 150 \\ & 150 \\ & 150 \end{aligned}$ | .4 .4 .4 .4 | $\begin{aligned} & 150 \\ & 150 \\ & 150 \\ & 150 \end{aligned}$ |  | 200 200 200 200 |
| $\begin{aligned} & \text { 2N2906 } \\ & 2 \mathrm{~N} 2906 \mathrm{~A} \\ & 2 \mathrm{~N} 2907 \\ & 2 \mathrm{~N} 2907 \mathrm{~A} \end{aligned}$ |  | GP <br> GP <br> GP <br> GP | $\begin{aligned} & \text { 2N2906 } \\ & \text { 2N2906A } \\ & \text { 2N2907 } \\ & \text { 2N2907A } \end{aligned}$ | $\begin{array}{r} 400 \\ 400 \\ 400 \\ 400 \end{array}$ | $\begin{aligned} & 60 \\ & 60 \\ & 60 \\ & 60 \end{aligned}$ | $\begin{aligned} & 40 \\ & 60 \\ & 40 \\ & 60 \end{aligned}$ | $\begin{array}{r} 40-120 \\ 40-120 \\ 100-300 \\ 100-300 \end{array}$ | $\begin{aligned} & 150 \\ & 150 \\ & 150 \\ & 150 \end{aligned}$ | . 4 | $\begin{aligned} & 150 \\ & 150 \\ & 150 \\ & 150 \end{aligned}$ |  | 200 200 200 200 |
| $\begin{aligned} & \text { 2N2909 } \\ & 2 \mathrm{~N} 2910 \\ & 2 \mathrm{~N} 2911 \\ & 2 \mathrm{~N} 213 \end{aligned}$ | NPN <br> NPN <br> NPN <br> NPN | GP <br> DU <br> SW <br> DU | $\begin{aligned} & \text { 2N2221A } \\ & \text { 2N2640 } \\ & \text { 2N2913 } \end{aligned}$ | $\begin{array}{r} 400 \\ 300 \\ \cdot 5 W \\ 300 \end{array}$ | $\begin{array}{r} 60 \\ 45 \\ 150 \\ 45 \end{array}$ | $\begin{array}{r} 40 \\ 25 \\ 125 \\ 45 \end{array}$ | $\begin{aligned} & 40-120 \\ & 70 . \\ & 20-60 \\ & 60-240 \end{aligned}$ | 150 .1 14 .01 | .25 1 .3 .35 | $\begin{array}{r} 150 \\ 10 \\ 1 \mathrm{~A} \\ 1 \end{array}$ | 50 | 50 11 1 60 |
| $\begin{aligned} & \text { 2N2914 } \\ & \text { 2N2915 } \\ & \text { 2N2915A } \\ & \text { 2N2916 } \end{aligned}$ | $\begin{aligned} & \text { NPN } \\ & \text { NPN } \\ & \text { NPN } \\ & \text { NPN } \end{aligned}$ | DU <br> DU <br> DU <br> DU | $\begin{aligned} & \text { 2N2914 } \\ & \text { 2N2915 } \\ & \text { 2N2915A } \\ & \text { 2N2916 } \end{aligned}$ | $\begin{aligned} & 300 \\ & 300 \\ & 300 \\ & 300 \end{aligned}$ | $\begin{aligned} & 45 \\ & 45 \\ & 45 \\ & 45 \end{aligned}$ | $\begin{aligned} & 45 \\ & 45 \\ & 45 \\ & 45 \end{aligned}$ | $\begin{array}{r} 150-600 \\ 60-240 \\ 60-240 \\ 150-600 \end{array}$ | $\begin{aligned} & .01 \\ & .01 \\ & .01 \\ & .01 \end{aligned}$ | .35 .35 .35 .35 | $\begin{aligned} & 1 \\ & 1 \\ & 1 \\ & 1 \end{aligned}$ |  | 60 60 60 60 |
| $\begin{aligned} & \text { 2N2916A } \\ & \text { 2N2917 } \\ & \text { 2N2918 } \\ & \text { 2N2919 } \end{aligned}$ | $\begin{aligned} & \text { NPN } \\ & \text { NPN } \\ & \text { NPN } \\ & \text { NPN } \end{aligned}$ | DU <br> DU <br> DU <br> DU | $\begin{aligned} & \text { 2N2916A } \\ & \text { 2N2917 } \\ & \text { 2N2918 } \\ & \text { 2N2919 } \end{aligned}$ | $\begin{aligned} & 300 \\ & 300 \\ & 300 \\ & 300 \end{aligned}$ | $\begin{aligned} & 45 \\ & 45 \\ & 45 \\ & 60 \end{aligned}$ | $\begin{aligned} & 45 \\ & 45 \\ & 45 \\ & 60 \end{aligned}$ | $\begin{array}{r} 150-600 \\ 60-240 \\ 150-600 \\ 60-240 \end{array}$ | $\begin{aligned} & .01 \\ & .01 \\ & .01 \\ & .01 \end{aligned}$ | .35 .35 .35 .35 | 1 1 1 1 |  | .60 60 60 60 |
| $\begin{array}{\|l} \text { 2N2919A } \\ \text { 2N2920 } \\ \text { 2N2920A } \\ \text { 2N2921 } \end{array}$ | NPN <br> NPN <br> NPN <br> NPN | DU <br> DU <br> DU <br> GP | $\begin{aligned} & \text { 2N2919A } \\ & \text { 2N2920 } \\ & \text { 2N2920A } \end{aligned}$ | $\begin{aligned} & 300 \\ & 300 \\ & 300 \\ & 200 \end{aligned}$ | $\begin{aligned} & 60 \\ & 60 \\ & 60 \\ & 25 \end{aligned}$ | $\begin{aligned} & 60 \\ & 60 \\ & 60 \\ & 25 \end{aligned}$ | $\begin{array}{r} 60-240 \\ 150-600 \\ 150-600 \end{array}$ | $\begin{aligned} & .01 \\ & .01 \\ & .01 \end{aligned}$ | .35 .35 .35 | $\begin{aligned} & 1 \\ & 1 \\ & 1 \end{aligned}$ | 35 | 60 60 60 |
| $\begin{aligned} & \text { 2N2922 } \\ & \text { 2N2923 } \\ & \text { 2N2924 } \\ & \text { 2N2925 } \end{aligned}$ |  | $\begin{aligned} & G P \\ & G P \\ & G P \\ & G P \end{aligned}$ | 2N3710 <br> 2N3710 2N3711 | 200 360 360 360 | 25 25 25 25 | $\begin{aligned} & 25 \\ & 25 \\ & 25 \\ & 25 \end{aligned}$ |  |  |  |  | 55 90 150 235 |  |
| 2N2926 <br> 2N2927 <br> 2N2936 <br> 2N2937 | NPN <br> PNP <br> NPN <br> NPN | $\begin{aligned} & G P \\ & G P \\ & G P \\ & G P \end{aligned}$ | $\begin{aligned} & \text { 2N3708 } \\ & \text { 2N2904 } \\ & \text { 2N2484 } \\ & \text { 2N2484 } \end{aligned}$ | $\begin{aligned} & 200 \\ & 800 \\ & 300 \\ & 300 \end{aligned}$ | $\begin{aligned} & 25 \\ & 25 \\ & 60 \\ & 60 \end{aligned}$ | $\begin{aligned} & 25 \\ & 25 \\ & 55 \\ & 55 \end{aligned}$ | $\begin{array}{r} 30-130 \\ 100-300 \\ 100-300 \end{array}$ | $\begin{array}{r} 50 \\ .01 \\ .01 \\ \hline \end{array}$ | .25 .3 .3 | $\begin{array}{r} 50 \\ 2 \\ 2 \\ \hline \end{array}$ | $\begin{array}{r} 35 \\ 25 \\ 150 \\ 150 \end{array}$ | 100 30 30 |
| $\begin{aligned} & \text { 2N2938 } \\ & \text { 2N2939 } \\ & \text { 2N2940 } \\ & \text { 2N2941 } \end{aligned}$ | NPN NPN NPN NRN | SW <br> RF <br> RF <br> RF |  | $\begin{aligned} & 300 \\ & 800 \\ & 800 \\ & 800 \end{aligned}$ | $\begin{array}{r} 25 \\ 75 \\ 120 \\ 150 \end{array}$ | $\begin{array}{r} 13 \\ 60 \\ 80 \\ 100 \end{array}$ | 30. <br> 60-240 <br> 60.240 <br> 60-240 | $\begin{array}{r} 50 \\ 150 \\ 150 \\ 150 \end{array}$ | . 4 | $\begin{array}{r} 50 \\ 150 \\ 150 \end{array}$ |  | 500 150 150 150 |
| $\begin{aligned} & 2 \mathrm{~N} 2944 \\ & 2 \mathrm{~N} 2944 \mathrm{~A} \\ & 2 \mathrm{~N} 2945 \\ & 2 \mathrm{~N} 2945 \mathrm{~A} \end{aligned}$ | PNP <br> PAP <br> PNP <br> PNP | $\begin{aligned} & s w \\ & s w \\ & s w \\ & s w \end{aligned}$ | $\begin{aligned} & \text { 2N2944 } \\ & \text { 2N2944A } \\ & \text { 2N2945 } \\ & \text { 2N2945A } \end{aligned}$ | 400 400 400 400 | 15 15 25 25 | 10 10 20 20 | 80 100 40 100 | $\begin{aligned} & 1 \\ & 1 \\ & 1 \\ & 1 \end{aligned}$ |  |  |  | 10 15 5 10 |

## TRANSISTOR INTERCHANGEABILITY MASTER LIST OF REGISTERED TYPES

| TYF NUMET |  | $\begin{aligned} & 8 \\ & 5 \\ & 5 \\ & 8 \\ & 8 \end{aligned}$ | $\begin{gathered} \text { II } \\ \text { REPACMENT } \\ \text { OR MBAREST } \\ \text { EOUYALENT } \end{gathered}$ | Maximum Ratives |  |  | EICTRICAL CHAMAGTIESTKS |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  | $\begin{gathered} \mathrm{PY} \\ \mathrm{~T}_{\mathrm{A}}=25^{\circ} \mathrm{C} \\ { }^{-1} \mathrm{C}=25^{\circ} \mathrm{C} \\ (\mathrm{~mW}) \\ \hline \end{gathered}$ | Veso <br> (V) | Vceo <br> (V) |  | $\begin{gathered} \mathbf{I c} \\ (\mathrm{mA}) \end{gathered}$ |  | $\begin{aligned} & \text { (sed) } \\ & \hline \text { Ic } \\ & \text { (mA) } \end{aligned}$ | $\begin{aligned} & \text { ho } \\ & \text { I khe } \\ & \text { MIN } \end{aligned}$ |  |
| $\begin{aligned} & \text { 2N2946 } \\ & \text { 2N2946A } \\ & \text { 2N2954 } \\ & \text { 2N2958 } \end{aligned}$ | $\left\lvert\, \begin{aligned} & \text { PNP } \\ & \text { PNP } \\ & \text { PNP } \\ & \text { PNP } \end{aligned}\right.$ | SW SW RF GP | $\begin{aligned} & \text { 2N2946 } \\ & \text { 2N2946A } \\ & \text { 2N918 } \\ & \text { 2N2218 } \end{aligned}$ | $\begin{array}{r}400 \\ 400 \\ 200 \\ \hline 3 W\end{array}$ | 40 40 30 60 | 35 35 20 20 | $\begin{aligned} & 30- \\ & 50- \\ & 25-300 \\ & 40-120 \end{aligned}$ | $\begin{array}{r} 1 \\ 1 \\ 2 \\ 150 \end{array}$ | . 5 | 150 | 25 | 3 5 300 250 |
| $\begin{aligned} & \text { 2N2959 } \\ & \text { 2N2960 } \\ & \text { 2N2961 } \\ & \text { 2N2967 } \end{aligned}$ | $\begin{aligned} & \text { PNP } \\ & \text { PNP } \\ & \text { PNP } \\ & \text { NPN } \end{aligned}$ | $\begin{aligned} & G P \\ & G P \\ & G P \\ & S W \end{aligned}$ | $\begin{aligned} & \text { 2N2219 } \\ & \text { 2N2219A } \\ & \text { 2N2219A } \end{aligned}$ | $\begin{aligned} & * 3 W \\ & * 3 W \\ & * 3 W \\ & 300 \end{aligned}$ | $\begin{aligned} & 60 \\ & 60 \\ & 60 \\ & 12 \end{aligned}$ | $\begin{array}{r} 20 \\ 30 \\ 30 \\ 6 \end{array}$ | $\begin{array}{r} 100-300 \\ 100-300 \\ 100-300 \\ 20.120 \end{array}$ | $\begin{array}{r} 150 \\ 150 \\ 150 \\ 10 \end{array}$ | .5 .5 .5 .3 | $\begin{array}{r} 150 \\ 150 \\ 150 \\ 3 \end{array}$ |  | $\begin{aligned} & 250 \\ & 250 \\ & 250 \\ & 400 \end{aligned}$ |
| $\begin{aligned} & \text { 2N2968 } \\ & \text { 2N2969 } \\ & \text { 2N2970 } \\ & \text { 2N2971 } \end{aligned}$ | $\begin{aligned} & \text { PNP } \\ & \text { PNP } \\ & \text { PNP } \\ & \text { PNP } \end{aligned}$ | $\left\lvert\, \begin{aligned} & s w \\ & s w \\ & s w \\ & s w \end{aligned}\right.$ | $\begin{aligned} & \text { 2N3250 } \\ & \text { 2N3250 } \\ & \text { 2N3250 } \\ & \text { 2N3250 } \end{aligned}$ | $\begin{aligned} & 150 \\ & 150 \\ & 150 \\ & 150 \end{aligned}$ | $\begin{aligned} & 30 \\ & 30 \\ & 30 \\ & 30 \end{aligned}$ | $\begin{aligned} & 10 \\ & 10 \\ & 20 \\ & 20 \end{aligned}$ | 15. 15. 10. 10 | .1 .1 .1 .1 | .6 .6 .8 .8 | $\begin{aligned} & 10 \\ & 10 \\ & 10 \\ & 10 \end{aligned}$ |  | 8 8 4 4 |
| $\begin{aligned} & \text { 2N2972 } \\ & \text { 2N2973 } \\ & \text { 2N2974 } \\ & \text { 2N2975 } \end{aligned}$ | $\begin{array}{\|l\|} \mathbf{N P N} \\ \mathbf{N P N} \\ \text { NPN } \\ \mathbf{N P N} \end{array}$ | $\left\lvert\, \begin{aligned} & D U \\ & D U \\ & D U \\ & D U \end{aligned}\right.$ | $\begin{aligned} & \text { 2N2972 } \\ & \text { 2N2973 } \\ & \text { 2N2974 } \\ & \text { 2N2975 } \end{aligned}$ | $\begin{aligned} & 250 \\ & 250 \\ & 250 \\ & 250 \end{aligned}$ | $\begin{aligned} & 45 \\ & 45 \\ & 45 \\ & 45 \end{aligned}$ | $\begin{aligned} & 45 \\ & 45 \\ & 45 \\ & 45 \end{aligned}$ | $\begin{array}{r} 60-240 \\ 150-600 \\ 60-240 \\ 150-600 \end{array}$ | .01 <br> .01 <br> .01 <br> .01 | .35 .35 .35 .35 | $\begin{aligned} & 1 \\ & 1 \\ & 1 \\ & 1 \end{aligned}$ |  | 60 60 60 60 |
| $\begin{array}{\|l\|} \text { 2N2976 } \\ \text { 2N2977 } \\ \text { 2N2978 } \\ \text { 2N2979 } \end{array}$ | $\left\lvert\, \begin{aligned} & \text { NPN } \\ & \text { NPN } \\ & \text { NPN } \\ & \text { NPN } \end{aligned}\right.$ | $\left\lvert\, \begin{aligned} & D U \\ & D U \\ & D U \\ & D U \end{aligned}\right.$ | $\begin{aligned} & \text { 2N2976 } \\ & \text { 2N2977 } \\ & \text { 2N2978 } \\ & \text { 2N2979 } \end{aligned}$ | $\begin{aligned} & 250 \\ & 250 \\ & 250 \\ & 250 \end{aligned}$ | $\begin{aligned} & 45 \\ & 45 \\ & 60 \\ & 60 \end{aligned}$ | $\begin{aligned} & 45 \\ & 45 \\ & 60 \\ & 60 \end{aligned}$ | $\begin{array}{r} 60-240 \\ 150-600 \\ 60-240 \\ 150-600 \end{array}$ | .01 <br> .01 <br> .01 <br> .01 | .35 .35 .35 .35 | $\begin{aligned} & 1 \\ & 1 \\ & 1 \\ & 1 \end{aligned}$ |  | 60 60 60 60 |
| $\begin{aligned} & \text { 2N2980 } \\ & \text { 2N2981 } \\ & \text { 2N2982 } \\ & \text { 2N3009 } \end{aligned}$ | NPN NPN NPN NPN | DU <br> DU <br> DU <br> SW | $\begin{aligned} & \text { 2N2060 } \\ & \text { 2N2223 } \\ & \text { 2N2223A } \end{aligned}$ | $\begin{aligned} & 250 \\ & 250 \\ & 250 \\ & 360 \end{aligned}$ | $\begin{array}{r} 100 \\ 100 \\ 100 \\ 40 \end{array}$ | $\begin{aligned} & 60 \\ & 60 \\ & 60 \\ & 15 \end{aligned}$ | $\begin{aligned} & 25-75 \\ & 50-200 \\ & 50-200 \\ & 30-120 \end{aligned}$ | $\begin{aligned} & .01 \\ & 10 \\ & 10 \\ & 30 \end{aligned}$ | $\begin{aligned} & 1.2 \\ & 1.2 \\ & 1.2 \\ & .18 \end{aligned}$ | 50 50 50 30 | 50 40 40 | 60 50 50 350 |
| $\begin{aligned} & \text { 2N3010 } \\ & \text { 2N3011 } \\ & \text { 2N3012 } \\ & \text { 2N3013 } \end{aligned}$ | NPN <br> NFN <br> PNP <br> NPN | $\begin{aligned} & \text { sw } \\ & \text { sw } \\ & \text { sw } \\ & \text { sw } \end{aligned}$ | 2N3012 | $\begin{aligned} & 300 \\ & 360 \\ & 360 \\ & 360 \end{aligned}$ | $\begin{aligned} & 15 \\ & 30 \\ & 12 \\ & 40 \end{aligned}$ | $\begin{array}{r} 6 \\ 12 \\ 12 \\ 15 \end{array}$ | $\begin{aligned} & 25-125 \\ & 30-120 \\ & 30-120 \\ & 30-120 \end{aligned}$ | $\begin{aligned} & 10 \\ & 10 \\ & 30 \\ & 30 \end{aligned}$ | .25 .2 .2 .18 | 10 10 30 30 |  | 600 400 400 350 |
| $\begin{aligned} & \text { 2N3014 } \\ & \text { 2N3015 } \\ & \text { 2N3019 } \\ & \text { 2N3020 } \end{aligned}$ | NPN <br> NPN <br> NPN <br> NPN | sW 8W OP OP | $\begin{aligned} & \text { 2N301s } \\ & \text { 2N2243A } \\ & \text { 2N1893 } \end{aligned}$ | $\begin{aligned} & 360 \\ & 600 \\ & 800 \\ & 800 \end{aligned}$ | $\begin{array}{r} 40 \\ 60 \\ 140 \\ 140 \end{array}$ | $\begin{aligned} & 20 \\ & 30 \\ & 80 \\ & 80 \end{aligned}$ | $\begin{array}{r} 30-120 \\ 30-120 \\ 100-300 \\ 40-120 \end{array}$ | $\begin{array}{r} 30 \\ 150 \\ 150 \\ 150 \end{array}$ | $\begin{array}{r} .18 \\ .4 \\ .2 \\ .2 \end{array}$ | $\begin{array}{r} 10 \\ 150 \\ 150 \\ 150 \end{array}$ | 60 30 | 350 250 100 80 |
| $\begin{aligned} & \text { 2N3033 } \\ & \text { 2N3034 } \\ & \text { 2N303s } \\ & \text { 2N3036 } \end{aligned}$ | NPN <br> NPN <br> NPN <br> NPN | $\begin{aligned} & s W \\ & s w \\ & s W \\ & o p \end{aligned}$ | 2N3036 | $\begin{aligned} & 300 \\ & 300 \\ & 300 \\ & 800 \end{aligned}$ | 100 70 50 120 | 80 | 50.150 | 150 | 1 1 1 .25 | $\begin{aligned} & 100 \\ & 100 \\ & 100 \\ & 150 \end{aligned}$ | 40 | 50 |
| $\begin{aligned} & 2 N 3037 \\ & 2 N 3038 \\ & 2 N 3039 \\ & 2 N 3040 \end{aligned}$ | NPN NPN PNP PNP | GP <br> GP <br> OP <br> GP | $\begin{aligned} & \text { 2N3037 } \\ & \text { 2N3038 } \\ & \text { 2N3039 } \\ & \text { 2N3040 } \end{aligned}$ | $\begin{aligned} & 360 \\ & 360 \\ & 360 \\ & 360 \end{aligned}$ | $\begin{array}{r} 120 \\ 100 \\ 50 \\ 40 \end{array}$ | $\begin{aligned} & 70 \\ & 60 \\ & 35 \\ & 30 \end{aligned}$ | $\begin{aligned} & 40-120 \\ & 80-240 \\ & 20-80 \\ & 40-160 \end{aligned}$ | $\begin{aligned} & 150 \\ & 150 \\ & 150 \\ & 150 \end{aligned}$ | $\begin{aligned} & .2 \\ & .2 \\ & .2 \end{aligned}$ | $\begin{aligned} & 10 \\ & 10 \\ & 10 \end{aligned}$ | 30 60 20 40 | 50  <br> 50  <br> 50  <br>  50 |

# TRANSISTOR INTERCHANGEABILITY MASTER LIST OF REGISTERED TYPES 

| TYPEnUMDER | $\begin{aligned} & 5 \\ & \frac{5}{8} \end{aligned}$ |  |  | MAXIMUM RATINOS |  |  | Elictical charactemstics |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  | $\begin{gathered} P_{T} \\ T_{A}=25^{\circ} \mathrm{C} \\ { }^{*}{ }^{\prime} \mathrm{C}=25^{\circ} \mathrm{C} \\ (\mathrm{~mW}) \\ \hline \end{gathered}$ | $v_{\mathrm{CBO}}$ (V) | $V_{c E O}$ <br> (V) | MiN Max | $\begin{gathered} 1 c \\ (\mathrm{~mA}) \end{gathered}$ | $\begin{array}{\|l\|} \hline V_{C l} \\ \hline \begin{array}{l} \text { max } \\ (v) \end{array} \\ \hline \end{array}$ |  | $\begin{gathered} h_{0} \\ \bullet \\ 1 \mathrm{ktt} \\ \text { min } \end{gathered}$ |  |
| $\begin{aligned} & \text { 2N3043 } \\ & \text { 2N } 3044 \\ & \text { 2N3045 } \\ & \text { 2N3046 } \end{aligned}$ | NPN NPN NPN NPN | $\begin{aligned} & D U \\ & D U \\ & D U \\ & D U \\ & D U \end{aligned}$ | $\begin{aligned} & 2 N 3043 \\ & 2 N 3044 \end{aligned}$ | $\begin{aligned} & 250 \\ & 250 \\ & 250 \\ & \mathbf{2 5 0} \\ & \mathbf{2 5 0} \end{aligned}$ | $\begin{aligned} & 45 \\ & 45 \\ & 45 \\ & 45 \end{aligned}$ | $\begin{aligned} & 45 \\ & 45 \\ & 45 \\ & 45 \end{aligned}$ | $\begin{array}{r} 100-300 \\ 100-300 \\ 100-300 \\ 50-200 \end{array}$ | $\begin{aligned} & .01 \\ & .01 \\ & .01 \\ & .01 \end{aligned}$ | $\begin{aligned} & 1 \\ & 1 \\ & 1 \\ & 1 \end{aligned}$ | $\begin{aligned} & 10 \\ & 10 \\ & 10 \\ & 10 \end{aligned}$ | $\begin{array}{r} 130 \\ 130 \\ 130 \\ 65 \end{array}$ | 30 30 30 30 |
|  | $\begin{aligned} & \text { NPN } \\ & \text { NPN } \\ & \text { PNP } \\ & \text { PNP } \end{aligned}$ | $\begin{aligned} & \text { DU } \\ & \text { DU } \\ & \text { DU } \\ & \text { DU } \end{aligned}$ | $\begin{array}{r} \text { 2N3049 } \\ \text { 2N3050 } \end{array}$ | $\begin{aligned} & 250 \\ & 250 \\ & 250 \\ & 250 \end{aligned}$ | $\begin{aligned} & 45 \\ & 45 \\ & 25 \\ & 25 \end{aligned}$ | $\begin{aligned} & 45 \\ & 45 \\ & 20 \\ & 20 \end{aligned}$ | $\begin{aligned} & 50-200 \\ & 50-200 \\ & 20.120 \\ & 20.120 \end{aligned}$ | $\begin{aligned} & .01 \\ & .01 \\ & .01 \\ & .01 \end{aligned}$ | 1 1 . .2 | $\begin{aligned} & 10 \\ & 10 \\ & 10 \\ & 10 \end{aligned}$ | 65 65 30 30 | 30 30 60 60 |
| $\begin{aligned} & \text { 2N3051 } \\ & \text { 2N3052 } \\ & \text { 2N3053 } \\ & \text { 2N3053A } \end{aligned}$ | PNP <br> NPN <br> NPN <br> NPN | $\begin{aligned} & \text { DU } \\ & \text { DU } \\ & \text { GP } \\ & \text { GP } \end{aligned}$ | $\begin{aligned} & \text { 2N3051 } \\ & \text { 2N3052 } \\ & \text { 2N3053 } \\ & \text { 2N3053 } \end{aligned}$ | 250 250 .50 $* 5 W$ | $\begin{aligned} & 25 \\ & 35 \\ & 60 \\ & 80 \end{aligned}$ | $\begin{aligned} & 20 \\ & 15 \\ & 40 \\ & 60 \end{aligned}$ | $\begin{aligned} & 20-120 \\ & 25-130 \\ & 50-250 \\ & 50-250 \end{aligned}$ | $\begin{array}{r} .01 \\ 10 \\ 150 \\ 150 \end{array}$ | .2 .25 1.4 .3 | $\begin{array}{r} 10 \\ 10 \\ 150 \\ 150 \end{array}$ | 30 | 60 200 100 100 |
| $\begin{aligned} & \text { 2N3056 } \\ & \text { 2N3056A } \\ & \text { 2N3057 } \\ & \text { 2N3057A } \end{aligned}$ | $\begin{aligned} & \text { NPN } \\ & \text { NPN } \\ & \text { NPN } \\ & \text { NPN } \end{aligned}$ | $\begin{aligned} & \text { GP } \\ & \mathbf{G P} \\ & \mathbf{G P} \\ & \mathbf{G P} \end{aligned}$ |  | 400 400 400 400 | $\begin{aligned} & 100 \\ & 140 \\ & 100 \\ & 140 \end{aligned}$ | $\begin{aligned} & 60 \\ & 80 \\ & 60 \\ & 80 \end{aligned}$ | $\begin{array}{r} 40-120 \\ 40.120 \\ 100-300 \\ 100-300 \end{array}$ | $\begin{aligned} & 150 \\ & 150 \\ & 150 \\ & 150 \end{aligned}$ | $\begin{array}{r} .25 \\ .25 \\ .25 \\ .2 \end{array}$ | $\begin{aligned} & 150 \\ & 150 \\ & 150 \\ & 150 \end{aligned}$ | 30 30 80 80 | 80 80 100 100 |
| 2N3058 2N3059 2N3060 2N3061 | $\begin{aligned} & \text { PNP } \\ & \text { PNP } \\ & \text { PNNP } \\ & \text { PNNP } \end{aligned}$ | $\begin{aligned} & s w \\ & s w \\ & s w \\ & s w \\ & s w \end{aligned}$ | $\begin{aligned} & \text { 2N2944 } \\ & \text { 2N2944 } \\ & \text { 2N2944 } \\ & \text { 2N2944 } \end{aligned}$ | 400 400 400 400 | 6 10 70 70 | 6 10 60 60 | 40.120 100.300 30.90 $00-180$ | 100 .01 1 1 |  |  | 40 100 30 60 |  |
| 2N3062 <br> 2N3063 <br> 2N3064 <br> 2N3085 | $\begin{aligned} & \text { PNP } \\ & \mathbf{P N P} \\ & \mathbf{P N P} \\ & \mathbf{P N P} \end{aligned}$ | $\begin{aligned} & s w \\ & s w \\ & s w \\ & s w \end{aligned}$ | $\begin{aligned} & 2 \mathrm{~N} 2944 \\ & \text { 2N2944 } \end{aligned}$ | 400 400 400 400 | 90 90 200 110 | 80 80 110 100 | $20-80$ 50.150 $15-45$ 30.90 | 1 1 1 |  |  | 20 50 15 30 |  |
| 2N3066 2N3067 2N3068 2N3069 | NCH NCH NCH NCH | $\begin{array}{\|l\|l\|} \hline \mathbf{F E} \\ \mathbf{F E} \\ \mathrm{FE} \\ \mathrm{FE} \end{array}$ | $\begin{aligned} & \text { 2N3459 } \\ & \text { 2N3460 } \\ & \text { 2N3458 } \end{aligned}$ | SEE FET INTERCHANGEABLITY LST SEE PET INTEACHANGEABLTTY LST 6EE FET INTERCHANGEAELITY LIST SEE FET INTERCHANGEABLITY LST |  |  |  |  |  |  |  |  |
| $\begin{aligned} & \text { 2N3070 } \\ & \text { 2N3071 } \\ & \text { 2N3072 } \\ & \text { 2N3073 } \end{aligned}$ | $\begin{array}{\|l\|l\|} \mathrm{NCH} \\ \mathrm{NCH} \\ \mathrm{NNP} \\ \mathrm{NNP} \end{array}$ | $\begin{aligned} & \text { FE } \\ & \text { FE } \\ & \text { OP } \\ & G P \\ & \hline \end{aligned}$ | 2N3459 <br> 2N3460 <br> 2N2904 <br> 2N2906 | SEE FET INTERCHANGEABLITY LIST SEE FLT INTERCHANGEABLITY LIST |  |  |  |  |  |  |  |  |
| $\begin{aligned} & \text { 2N3077 } \\ & \text { 2N3078 } \\ & \text { 2N3081 } \\ & \text { 2N301 } \\ & \text { 2N3082 } \end{aligned}$ | NPN NPN PNP NPN | $\begin{aligned} & G P \\ & G P \\ & G P \\ & G P \\ & S W \end{aligned}$ | $\begin{aligned} & \text { 2N930 } \\ & \text { 2N929 } \\ & \text { 2N2904A } \\ & \text { 3N76 } \end{aligned}$ | $\begin{aligned} & 360 \\ & 360 \\ & 600 \\ & 500 \end{aligned}$ | $\begin{aligned} & 80 \\ & 80 \\ & 70 \\ & 25 \end{aligned}$ | $\begin{aligned} & 60 \\ & 60 \\ & 50 \\ & 7 \end{aligned}$ | $\begin{aligned} & 100-400 \\ & 40-120 \\ & 20- \\ & 100- \end{aligned}$ | $\begin{aligned} & .01 \\ & .01 \\ & 500 \\ & .25 \end{aligned}$ | $\begin{array}{r} .35 \\ .35 \\ .3 \end{array}$ | $\begin{array}{r} 1 \\ 1 \\ 150 \end{array}$ | $\begin{array}{r} 120 \\ 50 \end{array}$ | 15 15 150 100 |
| 2N3083 2N3084 2N3085 2N3086 | NPN <br> NCH <br> NCH <br> NCH | $\begin{aligned} & \mathbf{S W} \\ & \hline \mathbf{F E} \\ & \mathbf{F E} \\ & \text { FE } \end{aligned}$ | 3N74 <br> 2N3459 <br> 2N3459 <br> 2N3459 |  |  |  |  |  |  |  |  | 100 |



## TRANSISTOR INTERCHANGEABILITY MASTER LIST OF REGISTERED TYPES



## TRANSISTOR INTERCHANGEABILITY MASTER LIST OF REGISTERED TYPES

| TYPE NUMEER |  |  | $\begin{aligned} & \text { II } \\ & \text { RENLACEMENT } \\ & \text { OR MEAREST } \\ & \text { ECUVAIENT } \end{aligned}$ | MAXIMUUM RATENGS |  |  | ELECPICAL CHARACTERISTICS |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  | $\begin{array}{ccc} \mathrm{P}_{\mathbf{T}} & & \\ \mathrm{T}_{\mathbf{A}}=25^{\circ} \mathrm{C} & \mathrm{~V}_{\mathrm{CBO}} & \mathrm{~V}_{\mathrm{CE}} \mathrm{O} \\ { }^{*} \mathrm{~T}_{\mathrm{C}}=25^{\circ} \mathrm{C} & & \\ (\mathrm{~mW}) & \text { (V) } & \text { (V) } \\ \hline \end{array}$ |  |  | hre |  | $V_{\text {cE }}$ (rat) |  | $\begin{gathered} \mathrm{hfo}_{0} \\ \mathrm{M} \mathrm{kAz} \\ \hline \end{gathered}$ | $\begin{array}{\|c\|} \hline \mathbf{T} \\ \\ \text { MNX } \\ \text { (MHz) } \\ \hline \end{array}$ |
| $\left\lvert\, \begin{aligned} & \text { 2N3309 } \\ & \text { 2N3309A } \\ & \text { 2N3310 } \\ & \text { 2N3317 } \end{aligned}\right.$ | $\begin{aligned} & \text { NPN } \\ & \text { NPN } \\ & \text { NPN } \\ & \text { PNP } \end{aligned}$ | $\begin{aligned} & R F \\ & R F \\ & R F \\ & R W \end{aligned}$ | $\begin{aligned} & \text { 2N3866 } \\ & \text { 2N3866 } \\ & \text { 2N918 } \\ & \text { 2N2944 } \end{aligned}$ | 800 $* 5 W$ 300 150 | 50 60 35 30 | $\begin{aligned} & 15 \\ & 30 \end{aligned}$ | $5-100$ $8-80$ 10 | 30 50 20 |  | $\begin{array}{r} 250 \\ 250 \\ 20 \end{array}$ |  | $\begin{aligned} & 300 \\ & 300 \\ & 300 \\ & 6.4 \end{aligned}$ |
| $\begin{aligned} & \text { 2N3318 } \\ & \text { 2N3319 } \\ & \text { 2N3326 } \\ & \text { 2N3328 } \end{aligned}$ | $\left\lvert\, \begin{aligned} & \text { PNP } \\ & \text { PNP } \\ & \mathrm{NPN} \\ & \text { PCH } \end{aligned}\right.$ | $\begin{aligned} & S W \\ & S W \\ & G P \\ & \text { FE } \end{aligned}$ | $\begin{aligned} & \text { 2N2944 } \\ & \text { 2N2944 } \\ & \text { 2N2218A } \\ & \text { 2N3328 } \end{aligned}$ | $\begin{gathered} 150 \\ 150 \\ 800 \\ \text { SEE FET } \end{gathered}$ | $\begin{gathered} 15 \\ 10 \\ 60 \\ \text { INTERCHA } \end{gathered}$ | $\begin{array}{r} 15 \\ 6 \\ 45 \end{array}$ | LTY LIST | 150 | 4 | 150 |  | $\begin{array}{r} 7.6 \\ 12 \\ 250 \end{array}$ |
| $\begin{array}{\|l\|} \text { 2N3329 } \\ \text { 2N3330 } \\ \text { 2N3331 } \\ \text { 2N3332 } \end{array}$ | PCH <br> PCH <br> PCH <br> PCH | FE <br> FE <br> FE <br> FE | $\begin{aligned} & \text { 2N3329 } \\ & \text { 2N3330 } \\ & \text { 2N3331 } \\ & \text { 2N3332 } \end{aligned}$ | SEE FET <br> SEE FET <br> SEE FET <br> SEE FET | NTERCH NTERCH NTERCH NTERCH | NGEABILI NGEABILIT NGEABLIT NGEABILIT | TY LIST TY LIST TY LIST TY LST |  |  |  |  |  |
| $\begin{aligned} & \text { 2N3333 } \\ & \text { 2N3334 } \\ & \text { 2N3335 } \\ & \text { 2N3336 } \end{aligned}$ | PCH <br> PCH <br> PCH <br> PCH | FE <br> FE <br> FE <br> FE | $\begin{aligned} & \text { 2N3333 } \\ & \text { 2N3334 } \\ & \text { 2N3335 } \\ & \text { 2N3336 } \end{aligned}$ | SEE FET <br> SEE FET <br> SEE FET <br> SEE FET | INTERCH INTERCH INTERCH INTERCH | angeabll <br> ANGEABIL <br> ANGEABIL <br> ANGEABIL | ITY LIST <br> ITY LIST <br> TTY LIST <br> ITY LIST |  |  |  |  |  |
| $\begin{aligned} & \text { 2N3337 } \\ & \text { 2N3338 } \\ & \text { 2N3339 } \\ & \text { 2N3340 } \end{aligned}$ | NPN <br> NPN <br> NPN <br> NPN | RF <br> RF <br> RF <br> SW | 2N2883 2N2883 2N2883 | $\begin{aligned} & 300 \\ & 300 \\ & 300 \\ & 400 \end{aligned}$ | 40 40 40 30 | 40 40 40 20 | $30-300$ $30-300$ $30-300$ 40 | $\begin{array}{r} 4 \\ 4 \\ 4 \\ .01 \end{array}$ | . 2 | . 01 | 30 30 30 | $\begin{array}{r} 400 \\ 400 \\ 400 \\ 70 \end{array}$ |
| $\begin{aligned} & \text { 2N3341 } \\ & \text { 2N3342 } \\ & \text { 2N3343 } \\ & \text { 2N3344 } \end{aligned}$ | $\begin{aligned} & \text { PNP } \\ & \text { PNP } \\ & \text { PNP } \\ & \text { PNP } \end{aligned}$ | $\begin{aligned} & s w \\ & s w \\ & s w \\ & s w \end{aligned}$ |  | 400 250 250 250 | 30 20 25 30 | 20 8 8 30 | 40 30 20 $25-$ | .01 5 .25 1 | .25 .1 | .01 5 |  | 50 2 2 |
| $\begin{aligned} & \text { 2N3345 } \\ & \text { 2N3346 } \\ & \text { 2N3347 } \\ & \text { 2N3348 } \end{aligned}$ | $\begin{aligned} & \text { PNP } \\ & \text { PNP } \\ & \text { PNP } \\ & \text { PNP } \end{aligned}$ | $\begin{aligned} & \text { SW } \\ & \text { SW } \\ & \text { DU } \\ & \text { DU } \end{aligned}$ | $\begin{aligned} & \text { 2N3347 } \\ & \text { 2N3348 } \end{aligned}$ | $\begin{aligned} & 250 \\ & 250 \\ & 300 \\ & 300 \end{aligned}$ | 50 50 60 60 | 50 50 45 45 | $\begin{aligned} & 15- \\ & 25- \\ & 40-300 \\ & 40-300 \end{aligned}$ | $\begin{array}{r} 1 \\ 1 \\ .01 \\ .01 \end{array}$ | $.5$ | $\begin{aligned} & 10 \\ & 10 \end{aligned}$ | 60 60 | 2 2 60 60 |
| $\begin{aligned} & \text { 2N3349 } \\ & \text { 2N3350 } \\ & \text { 2N3351 } \\ & \text { 2N3352 } \end{aligned}$ | $\begin{array}{\|l} \text { PNP } \\ \text { PNPP } \\ \text { PNP } \\ \text { PNP } \end{array}$ | DU DU DU DU | $\begin{aligned} & \text { 2N3349 } \\ & \text { 2N3350 } \\ & \text { 2N3351 } \\ & \text { 2N3352 } \end{aligned}$ | $\begin{aligned} & 300 \\ & 300 \\ & 300 \\ & 300 \end{aligned}$ | $\begin{aligned} & 60 \\ & 60 \\ & 60 \\ & 60 \end{aligned}$ | $\begin{aligned} & 45 \\ & 45 \\ & 45 \\ & 45 \end{aligned}$ | $\begin{array}{r} 40-300 \\ 100-300 \\ 100-300 \\ 100.300 \end{array}$ | .01 <br> .01 <br> .01 <br> .01 | .5 .5 .5 .5 | 10 10 10 10 | 60 150 150 150 | 60 60 60 60 |
| $\begin{aligned} & \text { 2N3365 } \\ & \text { 2N3366 } \\ & \text { 2N3367 } \\ & \text { 2N3368 } \end{aligned}$ | NCH <br> NCH <br> NCH <br> NCH | FE <br> FE <br> FE <br> FE | $\begin{aligned} & \text { 2N3459 } \\ & \text { 2N3460 } \\ & \text { 2N3458 } \end{aligned}$ | SEE FET INTERCHANGEABLLTY LIST SEE FET INTERCHANGEABILTY LIST SEE FET INTERCHANGEABLLTY LIST SEE FET INTERCHANGEABLITY LST |  |  |  |  |  |  |  |  |
| $\begin{aligned} & \text { 2N3369 } \\ & \text { 2N3370 } \\ & \text { 2N3374 } \\ & \text { 2N3376 } \end{aligned}$ | NCH <br> NCH <br> NPN <br> PCH | $\begin{aligned} & \text { FE } \\ & \text { FE } \\ & \text { RF } \\ & \text { RE } \end{aligned}$ | $\begin{aligned} & \text { 2N3460 } \\ & \text { 2N3460 } \\ & \text { 2N3329 } \end{aligned}$ | SEE FET INTERCHANGEABILITY LISTSEE FRT INTERCHANGEABIUTY LIST" $5 \mathrm{~W} \quad 80 \quad 80$ \| $10-$SEE FET INTERCHANGEABILITY LIST |  |  |  |  | . 3 | 150 |  | 230 |

## TRANSISTOR INTERCHANGEABILITY MASTER LIST OF REGISTERED TYPES

| type | $\begin{aligned} & \underset{K}{k} \\ & \frac{K}{2} \\ & \hline \end{aligned}$ |  |  |  |  |  | bectincal Charactarisics |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  |  |  | min max | $\begin{gathered} c \\ {\left[\begin{array}{c} c \\ (\mathrm{~m}) \end{array}\right.} \\ \hline \end{gathered}$ |  | $\begin{aligned} & \text { (set) } \\ & \hline \cdot \mathrm{Ic} \\ & \hline(\mathrm{~mA}) \\ & \hline \end{aligned}$ |  | $\begin{gathered} \text { TT } \\ \text { Min } \\ \text { (MHza) } \end{gathered}$ |
| $\begin{array}{\|l\|} \text { 2N3377 } \\ \text { 2N3378 } \\ \text { 2N3379 } \\ \text { 2N3380 } \end{array}$ | $\begin{aligned} & \mathrm{PCH} \\ & \mathrm{PCCH} \\ & \mathrm{PCCH} \\ & \mathrm{PCH} \end{aligned}$ | $\begin{aligned} & \text { FE } \\ & \text { FE } \\ & \text { FE } \\ & \text { FE } \end{aligned}$ | 2N3331 | SEE FET INTERCHANGENGHITY UST SEE FET INTERCHANGEABIITY UST SEE FET INTERCHANGEAGLITY UST SEE FET INTERCHANGEABILTY LIST |  |  |  |  |  |  |  |  |
| $\begin{array}{\|l\|l\|} \text { 2N3381 } \\ \text { 2N3382 } \\ \text { 2N3383 } \\ \text { 2N3384 } \end{array}$ | $\begin{aligned} & \mathrm{PCH} \\ & \mathrm{PCH} \\ & \mathrm{PCH} \\ & \mathrm{PCH} \end{aligned}$ | $\begin{aligned} & \text { FE } \\ & \text { FE } \\ & \text { FE } \\ & \text { FE } \\ & \hline \mathbf{F E} \end{aligned}$ | $\begin{aligned} & \text { 2N3994 } \\ & \text { 2N3993 } \end{aligned}$ | SEE FET INTERCHANGEABLITY LIST SEE FET INTERCHANGEABLUTY LST SEE FET INTERCHANGEABLITY LST SEE FET INTERCHANGEABHLTY LST |  |  |  |  |  |  |  |  |
| $\begin{aligned} & \text { 2N3385 } \\ & \text { 2N3386 } \\ & \text { 2N3387 } \\ & \text { 2N3388 } \end{aligned}$ | $\begin{aligned} & \mathrm{PCH} \\ & \mathrm{PCH} \\ & \mathrm{PCH} \\ & \mathrm{NCH} \\ & \mathrm{NPN} \end{aligned}$ | $\begin{aligned} & \mathrm{FE} \\ & \mathrm{FE} \\ & \mathrm{FE} \\ & \mathrm{SW} \end{aligned}$ | 2N3993 | SEE FET INTERCHANGEABMTY UST SEE FET INTERCHANGEABHLTY UST SEE FET INTERCHANGEABHITY UST |  |  |  |  | 1 | 2.5 |  | 36 |
| $\begin{array}{\|l\|} \hline \text { 2N3369 } \\ \text { 2N3390 } \\ \text { 2N3391 } \\ \text { 2N3391A } \end{array}$ | $\begin{aligned} & \text { NPN } \\ & \text { NPN } \\ & \text { NPN } \\ & \text { NPN } \end{aligned}$ | $\begin{aligned} & \text { SW } \\ & \text { GP } \\ & \text { GP } \\ & \text { GP } \end{aligned}$ | 71594 <br> A7T3391 <br> ATT3391A | $\begin{aligned} & 600 \\ & 360 \\ & 360 \\ & 360 \end{aligned}$ | $\begin{array}{r} 195 \\ 18 \\ 25 \\ 25 \end{array}$ | $\begin{array}{r} 160 \\ 18 \\ 25 \\ 25 \end{array}$ | $\begin{gathered} 60- \\ 400-800 \\ 250-500 \\ 250-500 \end{gathered}$ | $\begin{aligned} & 7 \\ & 2 \\ & 2 \\ & 2 \end{aligned}$ | 1 | 7 | 400 | 36 |
| $\begin{aligned} & \text { 2N3392 } \\ & \text { 2N3393 } \\ & \text { 2N3394 } \\ & \text { 2N3395 } \end{aligned}$ | $\begin{aligned} & \text { NPN } \\ & \text { NPN } \\ & \text { NPN } \\ & \text { NPN } \end{aligned}$ | GP <br> GP <br> GP <br> GP | ATT3392 <br> TIS95 <br> 7596 <br> T1594 | 360 360 360 360 | 25 25 25 25 | 25 25 25 25 | $150-300$ $90-180$ $55-110$ $150-500$ | 2 2 2 2 |  |  |  |  |
| 2N3396 <br> 2N3397 <br> 2N3398 <br> 2N3401 | $\begin{array}{\|l\|l} \text { NPN } \\ \text { NPN } \\ \text { NPN } \\ \text { PNP } \end{array}$ | $\begin{array}{\|l} G P \\ G P \\ G P \\ S W \end{array}$ | 7594 <br> 7594 <br> TIS94 <br> 2N2944 | 360 360 360 250 | 25 25 25 25 | 25 25 25 25 | $90-500$ $55-500$ $55-800$ | 2 2 2 | . 25 | 5 | 4 | . 1 |
| 2N3402 <br> 2N3403 <br> 2N3404 <br> 2N3. 4 | $\begin{aligned} & \text { NPN } \\ & \text { NPN } \\ & \text { NPN } \\ & \text { NPN } \end{aligned}$ | $\begin{aligned} & G P \\ & G P \\ & G P \\ & G P \\ & G P \end{aligned}$ | 2N3705 2N3704 2N3705 2N3704 | $\begin{aligned} & 560 \\ & 560 \\ & 560 \\ & 560 \end{aligned}$ | $\begin{aligned} & 25 \\ & 25 \\ & 50 \\ & 50 \end{aligned}$ | $\begin{aligned} & 25 \\ & 25 \\ & 50 \\ & 50 \end{aligned}$ | $\begin{array}{r} 75-225 \\ 180.540 \\ 75-225 \\ 180-540 \end{array}$ | $\begin{aligned} & 2 \\ & 2 \\ & 2 \\ & 2 \end{aligned}$ | .3 .3 .3 .3 | $\begin{aligned} & 50 \\ & 50 \\ & 50 \\ & 50 \end{aligned}$ | 75 180 75 180 |  |
| 2N3406 2N3407 2N3409 2N3410 | $\begin{aligned} & \text { PN } \\ & \text { NPN } \\ & \text { NPN } \\ & \text { NPN } \end{aligned}$ | $\begin{aligned} & \mathrm{U} \\ & \mathrm{RF} \\ & \mathrm{DU} \\ & \mathrm{DU} \end{aligned}$ | 2N918 <br> 2N2640 <br> 2N2639 | $\begin{aligned} & \text { SEE UNIJ } \\ & 200 \\ & 500 \\ & 500 \end{aligned}$ | $\begin{gathered} \text { UNCTIO } \\ 35 \\ 60 \\ 60 \end{gathered}$ | INTERCH 18 30 30 | $\begin{gathered} \text { ANGEABIUT } \\ 10.100 \\ 30.120 \\ 20.100 \end{gathered}$ | $\begin{array}{r} 10 \\ .1 \\ .01 \end{array}$ | $\begin{aligned} & .15 \\ & .15 \end{aligned}$ |  | 10 | 300 250 250 |
| 2N3411 <br> 2N3413 <br> 2N3414 <br> 2N3415 | NPN <br> PNP <br> NPN <br> NPN | $\begin{array}{\|l\|l} \text { DU } \\ G P \\ G P \\ G P \\ G P \end{array}$ | 2N2639 <br> 2N3705 <br> 2N3704 | $\begin{aligned} & 500 \\ & 400 \\ & 360 \\ & 360 \end{aligned}$ | $\begin{array}{r} 60 \\ 150 \\ 25 \\ 25 \end{array}$ | $\begin{array}{r} 30 \\ 150 \\ 25 \\ 25 \end{array}$ | $\begin{gathered} 20-100 \\ 10-45 \\ 75-225 \\ 180-540 \end{gathered}$ | .01 50 2 2 | 1.5 1.2 .3 .3 | 10 100 50 50 | 75 180 | 250 .25 |
| 2N3416 <br> 2N3417 <br> 2N3423 <br> 2N3424 | NPN NPN NPN NPN | $\begin{aligned} & \text { GP } \\ & \text { GP } \\ & \text { DU } \\ & \text { DU } \end{aligned}$ | 2N3705 <br> 2N3704 <br> D2T918 <br> D2T918 | $\begin{aligned} & 360 \\ & 360 \\ & 300 \\ & 300 \end{aligned}$ | $\begin{aligned} & 50 \\ & 50 \\ & 30 \\ & 30 \end{aligned}$ | $\begin{aligned} & 50 \\ & 50 \\ & 15 \\ & 15 \end{aligned}$ | $\begin{array}{r} 75-225 \\ 180-540 \\ 20-200 \\ 20-200 \end{array}$ | $\begin{aligned} & 2 \\ & 2 \\ & 3 \\ & 3 \end{aligned}$ | . .3 .3 .4 .4 | $\begin{aligned} & 50 \\ & 50 \\ & 10 \\ & 10 \end{aligned}$ | 75 180 | 600 600 |

## TRANSISTOR INTERCHANGEABILITY <br> MASTER LIST OF REGISTERED TYPES

| TYPE MUMBER | 总学8 | 7$\frac{3}{\mathbf{3}}$$\mathbf{3}$$\frac{1}{7}$53 | $\pi$ REPLACEMENT OR NEAREST EOUTVALENT | MAXIMUM RATINGS |  |  | ELECTRICAL CHARACTERISTICS |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  | $\begin{gathered} \mathrm{P}_{\mathrm{T}} \\ \mathrm{~T}_{\mathrm{A}}=25^{\circ} \mathrm{C} \\ { }^{*} \mathrm{~T}_{\mathrm{C}}=25^{\circ} \mathrm{C} \\ (\mathrm{~mW}) \\ \hline \end{gathered}$ | Vcbo <br> (V) | $\mathbf{V}_{\text {CEO }}$(V) | $h_{\text {FE }}$ |  | VCE(sat) |  | $\mathrm{Hf}_{\mathrm{f}}$ 1 kHz MIN | $\begin{gathered} \mathrm{T} \\ \text { MIN } \\ (\text { MHz }) \end{gathered}$ |
|  |  |  |  |  |  |  | MIN MAX | - le (mA) | MAX <br> (V) | (mA) |  |  |
| 2N3425 | NPN | DU |  | 300 | 40 | 15 | 30-120 | 10 | . 4 | 10 | 20 | 300 |
| 2N3426 | NPN | SW | 2N3724 | 600 | 25 | 12 | 30-120 | 300 |  | 300 |  | 450 |
| 2N3436 | NCH | FE | 2N3458 | SEE FET INTERCHANGEABHLTYY LIST SEE FET INTERCHANGEABLLITY LIST |  |  |  |  |  |  |  |  |
| 2N3437 | NCH | FE | 2N3459 |  |  |  |  |  |  |  |  |  |
| 2N3438 | NCH | FE | 2N3460 | SEE FET INTERCHANGEABILITY LIST |  |  |  |  |  |  |  |  |
| 2N3439 | NPN | GP |  | IW | 450 | 350 | 40-160 | 20 |  |  | 25 | 15 |
| 2N3440 | NPN | GP | 2N5058 | 1w | 300 | 250 | 40-160 | 20 |  |  | 25 | 15 |
| 2N3444 | NPN | SW | 2N3444 | 1W | 80 | 50 | 20-60 | 500 | . 35 | 150 |  | 150 |
| 2N3450 | NPN | SW | 2N2243 | 600 | 120 | 60 | 40.120 | 150 | . 5 | 150 |  | 100 |
| 2N3451 | PNP | SW | 2N3576 | 300 | 6 | 6 | 30-120 | 10 |  | 10 |  | 500 |
| 2N3452 | NCH | FE | 2N3821 | SEE FET INTERCHANGEABILITY LIST SEE FET INTERCHANGEABILITY LIST |  |  |  |  |  |  |  |  |
| 2N3453 | NCH | FE | 2N3821 |  |  |  |  |  |  |  |  |  |
| 2N3454 | NCH | FE |  | SEE FET INTERCHANGEABILITY LIST <br> SEE FET INTERCHANGEABILITY LIST <br> SEE FET INTERCHANGEABHLTY LIST <br> SEE FET INTERCHANGEABILITY LIST |  |  |  |  |  |  |  |  |
| 2N3455 | NCH | FE | 2N3821 |  |  |  |  |  |  |  |  |  |
| 2N3456 | NCH | FE | 2N3821 |  |  |  |  |  |  |  |  |  |
| 2N3457 | NCH | FE |  |  |  |  |  |  |  |  |  |  |
| 2N3458 | NCH | FE | 2N3458 | SEE FET INTERCHANGEABILITY LIST SEE FET INTERCHANGEABILITY LIST SEE FET INTERCHANGEABILITY LIST |  |  |  |  |  |  |  |  |
| 2N3459 | NCH | FE | 2N3459 |  |  |  |  |  |  |  |  |  |
| 2N3460 | NCH | FE | 2N3460 |  |  |  |  |  |  |  |  |  |
| 2N3462 | NPN | GP | 2N930 | 300 | 50 | 35 | 100-300 | . 01 | . 35 | 5 | 150 | 10 |
| 2N3463 | NPN | GP | 2N2586 | 300 | 60 | 45 | 120-360 | . 01 | . 35 | 1 | 150 | 45 |
| 2N3464 | NPN | GP | 2N2270 | *5W | 60 | 40 | 35-100 | 200 | 1 | 200 | 30 | 50 |
| $\left\{\begin{array}{l} \text { 2N3465 } \\ \text { 2N3466 } \end{array}\right.$ | $\begin{aligned} & \mathrm{NCH} \\ & \mathrm{NCH} \end{aligned}$ | $\left\lvert\, \begin{aligned} & \text { FE } \\ & \text { FE } \end{aligned}\right.$ | 2N3821 | SEE FET INTERCHANGEABMITY LISt SEE FET INTERCHANGEABILTYY LIST |  |  |  |  |  |  |  |  |
| 2N3467 | PNP | Sw | 2N3467 | IW | 40 | 40 | 40-120 | 500 | . 3 | 150 |  | 175 |
| 2N3468 | PNP | SW | 2N3468 | 1w | 50 | 50 | 25-75 | 500 | . 35 | 150 |  | 150 |
| 2N3478 | NPN | RF | 2N3570 | 200 | 30 | 15 | 25-150 | 2 |  |  | 25 | 750 |
| 2N3479 | P-N | US | 2N1671A | SEE UNIUUNCTION INTERCHANGEABILITY LIST |  |  |  |  |  |  |  |  |
| 2N3480 | P-N | UJ | 2N2646 | SEE UNIJUNCTION INTERCHANGEABILITY LIST SEE UNIJUNCTION INTERCHANGEABLITY LIST SEE UNIJUNCTION INTERCHANGEABILITY LIST SEE UNIJUNCTION INTERCHANGEABILITY LIST |  |  |  |  |  |  |  |  |
| 2N3481 | P-N | UJ | 2N4853 |  |  |  |  |  |  |  |  |  |
| 2N3482 | P-N | US |  |  |  |  |  |  |  |  |  |  |
| 2N3483 | P-N | UJ |  |  |  |  |  |  |  |  |  |  |
| 2N3484 | P-N | UJ |  | SEE UNIJUNCTION INTERCHANGEABILITY LIST |  |  |  |  |  |  |  |  |
| 2N3485 | PNP | GP | 2N3485 | 400 | 60 | 40 | 40-120 | 150 | . 4 | 150 |  | 200 |
| 2N3485A | PNP | GP | 2N3485A | 400 | 60 | 60 | 40-120 | 150 | . 4 | 150 |  | 200 |
| 2N3486 | PNP | GP | 2N3486 | 400 | 60 | 40 | 100-300 | 150 | . 4 | 150 |  | 200 |
| 2N3486A | PNP | GP | 2N3486A | 400 | 60 | 60 | 100-300 | 150 | . 4 | 150 |  | 200 |
| 2N3493 | NPN | SW |  | 150 | 12 | 8 | 40-120 | . 5 | . 15 | . 01 |  | 400 |
| 2N3494 | PNP | GP | 2N3494 | 600 | 80 | 80 | $35-$ | 100 | . 3 | 10 | 40 | 200 |
| 2N3495 | PNP | GP | 2N3495 | 600 | 120 | 120 | 35. | . 1 | . 35 | 10 | 40 | 150 |

## TRANSISTOR INTERCHANGEABILITY MASTER LIST OF REGISTERED TYPES

|  | 3$\frac{5}{5}$8 | $\begin{aligned} & 3 \\ & 8 \\ & 8 \\ & 8 \\ & 8 \end{aligned}$ | TIRERACEMENTOR NEARESTEOUVALENT | MAXIMUM RATIVNS |  |  | EPCHRCAL CMARACTİRIES |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  | $\begin{gathered} \mathrm{T}_{\mathrm{A}}=25^{\circ} \mathrm{C} \\ { }^{\circ} \mathrm{T}_{\mathrm{C}}=25^{\circ} \mathrm{C} \\ (\mathrm{~mW}) \end{gathered}$ | VCBO <br> (V) | VCEO <br> (V) | hre |  | VCE(met) |  | $\begin{gathered} \mathrm{h}_{\mathrm{fo}} \\ \mathrm{I} \text { kdtz } \\ \text { MNN } \end{gathered}$ | fr |
|  |  |  |  |  |  |  | MiN MAX - lc |  | $\max$ $i c$ <br> (V) (mA) |  |  |  |
| 2N3496 | PNP | GP | 2N3496 | 400 | 80 | 80 | 35. | 100 | . 3 | 10 | 40 | 200 |
| 2N3497 | PNP | GP | 2N3497 | 400 | 120 | 120 | 35. | . 1 | . 35 | 10 | 40 | 150 |
| 2N3498 | NPN | $G P$ | 2N2102 | IW | 100 | 100 | 40-120 | 150 | . 2 | 10 | 50 | 150 |
| 2N3499 | NPN | GP | 2N2102 | 1W | 100 | 100 | 100-300 | 150 | . 2 | 10 | 75 | 150 |
| 2N3500 | NPN | ${ }^{\text {GP }}$ | 2N2102 | 1w | 150 | 150 | 40.120 | 150 | . 2 | 10 | 50 | 150 |
| 2N3501 | NPN | GP | 2N2102 | 1w | 150 | 150 | 100-300 | 150 | . 2 | 10 | 75 | 150 |
| 2N3502 | PNP | GP | 2N3502 | 700 | 45 | 45 | 115-300 | 50 | . 25 | 50 | 135 | 200 |
|  |  |  | 2N3503 | 700 | 60 | 60 | 115-300 | 50 | . 25 | 50 | 135 | 200 |
| $\begin{aligned} & 2 N 3504 \\ & 2 N 3505 \\ & 2 N 3506 \\ & 2 N 3507 \end{aligned}$ | $\begin{aligned} & \text { PNP } \\ & \text { PNP } \\ & \text { NPN } \\ & \text { NPN } \end{aligned}$ | $\begin{aligned} & \text { GP } \\ & \text { GP } \\ & S W \\ & S W \end{aligned}$ | 2N3504 2N3505 | 400 | 45 | 45 | 115-300 | 50 | . 25 | 50 | 135 |  |
|  |  |  |  | 400 | 60 | 60 | 115-300 | 50 | . 25 | 50 | 135 | 200 |
|  |  |  |  | 1W | 60 | 40 | 40-200 | 1.5 | 1 | 1.5 |  | 60 |
|  |  |  |  | IW | 80 | 50 | 30.150 | 1.5 | 1 | 1.5 |  | 60 |
| $\begin{aligned} & \text { 2N3500 } \\ & \text { 2N3509 } \\ & 2 N 3510 \\ & 2 N 3511 \end{aligned}$ | $\begin{aligned} & \text { NPN } \\ & \text { NPN } \\ & \text { NPN } \\ & \text { NPN } \end{aligned}$ | SW | 2N3724 | 400 | 40 | 20 | 40-120 | 10 | . 25 | 10 |  | 500 |
|  |  | SW | 2N3724 | 400 | 40 | 20 | 100-300 | 10 |  | 10 |  | 500 |
|  |  | SW | 2N3724 | 360 | 40 | 10 | 25.150 | 150 |  | 10 |  | 350 |
|  |  |  |  | 360 | 40 | 15 | 30.120 | 150 | . 25 | 10 |  | 450 |
| $\begin{aligned} & \text { 2N3512 } \\ & \text { 2N3513 } \\ & \text { 2N3514 } \\ & \text { 2N3515 } \end{aligned}$ | NPN NPN NPN NPN |  | 2N2537 |  | 60 | 35 |  |  |  |  |  |  |
|  |  | DU | 2N2640 | 250 | 80 | 40 | $50-200$ | 1 | 1.2 | 50 | 50 | 50 |
|  |  | DU |  | 250 | 80 | 40 | 50-200 | 1 | 1.2 | 50 | 50 | 50 |
|  |  | DU |  | 250 | 80 | 40 | 50-200 | 1 | 1.2 | 50 | 50 | 50 |
| $\begin{aligned} & \text { 2N3516 } \\ & \text { 2N3517 } \\ & \text { 2N3518 } \\ & \text { 2N3519 } \end{aligned}$ |  |  | 2N2639 | 250 | 100 | 60 |  | 1 |  |  |  |  |
|  |  | DU |  | 250 | 100 | 60 | 50-200 | 1 | 1.2 | 50 | 50 | 60 |
|  |  | $1 D U$ |  | 250 | 100 | 60 | 50-200 | 1 | 1.2 | 50 | 50 | 60 |
|  |  |  |  | 250 | 60 | 30 | $150-600$ | 1 | 1 | 5 | 150 | 60 |
| $\begin{aligned} & \text { 2N3520 } \\ & \text { 2N3521 } \\ & \text { 2N3522 } \\ & \text { 2N3523 } \end{aligned}$ | NPN <br> NPN NPN NPN |  |  | 250 | 60 | 30 |  |  |  |  | 150 |  |
|  |  | DU | 2N2643 | 300 | 70 | 55 | 100-300 | . 01 |  | 10 |  | 30 |
|  |  | DU | 2N2643 | 250 | 70 | 55 | 100-300 | . 01 | 1 | 10 |  | 30 |
|  |  | DU |  | 250 | 70 | 55 | 100-300 | . 01 | 1 | 10 |  | 30 |
| 2N3524 <br> 2N3526 <br> 2N3527 <br> 2N3544 | NPN <br> NPN <br> PNP <br> NPN |  | 2N2640 |  |  |  |  |  |  |  |  | 30 |
|  |  | CP |  | 800 | 130 | 120 | 30-120 | 30 | 1 | 50 | 25 | 40 |
|  |  | SW | 2N2944 | 400 | 30 | 30 | 25-75 | . 1 |  |  | 100 | 5 |
|  |  |  |  | 300 | 25 |  | 25. | 10 |  |  |  | 600 |
| 2N3545 2N3546 2N3547 2N3548 | PNP <br> PNP <br> PNP <br> PNP | GP | 2N3978 | 360 | 20 | 20 | 40-120 | 10 | . 2 | 10 |  | 250 |
|  |  | SW | 2N3576 | 360 | 15 | 12 | 30-120 | 10 | . 15 | 10 |  | 700 |
|  |  | GP | 2N3799 | 360 | 60 | 60 | 100-500 | 1 | 1 | 10 | 120 | 45 |
|  |  | GP | 2N2604 | 400 | 60 | 45 | 100-300 | . 01 | 1 | 10 | 150 | 60 |
| 2N3549 <br> 2N35s0 <br> 2N3553 <br> 2N3554 | $\begin{aligned} & \text { PNP } \\ & \text { PNP } \\ & \text { NPN } \\ & \text { NPN } \end{aligned}$ | GP | 2N2604 | 400 | 60 | 60 | 100-500 | . 01 | 1 | 10 | 150 | 60 |
|  |  | SW | 2N2944 | 400 | 60 | 45 | 200-600 | . 01 | . 9 | 5 | 300 | 60 |
|  |  |  | 2N3553 | *W | 65 | 40 | 10.100 | 250 | 1 | 250 |  | 400 |
|  |  | SW | 2N3554 | 800 | 60 | 30 | 25-100 | 750 |  | 750 |  | 150 |

TRANSISTOR INTERCHANGEABILITY
MASTER LIST OF REGISTERED TYPES

| TYFI NUMMER |  | $\begin{aligned} & \frac{7}{6} \\ & \frac{8}{2} \\ & \frac{0}{6} \\ & 8 \end{aligned}$ | $\begin{gathered} \text { II } \\ \text { REMACEMENT } \\ \text { OR NBAREST } \\ \text { EOUVALENT } \end{gathered}$ | maximum ratines |  |  | EECTRICAL CHARACTEISTICS |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  | $\begin{gathered} \mathrm{P}_{\mathrm{Y}} \\ \mathrm{~T}_{A}=25^{\circ} \mathrm{C} \\ { }^{*} \mathrm{~T}_{\mathrm{C}}-25^{\circ} \mathrm{C} \\ (\mathrm{~mW}) \\ \hline \end{gathered}$ | VCBO <br> (V) | VCEO <br> (V) | hfE | $\begin{gathered} \mathrm{IC} \\ (\mathrm{~mA}) \end{gathered}$ | $\mathbf{V C E}$ <br> Max <br> (V) | set) (mA) | $\begin{gathered} h_{50} \\ 1 \mathrm{kHz} \\ \text { MiN } \end{gathered}$ | T MiN (MHz) |
| 2N3563 <br> 2N3564 <br> 2N3565 <br> 2N3566 | NPN NPN NPN NPN | $\begin{aligned} & R F \\ & R F \\ & G P \\ & G P \end{aligned}$ | TIS62 <br> 2N4996 <br> A5T3565 <br> TIS97 | $\begin{aligned} & 200 \\ & 200 \\ & 200 \\ & 300 \end{aligned}$ | 30 30 30 40 | 12 15 25 30 | $\begin{aligned} & 20-200 \\ & 20- \\ & 150-600 \\ & 150-600 \end{aligned}$ | $\begin{array}{r} 8 \\ 15 \\ 1 \\ 10 \end{array}$ | .3 .35 1 | $\begin{array}{r} 20 \\ 1 \\ 100 \\ \hline \end{array}$ | 20 | $\begin{array}{r} 600 \\ 400 \\ 40 \\ 40 \end{array}$ |
| $\begin{aligned} & \text { 2N3567 } \\ & \text { 2N3568 } \\ & \text { 2N3569 } \\ & \text { 2N3570 } \end{aligned}$ | NPN NPN <br> NPN NPN | $\begin{aligned} & \text { GP } \\ & G P \\ & G P \\ & \text { RF } \end{aligned}$ | A5T3567 <br> A5T3568 <br> A5T3569 <br> 2N3570 | $\begin{aligned} & 300 \\ & 300 \\ & 300 \\ & 200 \end{aligned}$ | 80 80 80 30 | 40 60 40 15 | $\begin{array}{r} 40-120 \\ 40-120 \\ 100-300 \\ 20-150 \end{array}$ | 150 150 150 5 | .25 .25 .35 | 150 150 150 | 20 | 60 60 60 150 |
| $\begin{aligned} & \text { 2N3571 } \\ & \text { 2N3572 } \\ & \text { 2N3573 } \\ & \text { 2N3574 } \end{aligned}$ | $\begin{aligned} & \text { NPN } \\ & \text { NPN } \\ & \text { PCH } \\ & \text { PCH } \end{aligned}$ | $\begin{aligned} & \text { RF } \\ & \text { RF } \\ & \text { FE } \\ & \text { FE } \end{aligned}$ | $\begin{aligned} & \text { 2N3571 } \\ & \text { 2N3572 } \\ & \text { 2N3573 } \\ & \text { 2N3574 } \end{aligned}$ | $\begin{aligned} & 200 \\ & 200 \\ & \text { SEE FET } \\ & \text { SEE FET } \end{aligned}$ |  | $\begin{array}{r} 15 \\ 13 \\ \text { NGEABMIT } \\ \text { NGEABILIT } \end{array}$ | $\begin{aligned} & 20-200 \\ & 20-300 \\ & \text { TY LIST } \\ & \text { TY LIST } \end{aligned}$ | $\begin{aligned} & 5 \\ & 5 \end{aligned}$ |  |  | $\begin{aligned} & 20 \\ & 20 \end{aligned}$ | $\begin{aligned} & 150 \\ & 100 \end{aligned}$ |
| $\begin{array}{\|l\|} \hline \text { 2N3575 } \\ \text { 2N3576 } \\ \text { 2N3578 } \\ \text { 2N3579 } \end{array}$ | $\left\lvert\, \begin{aligned} & \text { PCH } \\ & \text { PNP } \\ & \text { PCH } \\ & \text { PNP } \end{aligned}\right.$ | $\begin{array}{\|l\|} \hline F E \\ \text { SW } \\ \text { FE } \\ \text { GP } \end{array}$ | $\begin{aligned} & \text { 2N3575 } \\ & \text { 2N3576 } \\ & \text { 2N2608 } \\ & \text { 2N3799 } \end{aligned}$ | SEE FET <br> 360 SEE FET 400 | $\begin{aligned} & \text { NTERCHA } \\ & 20 \\ & \text { NTERCHA } \\ & 60 \end{aligned}$ | $\begin{gathered} \text { NGEABILIT } \\ 15 \\ \text { NGEABIL } \\ 60 \end{gathered}$ | $\begin{aligned} & \text { IY LIST } \\ & \text { 40-120 } \\ & \text { TY LIST } \\ & 30-120 \end{aligned}$ | $\begin{array}{r} 10 \\ 1 \end{array}$ | $\begin{array}{r} .15 \\ .5 \end{array}$ | $\begin{array}{r} 10 \\ 5 \end{array}$ | 30 | 400 80 |
| $\begin{aligned} & \text { 2N3580 } \\ & \text { 2N35s1 } \\ & \text { 2N3582 } \\ & \text { 2N3586 } \end{aligned}$ | $\begin{aligned} & \text { PNP } \\ & \text { PNP } \\ & \text { PNP } \\ & \text { PNP } \end{aligned}$ | $\begin{aligned} & G P \\ & G P \\ & G P \\ & S W \end{aligned}$ | $\begin{aligned} & \text { 2N3799 } \\ & \text { 2N3799 } \\ & \text { 2N3799 } \\ & \text { 3N108 } \end{aligned}$ | 400 400 400 125 | $\begin{aligned} & 60 \\ & 50 \\ & 50 \\ & 45 \end{aligned}$ | 60 40 40 45 | $\begin{array}{r} 60-240 \\ 50-150 \\ 100-300 \end{array}$ | 1 .1 .1 | .5 .5 .5 | $\begin{aligned} & 5 \\ & 5 \\ & 5 \end{aligned}$ | 60 50 100 | 80 30 30 .1 |
| $\begin{aligned} & \text { 2N3587 } \\ & \text { 2N3600 } \\ & \text { 2N3608 } \\ & \text { 2N3609 } \end{aligned}$ | $\begin{aligned} & \mathrm{NPN} \\ & \mathrm{NPN} \\ & \mathrm{PCH} \\ & \mathrm{PCH} \end{aligned}$ | $\begin{aligned} & \mathrm{DU} \\ & \mathrm{RF} \\ & \mathrm{FE} \\ & \mathrm{FE} \end{aligned}$ | 2N2640 2N4252 3N155 | $\begin{aligned} & 300 \\ & 200 \\ & \text { SEE FET } \\ & \text { SEE FET } \end{aligned}$ | $\begin{gathered} 60 \\ 30 \\ \text { INTERCHA } \end{gathered}$ <br> NTERCH | $\begin{array}{r} 45 \\ 15 \\ \text { NGEABHII } \\ \text { NGEABMII } \end{array}$ | $\begin{aligned} & 80-500 \\ & 20-150 \\ & \text { TY LIST } \\ & \text { TY LIST } \end{aligned}$ | 1 | 1 | 10 | 40 | 80 850 |
| $\begin{aligned} & \text { 2N3610 } \\ & \text { 2N3631 } \\ & \text { 2N3633 } \\ & \text { 2N3634 } \end{aligned}$ | PCH <br> NCH <br> NPN <br> PNP | FE <br> FE <br> SW <br> GP | 2N3634 | $\begin{aligned} & \text { SEE FET } \\ & \text { SEE FET } \\ & 300 \\ & \text { IW } \end{aligned}$ | $\begin{gathered} \text { INTERCH } \\ \text { INTERCH } \\ 15 \\ 140 \end{gathered}$ | NGEABLLIT NGEABIIIT 6 140 | $\begin{aligned} & \text { ITY LIST } \\ & \text { ITY LIST } \\ & 50-150 \\ & 50.150 \end{aligned}$ | $\begin{aligned} & 10 \\ & 50 \end{aligned}$ | $\begin{array}{r} .21 \\ .5 \end{array}$ | $\begin{array}{r} 3 \\ 50 \end{array}$ | 40 | 1.30 150 |
| $\begin{aligned} & \text { 2N3635 } \\ & \text { 2N3636 } \\ & \text { 2N3637 } \\ & \text { 2N3638 } \end{aligned}$ | PNP PNP PNP PNP | GP <br> GP <br> © <br> SW | $\begin{aligned} & \text { 2N3635 } \\ & \text { 2N3636 } \\ & \text { 2N3637 } \\ & \text { AST3638 } \end{aligned}$ | $\begin{aligned} & 16 \\ & 10 \\ & 16 \\ & 300 \end{aligned}$ | $\begin{array}{r} 140 \\ 175 \\ 175 \\ 25 \end{array}$ | $\begin{array}{r} 140 \\ 175 \\ 175 \\ 25 \end{array}$ | $\begin{aligned} & 100-300 \\ & 50-150 \\ & 100-300 \\ & 30- \end{aligned}$ | $\begin{aligned} & 50 \\ & 50 \\ & 50 \\ & 50 \end{aligned}$ | $\begin{array}{r} .5 \\ .5 \\ .5 \\ .25 \end{array}$ | $\begin{aligned} & 50 \\ & 50 \\ & 50 \\ & 50 \end{aligned}$ | 80 40 80 | 200 150 200 100 |
| $\begin{aligned} & \text { 2N3638A } \\ & \text { 2N3639 } \\ & \text { 2N3640 } \\ & \text { 2N3641 } \end{aligned}$ | PNP <br> PNP <br> PNP <br> NPN | $\begin{aligned} & \text { SW } \\ & \text { SW } \\ & \text { SW } \\ & R F \end{aligned}$ | A5T3638A <br> 2N5449 | $\begin{aligned} & 300 \\ & 200 \\ & 200 \\ & 350 \end{aligned}$ | $\begin{array}{r} 25 \\ 6 \\ 12 \\ 60 \end{array}$ | $\begin{array}{r} 25 \\ 6 \\ 12 \\ 30 \end{array}$ | $\begin{aligned} & 100- \\ & 30-120 \\ & 30-120 \\ & 40-120 \end{aligned}$ | $\begin{array}{r} 50 \\ 10 \\ 10 \\ 150 \end{array}$ | $\begin{array}{r} .25 \\ .16 \\ .2 \\ .22 \end{array}$ | $\begin{array}{r} 50 \\ 10 \\ 10 \\ 150 \end{array}$ |  | 150 500 500 250 |
| $\begin{aligned} & \text { 2N3642 } \\ & \text { 2N3643 } \\ & \text { 2N3644 } \\ & 2 N 3645 \end{aligned}$ | NPN NPN PNP PNP | $\begin{aligned} & R F \\ & R F \\ & \text { SW } \\ & S W \end{aligned}$ | 2N5449 <br> 2N5449 <br> A5T3644 <br> A5T3645 | $\begin{aligned} & 350 \\ & 350 \\ & 300 \\ & 300 \end{aligned}$ | $\begin{aligned} & 60 \\ & 60 \\ & 45 \\ & 60 \end{aligned}$ | $\begin{aligned} & 45 \\ & 30 \\ & 45 \\ & 60 \end{aligned}$ | $\begin{array}{r} 40-120 \\ 100-300 \\ 100-300 \\ 100-300 \end{array}$ | $\begin{aligned} & 150 \\ & 150 \\ & 150 \\ & 150 \end{aligned}$ | .22 .22 .4 .4 | $\begin{aligned} & 150 \\ & 150 \\ & 150 \\ & 150 \end{aligned}$ |  | 250 250 200 200 |

## TRANSISTOR INTERCHANGEABILITY MASTER LIST OF REGISTERED TYPES

| TYFE NUMLE | $\begin{aligned} & 8 \\ & 8 \\ & 8 \end{aligned}$ | 8888888 | $\begin{gathered} \text { II } \\ \text { Rupactmant } \\ \text { OR MANEST } \\ \text { ROUVAIENT } \end{gathered}$ | MAXIMUM RATMNOS |  |  | Pactical CMANAGTEISIICS |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  | $\begin{gathered} \mathrm{PT}_{\mathrm{T}} \\ \mathrm{~T}_{\mathrm{A}}=25^{\circ} \mathrm{C} \\ { }^{{ }^{2} \mathrm{C}=25^{\circ} \mathrm{C}} \\ (\mathrm{~mW}) \end{gathered}$ | Vceo | Vceo <br> (V) | MiN MA | $\begin{gathered} \mathbf{L} \\ (\mathrm{mA}) \end{gathered}$ | $\begin{array}{\|l\|} \hline \mathbf{V C u} \\ \hline \begin{array}{l} \text { Max } \\ (V) \end{array} \\ \hline \end{array}$ | $\begin{aligned} & (\mathrm{min}) \\ & \hline \mathrm{Ic} \\ & (\mathrm{~mA}) \end{aligned}$ |  | $\begin{gathered} \text { Y } \\ \text { MN } \\ \text { (MHz) } \end{gathered}$ |
| $\begin{aligned} & \text { 2N3646 } \\ & \text { 2N3647 } \\ & \text { 2N3648 } \\ & \text { 2N3659 } \end{aligned}$ | $\begin{aligned} & \text { NPN } \\ & \text { NPN } \\ & \text { NPN } \\ & \text { NPN } \end{aligned}$ | $\begin{aligned} & \text { SW } \\ & \text { SW } \\ & \text { SW } \\ & \text { GP } \end{aligned}$ | A5T3903 <br> 2N5058 | $\begin{array}{r} 200 \\ 400 \\ 400 \\ 4 W \end{array}$ | $\begin{array}{r} 40 \\ 40 \\ 40 \\ 220 \end{array}$ | $\begin{array}{r} 15 \\ 10 \\ 15 \\ 170 \end{array}$ | $\begin{aligned} & 30-120 \\ & 25-150 \\ & 30-120 \\ & 20 . \end{aligned}$ | $\begin{array}{r} 30 \\ 150 \\ 150 \\ 10 \end{array}$ | $\begin{array}{r} .3 \\ .25 \\ .25 \end{array}$ | $\begin{aligned} & 30 \\ & 10 \\ & 10 \end{aligned}$ | $\begin{aligned} & 20 \\ & 20 \\ & 20 \end{aligned}$ | $\begin{array}{r} 350 \\ 350 \\ 450 \\ 50 \end{array}$ |
| $\begin{aligned} & \text { 2N3660 } \\ & \text { 2N3661 } \\ & \text { 2N3662 } \\ & \text { 2N3663 } \end{aligned}$ | $\begin{aligned} & \text { PNP } \\ & \text { PNP } \\ & \text { NPN } \\ & \text { NPN } \end{aligned}$ | $\begin{aligned} & \mathbf{G P} \\ & \mathbf{G P} \\ & \mathbf{R F} \\ & \mathbf{R F} \end{aligned}$ | 2N4030 <br> 2N4030 <br> TIS62 <br> T1562 | + $5 W$ $.5 W$ 200 200 | 40 60 18 30 | 30 50 12 12 | $25-100$ $25-100$ 20. 20. | 500 500 8 8 | 1.2 1.2 .6 .6 | 500 500 10 10 |  | 25 25 700 700 |
| $\begin{array}{\|l\|} \text { 2N3664 } \\ \text { 2N3665 } \\ \text { 2N3666 } \\ \text { 2N3671 } \end{array}$ | $\begin{aligned} & \text { NPN } \\ & \text { NPN } \\ & \text { NPN } \\ & \text { PNP } \end{aligned}$ | $\begin{array}{\|l} \text { RF } \\ \text { SW } \\ \text { SW } \\ \text { GP } \end{array}$ | 2N2905 | $\begin{gathered} 5 w \\ \cdot 5 W \\ \cdot 5 w \\ 600 \end{gathered}$ | $\begin{array}{r} 60 \\ 120 \\ 120 \\ 60 \end{array}$ | $\begin{aligned} & 60 \\ & 80 \\ & 80 \\ & 50 \end{aligned}$ | $\begin{array}{r} 8-80 \\ 40-120 \\ 100-300 \\ 75-225 \end{array}$ | $\begin{array}{r} 50 \\ 150 \\ 150 \\ 150 \end{array}$ | .75 .5 .5 .4 | $\begin{aligned} & 250 \\ & 150 \\ & 150 \\ & 150 \end{aligned}$ |  | 300 60 60 200 |
| $\begin{aligned} & \text { 2N3672 } \\ & \text { 2N3673 } \\ & \text { 2N3677 } \\ & \text { 2N3678 } \end{aligned}$ | $\begin{aligned} & \text { PNP } \\ & \text { PNP } \\ & \text { PNP } \\ & \text { NPN } \end{aligned}$ | GP <br> GP <br> SW <br> ${ }^{6}$ | $\begin{aligned} & \text { 2N2907 } \\ & \text { 2N3486A } \\ & \text { 2N2944 } \\ & \text { 2N2218A } \end{aligned}$ | 400 350 400 800 | 60 60 30 75 | 50 50 20 55 | $\begin{aligned} & 75-225 \\ & 75-225 \\ & 40-120 \end{aligned}$ | $\begin{aligned} & 150 \\ & 150 \\ & 150 \end{aligned}$ | $\begin{aligned} & .4 \\ & .4 \\ & .4 \end{aligned}$ | $\begin{aligned} & 150 \\ & 150 \\ & 150 \end{aligned}$ |  | 200 200 5 250 |
| $\begin{aligned} & \text { 2N3679 } \\ & \text { 2N3680 } \\ & \text { 2N3681 } \\ & \text { 2N3682 } \end{aligned}$ | P-N <br> NPN <br> NPN <br> NPN | $\begin{aligned} & \text { UJ } \\ & \text { DU } \\ & \text { RF } \\ & \text { RF } \end{aligned}$ | $\begin{aligned} & \text { 2N3680 } \\ & \text { 2N3570 } \\ & \text { 2N918 } \end{aligned}$ | $\begin{array}{ccc}\text { SEE UNIUUNCTION } & \text { INTERCH } \\ 300 & 60 & 50 \\ 200 & 10 & 7 \\ 360 & 40 & 15\end{array}$ |  |  | $\begin{aligned} & \text { ANGEABLII } \\ & 150-600 \\ & 20-220 \\ & 40-120 \end{aligned}$ | ST $\begin{array}{r} .01 \\ 2 \\ 10 \end{array}$ | $\begin{array}{r} .7 \\ .37 \end{array}$ | $\begin{array}{r} 10 \\ 4 \end{array}$ | 300 20 45 | $\begin{array}{r} 60 \\ 1.30 \\ 600 \end{array}$ |
| 2N3683 2N3604 2N3685 2N3686 | NPN <br> NCH <br> NCH <br> NCH | $\begin{aligned} & \text { RF } \\ & \text { FE } \\ & \text { FE } \\ & \text { FE } \end{aligned}$ | $\begin{aligned} & \text { 2N3570 } \\ & \text { 2N3822 } \\ & \text { 2N3821 } \\ & \text { 2N3821 } \end{aligned}$ |  |  |  |  |  |  |  | 30 | 16 |
| $\begin{aligned} & \text { 2N3687 } \\ & \text { 2N3688 } \\ & \text { 2N3689 } \\ & \text { 2N3690 } \end{aligned}$ | NCH <br> NPN <br> NPN <br> NPN | $\begin{aligned} & \mathbf{F E} \\ & \text { RF } \\ & \text { RF } \\ & \text { RF } \end{aligned}$ | TIS84 T1584 7584 | $\begin{aligned} & \text { SEE FET II } \\ & 200 \\ & 200 \\ & 200 \end{aligned}$ | $\begin{gathered} \text { NTERCHA } \\ 40 \\ 40 \\ 40 \end{gathered}$ | $\begin{gathered} \text { NGEABLL } \\ 40 \\ 40 \\ 40 \end{gathered}$ | $\begin{array}{r} \text { Y LIST } \\ 30 \\ 30 . \\ 30 . \end{array}$ | 4 |  |  |  | 400 400 400 |
| $\begin{aligned} & 2 N 3691 \\ & \text { 2N3692 } \\ & 2 N 3699 \\ & 2 N 3694 \end{aligned}$ | NPN <br> NPN <br> NPN <br> NPN | OP <br> GP <br> RF <br> RF | $\begin{aligned} & \text { T1599 } \\ & \text { T1598 } \\ & 2 N 4994 \\ & 2 N 4995 \end{aligned}$ | $\begin{aligned} & 200 \\ & 200 \\ & 200 \\ & 200 \end{aligned}$ | $\begin{aligned} & 35 \\ & 35 \\ & 45 \\ & 45 \end{aligned}$ | $\begin{aligned} & 25 \\ & 25 \\ & 45 \\ & 45 \end{aligned}$ | $\begin{array}{r} 40 \\ 100 \\ 40 \\ 100 \end{array}$ | $\begin{aligned} & 10 \\ & 10 \\ & 10 \\ & 10 \end{aligned}$ | $.7$ | $\begin{aligned} & 10 \\ & 10 \end{aligned}$ | $\begin{array}{r} 40 \\ 100 \end{array}$ | $\begin{aligned} & 200 \\ & 200 \\ & 200 \\ & 200 \end{aligned}$ |
| $\begin{aligned} & \text { 2N3695 } \\ & \text { 2N3696 } \\ & \text { 2N3697 } \\ & \text { 2N3698 } \end{aligned}$ | PCH <br> PCH <br> PCH <br> PCH | FE <br> PR <br> FE <br> FE | $\begin{aligned} & \text { 2N3329 } \\ & \text { 2N3329 } \end{aligned}$ | SEE FET INTERCHANOEAEHITY LIST SEE FET INTERCHANGEABLLTY LIST geE FET INTERCHANOEABUTY LIST SEE FET INTLACHANGEABLITY LIST |  |  |  |  |  |  |  |  |
| $\begin{aligned} & \text { 2N3700 } \\ & \text { 2N3701 } \\ & \text { 2N3702 } \\ & \text { 2N3703 } \end{aligned}$ | NPN <br> NPN <br> PNP <br> PNP | GP <br> GP <br> OP <br> GP | $\begin{aligned} & \text { 2N720A } \\ & \text { 2N720A } \\ & \text { 2N3702 } \\ & \text { 2N3703 } \end{aligned}$ | $\begin{aligned} & 500 \\ & 300 \\ & 360 \\ & 360 \end{aligned}$ | $\begin{array}{r} 140 \\ 140 \\ 40 \\ 50 \end{array}$ | 80 80 25 30 | $\begin{array}{r} 100-300 \\ 40.120 \\ 60-300 \\ 30-150 \end{array}$ | $\begin{array}{r} 150 \\ 150 \\ 50 \\ 50 \end{array}$ | $\begin{array}{r} .2 \\ .2 \\ .25 \\ .25 \end{array}$ | $\begin{array}{r} 150 \\ 150 \\ 50 \\ 50 \end{array}$ | $\begin{aligned} & 80 \\ & 30 \end{aligned}$ | 100 80 100 100 |

## TRANSISTOR INTERCHANGEABILITY MASTER LIST OF REGISTERED TYPES

| TYPE NUMDEE |  | 888888 | $\begin{gathered} \text { TI } \\ \text { RERLACEMENT } \\ \text { OR NEAREST } \\ \text { ECUIVALENT } \end{gathered}$ | MAXIMLUM RATMVOS |  |  | ERCTRICAL CHANACTERISTICS |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  | $\begin{gathered} \mathrm{P} \\ \mathrm{~T}_{\mathrm{A}}=25^{\circ} \mathrm{C} \\ { }^{*} \mathrm{~T}_{\mathrm{C}}=25^{\circ} \mathrm{C} \\ (\mathrm{~mW}) \end{gathered}$ | Veso (V) | VCEO (V) | M Min max | $\begin{gathered} \hline \mathrm{L} \\ (\mathrm{~mA}) \end{gathered}$ | Max <br> M) | $\begin{aligned} & \text { (sent) } \\ & \hline \mathrm{IC} \\ & \text { (mA) } \end{aligned}$ | Mfo 1 kftz MN | f Mins (MHz) |
| $\begin{aligned} & \text { 2N3704 } \\ & \text { 2N3705 } \\ & \text { 2N3706 } \\ & \text { 2N3707 } \end{aligned}$ | NPN NPN NPN NPN | GP <br> GP <br> GP <br> GP | 2N3704 <br> 2N3705 <br> 2N3706 <br> 2N3707 | $\begin{aligned} & 360 \\ & 360 \\ & 360 \\ & 360 \end{aligned}$ | $\begin{aligned} & 50 \\ & 50 \\ & 40 \\ & 30 \end{aligned}$ | $\begin{aligned} & 30 \\ & 30 \\ & 20 \\ & 30 \end{aligned}$ | $\begin{array}{r} 100-300 \\ 50-150 \\ 30-600 \\ 100-400 \end{array}$ | $\begin{aligned} & 50 \\ & 50 \\ & 50 \\ & .1 \end{aligned}$ | .6 .8 1 1 | $\begin{array}{r} 100 \\ 100 \\ 100 \\ 10 \end{array}$ |  | $\begin{aligned} & 100 \\ & 100 \\ & 100 \\ & 100 \end{aligned}$ |
| $\begin{aligned} & \text { 2N3708 } \\ & \text { 2N3709 } \\ & \text { 2N3710 } \\ & \text { 2N3711 } \end{aligned}$ | NPN <br> NPN <br> NPN <br> NPN | GP <br> GP <br> GP <br> GP | $\begin{aligned} & \text { 2N3708 } \\ & \text { 2N3709 } \\ & \text { 2N3710 } \\ & \text { 2N3711 } \end{aligned}$ | $\begin{aligned} & 360 \\ & 360 \\ & 360 \\ & 360 \end{aligned}$ | $\begin{aligned} & 30 \\ & 30 \\ & 30 \\ & 30 \end{aligned}$ | $\begin{aligned} & 30 \\ & 30 \\ & 30 \\ & 30 \end{aligned}$ | $\begin{array}{r} 45-660 \\ 45-165 \\ 90-330 \\ 180-660 \end{array}$ | 1 1 1 | 1 1 1 1 | $\begin{aligned} & 10 \\ & 10 \\ & 10 \\ & 10 \end{aligned}$ | $\begin{array}{r} 45 \\ 45 \\ 90 \\ 180 \end{array}$ |  |
| $\begin{array}{\|l\|} \text { 2N3712 } \\ \text { 2N3721 } \\ \text { 2N3722 } \\ \text { 2N3723 } \end{array}$ | NPN NPN <br> NPN <br> NPN | GP <br> GP <br> SW <br> SW | $\begin{aligned} & \text { 2N3711 } \\ & \text { 2N3725 } \end{aligned}$ | $\begin{aligned} & 800 \\ & 360 \\ & 800 \\ & 800 \end{aligned}$ | $\begin{array}{r} 150 \\ 18 \\ 80 \\ 100 \end{array}$ | $\begin{array}{r} 150 \\ 18 \\ 60 \\ 80 \end{array}$ | $\begin{aligned} & 30-150 \\ & 60-660 \\ & 40-150 \\ & 40-150 \end{aligned}$ | $\begin{array}{r} 30 \\ 10 \\ 100 \\ 100 \end{array}$ | $\begin{array}{r} 2 \\ .22 \\ .25 \end{array}$ | $\begin{array}{r} 50 \\ 100 \\ 10 \end{array}$ | 25 | $\begin{gathered} 40 \\ 300 \\ 300 \end{gathered}$ |
| $\begin{aligned} & \text { 2N3724 } \\ & \text { 2N372AA } \\ & \text { 2N3725 } \\ & \text { 2N3725A } \end{aligned}$ | NPN <br> NPN <br> NPN <br> NPN | $\left\lvert\, \begin{aligned} & s w \\ & s w \\ & s w \\ & s w \end{aligned}\right.$ | $\begin{aligned} & \text { 2N3724 } \\ & \text { 2N3724A } \\ & \text { 2N3725 } \\ & \text { 2N3725A } \end{aligned}$ | 800 <br> IW <br> 800 <br> 1W | $\begin{aligned} & 50 \\ & 50 \\ & 80 \\ & 80 \end{aligned}$ | $\begin{aligned} & 30 \\ & 30 \\ & 50 \\ & 50 \end{aligned}$ | $\begin{aligned} & 60-150 \\ & 60-150 \\ & 60-150 \\ & 60-150 \end{aligned}$ | $\begin{aligned} & 100 \\ & 100 \\ & 100 \\ & 100 \end{aligned}$ | $\begin{array}{r} .2 \\ .2 \\ .26 \\ .26 \end{array}$ | $\begin{aligned} & 100 \\ & 100 \\ & 100 \\ & 100 \end{aligned}$ |  | $\begin{aligned} & 300 \\ & 300 \\ & 300 \\ & 300 \end{aligned}$ |
| $\begin{aligned} & \text { 2N3726 } \\ & \text { 2N3727 } \\ & \text { 2N3728 } \\ & \text { 2N3729 } \end{aligned}$ | $\begin{aligned} & \text { PNP } \\ & \text { PNP } \\ & \text { NPN } \\ & \text { NPN } \end{aligned}$ | $\left\lvert\, \begin{aligned} & D U \\ & D U \\ & D U \\ & D U \end{aligned}\right.$ | $\begin{aligned} & \text { 2N3810 } \\ & \text { 2N3810 } \\ & \text { 2N2060 } \\ & \text { 2N2060 } \end{aligned}$ | $\begin{aligned} & 400 \\ & 400 \\ & 450 \\ & 450 \end{aligned}$ | $\begin{aligned} & 45 \\ & 45 \\ & 60 \\ & 60 \end{aligned}$ | $\begin{aligned} & 45 \\ & 45 \\ & 30 \\ & 30 \end{aligned}$ | $\begin{array}{r} 135-350 \\ 135-350 \\ 80-280 \\ 80-280 \end{array}$ | $\begin{array}{r} 1 \\ 1 \\ 150 \\ 150 \end{array}$ | $\begin{aligned} & .25 \\ & .25 \\ & .22 \\ & .22 \end{aligned}$ | $\begin{array}{r} 50 \\ 50 \\ 150 \\ 150 \end{array}$ | $\begin{array}{r} 135 \\ 135 \\ 50 \\ 50 \end{array}$ | $\begin{aligned} & 200 \\ & 200 \\ & 250 \\ & 250 \end{aligned}$ |
| $\begin{aligned} & \text { 2N3734 } \\ & \text { 2N373AA } \\ & \text { 2N3735 } \\ & \text { 2N3735A } \end{aligned}$ | $\begin{aligned} & \text { NPN } \\ & \text { NPN } \\ & \text { NPN } \\ & \text { NPN } \end{aligned}$ | $\begin{aligned} & \text { SW } \\ & \text { sw } \\ & \text { SW } \\ & \text { sw } \end{aligned}$ | $\begin{aligned} & \text { 2N3734 } \\ & \text { 2N3734 } \\ & \text { 2N3735 } \\ & \text { 2N3735 } \end{aligned}$ | $\begin{aligned} & \text { iw } \\ & \text { iw } \\ & \text { iw } \\ & \text { iw } \end{aligned}$ | 50 50 75 75 | 30 30 50 50 | $\begin{aligned} & 30-120 \\ & 30-120 \\ & 20-80 \\ & 20-80 \end{aligned}$ | 14 14 14 1A | .2 .9 .2 .9 | 10 14 10 14 |  | 300 250 250 250 |
| $\left\lvert\, \begin{aligned} & \text { 2N3736 } \\ & \text { 2N3736A } \\ & \text { 2N3737 } \\ & \text { 2N3737A } \end{aligned}\right.$ | $\begin{aligned} & \text { NPN } \\ & \text { NPN } \\ & \text { NPN } \\ & \text { NPN } \end{aligned}$ | $\left\lvert\, \begin{aligned} & s w \\ & s w \\ & s w \\ & s w \end{aligned}\right.$ |  | $\begin{aligned} & 500 \\ & 500 \\ & 500 \\ & 500 \end{aligned}$ | 50 50 75 75 | $\begin{aligned} & 30 \\ & 30 \\ & 50 \\ & 50 \end{aligned}$ | $\begin{aligned} & 30-120 \\ & 30-120 \\ & 20-80 \\ & 20-80 \end{aligned}$ | 14 14 14 14 | .2 .9 .2 .9 | 10 14 10 14 |  | 300 250 250 250 |
| $\begin{aligned} & \text { 2N3742 } \\ & \text { 2N3743 } \\ & \text { 2N3762 } \\ & \text { 2N3763 } \end{aligned}$ | $\begin{aligned} & \text { NPN } \\ & \text { PNP } \\ & \text { PNP } \\ & \text { PNP } \end{aligned}$ | $\left\lvert\, \begin{aligned} & G P \\ & G P \\ & S W \\ & S W \end{aligned}\right.$ | $\begin{aligned} & \text { 2N5058 } \\ & \text { 2N3244 } \\ & \text { 2N3245 } \end{aligned}$ | $\begin{aligned} & \text { iw } \\ & \text { iw } \\ & \text { iw } \\ & \text { iw } \end{aligned}$ | $\begin{array}{r} 300 \\ 300 \\ 40 \\ 60 \end{array}$ | $\begin{array}{r} 300 \\ 300 \\ 40 \\ 60 \end{array}$ | $\begin{aligned} & 20-200 \\ & 25-250 \\ & 30-120 \\ & 20-80 \end{aligned}$ | $\begin{aligned} & 30 \\ & 30 \\ & \text { 1A } \\ & \text { 1A } \end{aligned}$ | 1 5 .1 .1 | $\begin{aligned} & 10 \\ & 10 \\ & 10 \\ & 10 \end{aligned}$ | 20 30 | 30 30 180 150 |
| $\begin{aligned} & \text { 2N3764 } \\ & \text { 2N3765 } \\ & \text { 2N3774 } \\ & \text { 2N3775 } \end{aligned}$ | PNP <br> PNP <br> PNP <br> PNP | $\begin{aligned} & \text { GP } \\ & \text { GP } \\ & \text { GP } \\ & \text { GP } \end{aligned}$ | $\begin{aligned} & \text { 2N3486 } \\ & \text { 2N3486A } \\ & \text { 2N4030 } \\ & \text { 2N4030 } \end{aligned}$ | $\begin{array}{r} 500 \\ 500 \\ \cdot 5 w \\ \cdot 5 w \end{array}$ | $\begin{aligned} & 40 \\ & 60 \\ & 40 \\ & 60 \end{aligned}$ | $\begin{aligned} & 40 \\ & 60 \\ & 60 \end{aligned}$ | $\begin{aligned} & 30-120 \\ & 20-80 \\ & 20-60 \\ & 20-60 \end{aligned}$ | 14 14 200 200 | .1 .1 .2 .2 | 10 10 200 200 |  | 180 150 1 1 |
| $\begin{aligned} & \text { 2N3776 } \\ & \text { 2N3777 } \\ & \text { 2N3778 } \\ & \text { 2N3779 } \end{aligned}$ | PNP PNP PNP PNP | $\begin{aligned} & G P \\ & G P \\ & G P \\ & G P \end{aligned}$ |  | $\begin{aligned} & \text { "5w } \\ & * 5 w \\ & * 5 W \\ & \cdot 5 w \end{aligned}$ | $\begin{array}{r} 80 \\ 100 \\ 40 \\ 60 \end{array}$ | 80 100 40 60 | $\begin{aligned} & 20-60 \\ & 20-60 \\ & 10-40 \\ & 10-40 \end{aligned}$ | 200 200 200 200 | .2 .2 .2 .2 | 200 200 200 200 |  | 1 1 1 1 |

## TRANSISTOR INTERCHANGEABILITY MASTER LIST OF REGISTERED TYPES

| TYPENUMBER |  |  | $\begin{aligned} & \text { TI } \\ & \text { REMLACEMENT } \\ & \text { OR NEAREST } \\ & \text { EQUVAULENT } \end{aligned}$ | maximum ratines |  |  | aECTRICAL Characteristics |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  |  |  | hPE |  | $\mathrm{V}_{\text {cz(ser) }}$ |  | $\left\{\begin{array}{c} h_{60} \\ 1 \mathrm{k} k \mathrm{tz} \\ \mathrm{MmN} \end{array}\right.$ |  |
|  |  |  |  |  |  |  | Min max | $\begin{gathered} \mathrm{Ic} \\ (\mathrm{~mA}) \end{gathered}$ | $\begin{aligned} & \max \\ & \text { (v) } \end{aligned}$ | $\begin{gathered} \mathbf{I C} \\ (\mathrm{mA}) \end{gathered}$ |  |  |
| ${ }^{2 N} 3780$ | PNP | GP |  | *5W | 80 | 80 | 10-40 | 200 | . 2 | 200 |  | 1 |
| 2N3781 | PNP | GP |  | *5W | 100 | 100 | 10.40 | 200 | . 2 | 200 |  | 1 |
| 2N3782 | PNP | GP | 2N4030 | *5W | 40 | 40 | 10.60 | 1A | . 75 | 14 |  | 1 |
| 2N3795 | PNP | GP |  | -5W | 120 | 120 | 12-36 | 10 | . 2 | 10 |  | . 5 |
| $\begin{array}{\|l\|} \text { 2N3796 } \\ \text { 2N3797 } \\ \text { 2N3798 } \\ \text { 2N3799 } \end{array}$ | $\begin{array}{\|l\|} \mathrm{NCH} \\ \mathrm{NCH} \\ \mathrm{NCH} \\ \mathrm{PNP} \\ \mathrm{PNP} \end{array}$ | $\begin{aligned} & \mathrm{FE} \\ & \mathrm{FE} \\ & \mathrm{GP} \\ & \mathrm{GP} \end{aligned}$ | $\begin{aligned} & \text { 2N3798 } \\ & \text { 2N3799 } \end{aligned}$ | SEE FET INTERCHANGEABILTY LIST SEE FET INTERCHANGEABIUTY LIST |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  | 60 | 60 | 150-450 | . 5 | . 2 | . 1 | 150 | 30 |
|  |  |  |  |  | 60 | 60 | 300.900 | . 5 | . 2 | . 1 | 300 | 30 |
| $\begin{array}{\|l\|l} \text { 2N3800 } \\ \text { 2N3801 } \\ \text { 2N3802 } \\ \text { 2N3803 } \end{array}$ | PNP | DU | 2N3352 | 250 | 60 | 60 | 150-450 | . 1 | . 2 | . 1 | 150 | 100 |
|  | PNP | DU | 2N3352 | 250 | 60 | 60 | 300-900 | . 1 | . 2 | . 1 | 300 | 100 |
|  | PNP | DU | 2N3347 | 250 | 60 | 60 | 150-450 | . 1 | . 2 | . 1 | 150 | 100 |
|  | PNP | DU | 2N3351 | 250 | 60 | 60 | 300-900 | . 1 | . 2 | . 1 | 300 | 100 |
| $\begin{aligned} & \text { 2N3804 } \\ & \text { 2N3804A } \\ & \text { 2N3805 } \\ & \text { 2N3805A } \end{aligned}$ | PNP | DU | 2N3350 | 250 | 60 | 60 | 150-450 | . 1 | . 2 | . 1 | 150 | 100 |
|  | PNP | DU | 2N3350 | 250 | 60 | 60 | 150-450 | . 1 | . 2 | . 1 | 150 | 30 |
|  | PNP | DU | 2N3350 | 250 | 60 | 60 | 300-900 | . 1 | . 2 | . 1 | 300 | 100 |
|  | PNP | DU | 2N3350 | 250 | 60 | 60 | 300-900 | . 1 | . 2 | . 1 | 300 | 30 |
| 2N3806 <br> 2N3807 <br> 2N3808 <br> 2N3809 | PNP | DU | 2N3806 | 500 | 60 | 60 | 150-450 | . 1 | . 2 | . 1 | 150 | 100 |
|  | PNP | DU | 2N3807 | 500 | 60 | 60 | 300-900 | . 1 | . 2 | . 1 | 300 | 100 |
|  | PNP | DU | 2N3808 | $500^{\circ}$ | 60 | 60 | 150450 | . 1 | . 2 | . 1 | 150 | 100 |
|  | PNP | DU | 2N3809 | 500 | 60 | $\infty$ | 300-900 | . 1 | . 2 | . 1 | 300 | 100 |
| 2N3810 <br> 2N3810A <br> 2N3811 <br> 2N3811A | PNP | DU | 2N3810 | 500 | 60 | $\infty$ | 150-450 | . 1 | . 2 | . 1 | 150 | 100 |
|  | PNP | DU | 2N3810 | 500 | 60 | 60 | 150-450 | . 1 | . 2 | . 1 | 150 | 30 |
|  | PNP | DU | 2N3811 | 500 | 60 | 60 | 300-900 | . 1 | . 2 | . 1 | 300 | 100 |
|  | PNP | DU | 2N3811 | 500 | 60 | 60 | 300-900 | . 1 | . 2 | . 1 | 300 | 30 |
| 2N3812 <br> 2 N 3813 <br> 2N3814 <br> 2N3815 | PNP | DU |  | 350 | 60 | 60 | 150-450 | . 1 | . 2 | . 1 | 150 | 100 |
|  | PNP | DU |  | 350 | 60 | 60 | 300-900 | . 1 | . 2 | . 1 | 300 | 100 |
|  | PNP | DU |  | 350 | 60 | 60 | 150-450 | . 1 | . 2 | . 1 | 150 | 100 |
|  | PNP | DU |  | 350 | 60 | 60 | 300-900 | . 1 | . 2 | . 1 | 300 | 100 |
| 2N3816 <br> 2N3816A <br> 2N3817 <br> 2N3817A | PNP | DU |  | 350 | 60 | 60 | 150-450 | . 1 | . 2 | . 1 | 150 | 100 |
|  | PNP | DU |  | 250 | 60 | 60 | $150-450$ | . 1 | . 2 | . 1 | 150 | 30 |
|  | PNP | DU |  | 350 | 60 | 60 | 300-900 | . 1 | . 2 | . 1 | 300 | 100 |
|  | PNP | DU |  | 250 | 60 | 60 | 300-900 | . 1 | . 2 | . 1 | 300 | 30 |
| 2N3819 2N3820 2N3821 2N3822 | NCH | fE | 2N3819 | SEE FET INTERCHANGEABLLTY LIST SEE FET INTERCHANGEABILTYY LIST SEE FET INTERCHANGEABLITYY LIST SEE FET INTERCHANGEABILTY LIST |  |  |  |  |  |  |  |  |
|  | PCH | FE | 2N3820 |  |  |  |  |  |  |  |  |  |
|  | NCH | FE | 2N3821 |  |  |  |  |  |  |  |  |  |
|  | NCH | FE | 2N3822 |  |  |  |  |  |  |  |  |  |
| $\begin{aligned} & \text { 2N3823 } \\ & \text { 2N3824 } \\ & \text { 2N3825 } \\ & \text { 2N3826 } \end{aligned}$ | NCH <br> NCH <br> NPN <br> NPN | $\begin{array}{\|l\|l} \hline \mathbf{F E} \\ \mathrm{FE} \\ \mathrm{RF} \\ \mathrm{RF} \end{array}$ | 2N3823 | SEE FET INTERCHANGEABLITY LIST SEE FET INTERCHANGEABILITY LIST |  |  |  |  |  |  |  |  |
|  |  |  | 2N3824 |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  | . 25 | 2 |  |  |
|  |  |  | 2N4994 | 360 | 60 | 45 | 40-160 | 10 |  |  |  | 200 |

## TRANSISTOR INTERCHANGEABILITY MASTER LIST OF REGISTERED TYPES

| TYPE NUMEER | $\begin{aligned} & \text { 息 } \\ & \frac{8}{6} \end{aligned}$ | 83333 | $\begin{aligned} & \text { T1 } \\ & \text { REPLACEMENT } \\ & \text { OR MEAREST } \\ & \text { ECUIVALENT } \end{aligned}$ | MAXIMOM RATNVOS |  |  | ELECTRLCAL CHARACTERISTICS |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  | $\begin{gathered} T_{A}=25^{\circ} \mathrm{C} \\ { }^{*} \mathrm{~T}_{\mathrm{C}}=25^{\circ} \mathrm{C} \\ (\mathrm{~mW}) \\ \hline \end{gathered}$ | Vcso (V) | Vceo (V) | MBN MAX | $\begin{gathered} \mathbf{L C}^{\prime} \\ (\mathrm{ma}) \\ \hline \end{gathered}$ |  | (set) (ma) | $\begin{aligned} & \mathrm{h}_{\mathrm{fe}} \\ & \mathrm{I} \text { kdz } \\ & \operatorname{MiN} \end{aligned}$ | TT |
| $\begin{aligned} & \text { 2N3827 } \\ & \text { 2N3828 } \\ & \text { 2N3829 } \\ & \text { 2N3830 } \end{aligned}$ | NPN <br> NPN <br> PNP <br> NPN | $\begin{aligned} & \text { RF } \\ & \text { RF } \\ & \text { SW } \\ & \text { GP } \end{aligned}$ | $\begin{aligned} & \text { 2N4997 } \\ & \text { 2N3829 } \\ & \text { 2N2193 } \end{aligned}$ | $\begin{aligned} & 360 \\ & 300 \\ & 360 \\ & 1 W \end{aligned}$ | 60 40 35 80 | 45 40 20 50 | $\begin{array}{r} 100-400 \\ 30-200 \\ 30-120 \\ 30- \end{array}$ | $\begin{array}{r} 10 \\ 12 \\ 30 \\ 150 \end{array}$ | .18 .3 | 10 150 |  | 200 360 350 200 |
| $\begin{aligned} & \text { 2N3831 } \\ & \text { 2N3832 } \\ & \text { 2N3838 } \\ & \text { 2N3839 } \end{aligned}$ | $\begin{aligned} & \text { NPN } \\ & \mathbf{N P N} \\ & N / P \\ & \text { NPN } \end{aligned}$ | $\begin{array}{\|l} \text { GP } \\ \text { SW } \\ G P \\ R F \end{array}$ | 2N2193 2N3571 | $\begin{aligned} & 1 W \\ & 200 \\ & 250 \\ & 200 \end{aligned}$ | 70 15 60 30 | 40 6 40 15 | $\begin{aligned} & 35- \\ & 25-125 \\ & 100-300 \\ & 30- \end{aligned}$ | $\begin{array}{r} 150 \\ 2 \\ 150 \\ 3 \end{array}$ | .3 .4 .4 | $\begin{array}{r} 150 \\ 10 \\ 150 \end{array}$ | 60 | $\begin{aligned} & 200 \\ & 800 \\ & 200 \\ & 200 \end{aligned}$ |
| $\begin{aligned} & \text { 2N3840 } \\ & \text { 2N3841 } \\ & 2 N 3842 \\ & 2 N 3843 \end{aligned}$ | $\begin{aligned} & \text { PNP } \\ & \text { PNP } \\ & \text { PNP } \\ & \mathbf{N P N} \end{aligned}$ | $\begin{aligned} & \text { SW } \\ & \text { SW } \\ & \text { SW } \\ & \text { RF } \end{aligned}$ | $\begin{aligned} & \text { 2N2946 } \\ & \text { 2N2946 } \\ & \text { 2N2946 } \\ & \text { T1594 } \end{aligned}$ | $\begin{aligned} & 400 \\ & 300 \\ & 300 \\ & 200 \end{aligned}$ | $\begin{array}{r} 50 \\ 100 \\ 120 \\ 30 \end{array}$ | $\begin{array}{r} 50 \\ 100 \\ 120 \\ 30 \end{array}$ | 30. <br> 15- <br> 10. <br> 20-40 | .2 .2 1 2 | $\begin{array}{r} .1 \\ .12 \\ 1 \end{array}$ | $\begin{gathered} 5 \\ 5 \\ 10 \end{gathered}$ |  | 6 1.5 1 60 |
| $\begin{aligned} & \text { 2N3843A } \\ & \text { 2N3844 } \\ & \text { 2N3844A } \\ & \text { 2N3845 } \end{aligned}$ | $\left\lvert\, \begin{aligned} & \text { NPN } \\ & \text { NPN } \\ & \text { NPN } \\ & \text { NPN } \end{aligned}\right.$ | $\begin{aligned} & \text { RF } \\ & \text { RF } \\ & \text { RF } \\ & \text { RF } \end{aligned}$ | $\begin{aligned} & \text { TIS94 } \\ & \text { TIS94 } \\ & \text { TIS94 } \\ & \text { TIS94 } \end{aligned}$ | 200 200 200 200 | 30 30 30 30 | 30 30 30 30 | $\begin{aligned} & 20-40 \\ & 35-70 \\ & 35-70 \\ & 60-120 \end{aligned}$ | 2 2 2 2 | 1 1 1 1 | 10 10 10 10 |  | 60 90 90 120 |
| $\begin{aligned} & \text { 2N3845A } \\ & \text { 2N385A } \\ & \text { 2N3854A } \\ & \text { 2N3855 } \end{aligned}$ | NPN NPN NPN NPN | $\begin{aligned} & R F \\ & R F \\ & R F \\ & R F \end{aligned}$ | $\begin{aligned} & \text { TIS94 } \\ & \text { TIS94 } \\ & \text { TIS94 } \\ & \text { TIS94 } \end{aligned}$ | $\begin{aligned} & 200 \\ & 200 \\ & 200 \\ & 200 \end{aligned}$ | 30 18 30 18 | $\begin{aligned} & 30 \\ & 18 \\ & 30 \\ & 18 \end{aligned}$ | $\begin{aligned} & 60-120 \\ & 35-70 \\ & 35-70 \\ & 60-120 \end{aligned}$ | 2 2 2 2 | 1 .2 .2 .2 | 10 10 10 10 |  | 120 100 100 130 |
| $\begin{aligned} & \text { 2N3855A } \\ & \text { 2N3856 } \\ & \text { 2N3856A } \\ & \text { 2N3858 } \end{aligned}$ | NPN <br> NPN <br> NPN <br> NPN | $\begin{aligned} & \text { RF } \\ & \text { RF } \\ & \text { RF } \\ & \text { RF } \end{aligned}$ | $\begin{aligned} & \text { TIS94 } \\ & \text { TIS94 } \\ & \text { TIS94 } \\ & \text { TIS95 } \end{aligned}$ | $\begin{aligned} & 200 \\ & 200 \\ & 200 \\ & 360 \end{aligned}$ | $\begin{aligned} & 30 \\ & 18 \\ & 30 \\ & 30 \end{aligned}$ | $\begin{aligned} & 30 \\ & 18 \\ & 30 \\ & 30 \end{aligned}$ | $\begin{array}{r} 60-120 \\ 100-200 \\ 100-200 \\ 60-120 \end{array}$ | 2 2 2 2 | .2 .2 .2 .125 | 10 10 10 10 |  | 130 140 140 90 |
| $\begin{aligned} & \text { 2N3858A } \\ & \text { 2N3859 } \\ & \text { 2N3859A } \\ & \text { 2N3860 } \end{aligned}$ | NPN NPN NPN NPN | $\begin{aligned} & R F \\ & R F \\ & R F \\ & R F \\ & R F \end{aligned}$ | $\begin{aligned} & \text { TIS95 } \\ & \text { TIS95 } \\ & \text { TIS95 } \\ & \text { TIS95 } \end{aligned}$ | $\begin{aligned} & 360 \\ & 360 \\ & 360 \\ & 360 \end{aligned}$ | $\begin{aligned} & 60 \\ & 30 \\ & 60 \\ & 30 \end{aligned}$ | $\begin{aligned} & 60 \\ & 30 \\ & 60 \\ & 30 \end{aligned}$ | $\begin{array}{r} 60.120 \\ 100-200 \\ 120-200 \\ 150-300 \end{array}$ | 2 2 2 2 | .125 .125 .125 .125 | $\begin{aligned} & 10 \\ & 10 \\ & 10 \\ & 10 \end{aligned}$ |  | 90 90 90 90 |
| $\begin{aligned} & \text { 2N3862 } \\ & \text { 2N3866 } \\ & \text { 2N3866A } \\ & \text { 2N3867 } \end{aligned}$ | NPN <br> NPN <br> NPN <br> PNP | SW <br> RF <br> RF <br> SW | $\begin{aligned} & \text { 2N3866 } \\ & \text { 2N3866 } \end{aligned}$ | $\begin{array}{r} 360 \\ -5 W \\ 5 W \\ 1 W \end{array}$ | $\begin{aligned} & 50 \\ & 55 \\ & 55 \\ & 40 \end{aligned}$ | 20 30 30 40 | $\begin{aligned} & 50-150 \\ & 10-200 \\ & 25-200 \\ & 40-200 \end{aligned}$ | 10 50 50 1.5 | .25 1 1 .75 | $\begin{array}{r} 10 \\ 100 \\ 100 \\ 1.5 \end{array}$ |  | 600 500 800 60 |
| $\begin{array}{\|l} \text { 2N3868 } \\ \text { 2N3869 } \\ \text { 2N3877 } \\ \text { 2N3877A } \end{array}$ | PNP NPN NPN NPN | SW <br> RF <br> GP <br> GP | $\begin{aligned} & \text { 2N5550 } \\ & \text { 2N5550 } \end{aligned}$ | $1 W$ 800 360 360 | 60 40 70 85 | 60 20 70 85 | $30-150$ 20.150 20 20 | 1.5 30 2 2 | .75 .7 1 1 | 1.5 450 10 10 |  | 60 400 |
| $\begin{aligned} & \text { 2N3880 } \\ & \text { 2N3881 } \\ & \text { 2N3882 } \\ & \text { 2N3900 } \end{aligned}$ | NPN NPN PCH NPN | RF <br> RF <br> FE <br> GP | $\begin{aligned} & \text { 2N3570 } \\ & \text { 2N3711 } \end{aligned}$ | $\begin{gathered} 200 \\ 600 \\ \text { SEE FET } \\ 360 \end{gathered}$ | $\begin{gathered} 30 \\ 60 \\ \text { INTERCH } \\ 18 \end{gathered}$ | $\begin{gathered} 15 \\ 35 \\ \text { ANGEABLL } \\ 18 \end{gathered}$ | $\begin{aligned} & 30-200 \\ & \text { UST } \\ & 250-500 \end{aligned}$ | 3 <br> 2 | 1.5 | 150 | $\begin{array}{r} 50 \\ 50 \\ 170 \end{array}$ | 1.26 70 |

## TRANSISTOR INTERCHANGEABILITY MASTER LIST OF REGISTERED TYPES

| TYPE Number |  | $\begin{aligned} & 8 \\ & \frac{8}{8} \\ & \frac{8}{5} \\ & 8 \end{aligned}$ | IImemacrmantOR MimasestEOUNAIENT | MAXIMUM RATMESS |  |  | ELECTRICAL CHANACTEXISTICS |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  | $\begin{gathered} \mathrm{PT}_{\mathrm{Y}} \\ \mathrm{~T}_{\mathrm{A}}=25^{\circ} \mathrm{C} \\ { }^{*} \mathrm{~T}_{\mathrm{C}}=25^{\circ} \mathrm{C} \\ (\mathrm{~mW}) \\ \hline \end{gathered}$ | Veso <br> (V) | Veso$(V)$ | hre |  | VCE(sat) |  | $\begin{gathered} \text { Mfo } \\ \text { M hits } \\ \text { MMN } \end{gathered}$ | $\begin{gathered} \text { TT } \\ \text { min } \\ \text { (MOHz) } \end{gathered}$ |
|  |  |  |  |  |  |  | M M M M | $\begin{gathered} V_{C} \\ (\mathrm{ma}) \end{gathered}$ | $\begin{aligned} & \mathrm{max} \\ & (\mathrm{~V}) \\ & \hline \end{aligned}$ | $\begin{array}{r} \mathrm{LC} \\ (\mathrm{~mA}) \\ \hline \end{array}$ |  |  |
| $\begin{aligned} & \text { 2N3900A } \\ & \text { 2N3901 } \\ & \text { 2N3903 } \\ & \text { 2N3904 } \end{aligned}$ | NPN <br> NPN <br> NPN <br> NPN | GP <br> GP <br> SW <br> SW | $\begin{aligned} & 2 N 3711 \\ & 2 N 3711 \\ & 2 N 3903 \\ & 2 N 3904 \end{aligned}$ | $\begin{aligned} & 360 \\ & 360 \\ & 310 \\ & 310 \end{aligned}$ | $\begin{aligned} & 18 \\ & 18 \\ & 60 \\ & 60 \end{aligned}$ | $\begin{aligned} & 18 \\ & 18 \\ & 40 \\ & 40 \end{aligned}$ | $\begin{array}{r} 250-500 \\ 350-700 \\ 50-150 \\ 100-300 \end{array}$ | $\begin{array}{r} 2 \\ 2 \\ 10 \\ 10 \end{array}$ | . 2 | $\begin{aligned} & 10 \\ & 10 \end{aligned}$ | $\begin{aligned} & 170 \\ & 350 \end{aligned}$ | 250 300 |
| $\begin{aligned} & \text { 2N3905 } \\ & \text { 2N3906 } \\ & \text { 2N3907 } \\ & \text { 2N3908 } \end{aligned}$ | PNP <br> PNP <br> NPN <br> NPN | SW <br> SW <br> DU <br> DU | 2N3905 <br> 2N3906 <br> 2N2915 <br> 2N2916 | $\begin{aligned} & 310 \\ & 310 \\ & 300 \\ & 300 \end{aligned}$ | $\begin{aligned} & 40 \\ & 40 \\ & 60 \\ & 60 \end{aligned}$ | $\begin{aligned} & 40 \\ & 40 \\ & 45 \\ & 60 \end{aligned}$ | $\begin{array}{r} 50-150 \\ 100-300 \\ 60-300 \\ 100-500 \end{array}$ | 10 10 .01 .01 | .25 .25 .35 .35 | $\begin{array}{r} 10 \\ 10 \\ 1 \\ 1 \end{array}$ |  | 200 250 60 60 |
| $\begin{aligned} & \text { 2N3909 } \\ & \text { 2N3910 } \\ & \text { 2N3911 } \\ & \text { 2N3910 } \end{aligned}$ | $\begin{aligned} & \mathrm{PCH} \\ & \text { PNP } \\ & \text { PNP } \\ & \text { PNNP } \end{aligned}$ | $\left\lvert\, \begin{aligned} & \text { FE } \\ & \text { SW } \\ & \text { SW } \\ & \text { SW } \end{aligned}\right.$ | $\begin{aligned} & \text { 2N3909 } \\ & \text { 2N2946A } \\ & \text { 2N2946A } \\ & \text { 2N2946A } \end{aligned}$ | $\begin{aligned} & \text { SEE FET } \\ & 500 \\ & 500 \\ & 500 \end{aligned}$ | 60 <br> 60 <br> 60 | $\begin{aligned} & 50 \\ & 40 \\ & 30 \end{aligned}$ | $\begin{aligned} & \text { IY LST } \\ & 40-160 \\ & 60-240 \\ & 90- \end{aligned}$ | 1 1 | .3 .3 .3 | $\begin{aligned} & 10 \\ & 10 \\ & 10 \end{aligned}$ |  | 4 8 10 |
| $\begin{aligned} & \text { 2N3913 } \\ & \text { 2N3914 } \\ & \text { 2N3915 } \\ & \text { 2N3916 } \end{aligned}$ | $\begin{aligned} & \text { PNP } \\ & \text { PNP } \\ & \text { PNP } \\ & \text { NPN } \end{aligned}$ | $\begin{aligned} & \text { SW } \\ & \text { SW } \\ & \text { SW } \\ & \text { GP } \end{aligned}$ |  | 400 400 400 $* 5 W$ | 60 60 60 150 | 50 40 30 150 | $\begin{aligned} & 40-160 \\ & 60-240 \\ & 90 \\ & 40-200 \end{aligned}$ | 1 1 1 150 | .3 .3 .3 5 | $\begin{array}{r} 10 \\ 10 \\ 10 \\ 150 \end{array}$ | 30 | 4 8 10 50 |
| 2N3921 <br> 2N3922 <br> 2N3923 <br> 2N3930 | NCH <br> NCH <br> NPN <br> PNP | $\begin{aligned} & \text { FE } \\ & \text { FE } \\ & \text { GP } \\ & \mathbf{G P} \end{aligned}$ | 2N5545 | SEE FET <br> SEE FET <br> 800 <br> 400 | SEE FET INTERCHANGEARMTY LIST SEE FET INTERCHANGEAEMITY LIST |  |  | $\begin{aligned} & 25 \\ & 10 \end{aligned}$ | $\begin{array}{r} 1 \\ .25 \end{array}$ | $\begin{aligned} & 25 \\ & 10 \end{aligned}$ | 20 100 | 40 40 |
| 2N3931 2N3932 2N3933 2N3934 | PNP <br> NPN <br> NPN <br> NCH | $\begin{aligned} & \text { GP } \\ & \text { RF } \\ & \text { RF } \\ & \text { FE } \end{aligned}$ | $\begin{aligned} & \text { 2N6937 } \\ & \text { 2N3571 } \\ & \text { 2N5545 } \end{aligned}$ | $\begin{gathered} 700 \\ 200 \\ 200 \\ \text { SEE FET } \end{gathered}$ | $\begin{array}{r} 180 \\ 30 \\ 40 \\ \text { NTERCHA } \end{array}$ | $\begin{array}{r} 180 \\ 20 \\ 30 \end{array}$ | $\begin{aligned} & 80-300 \\ & 40-150 \\ & 60-200 \\ & \text { LST } \end{aligned}$ | 10 2 2 | . 25 | 10 | 100 50 60 | 40 750 750 |
| $\begin{aligned} & \text { 2N3935 } \\ & \text { 2N3941 } \\ & \text { 2N3942 } \\ & \text { 2N3943 } \end{aligned}$ | NCH <br> NPN <br> NPN <br> NPN | $\text { \| } \begin{aligned} & \text { FE } \\ & \text { DU } \\ & \text { DU } \\ & \text { DU } \end{aligned}$ | 2N5546 | $\begin{gathered} \text { SEE FET } \\ 300 \\ 300 \\ 500 \end{gathered}$ | ITERCHA 60 60 60 | $\begin{aligned} & \text { VEABL } \\ & 45 \\ & 45 \\ & 45 \end{aligned}$ | $\begin{aligned} & \text { Y LIST } \\ & 400-1200 \\ & 400.1200 \\ & 400.1200 \end{aligned}$ | $\begin{aligned} & .01 \\ & .01 \\ & .01 \end{aligned}$ |  |  | $\begin{aligned} & 300 \\ & 300 \\ & 300 \end{aligned}$ | 200 200 200 |
| $\begin{aligned} & \text { 2N3944 } \\ & \text { 2N3945 } \\ & \text { 2N3946 } \\ & \text { 2N3947 } \end{aligned}$ | NPN <br> NPN <br> NPN <br> NPN | DU <br> GP <br> GP <br> GP | $\begin{aligned} & \text { 2N2270 } \\ & \text { 2N2217 } \\ & \text { 2N2219 } \end{aligned}$ | $\begin{array}{r} 500 \\ -5 W \\ 360 \\ 360 \end{array}$ | $\begin{aligned} & 60 \\ & 70 \\ & 60 \\ & 60 \end{aligned}$ | $\begin{aligned} & 45 \\ & 50 \\ & 40 \\ & 40 \end{aligned}$ | $\begin{gathered} 400-1200 \\ 40-250 \\ 50-150 \\ 100-300 \end{gathered}$ | $\begin{array}{r} .01 \\ 150 \\ 10 \\ 10 \end{array}$ | $\begin{aligned} & .5 \\ & .3 \\ & .3 \end{aligned}$ | $\begin{array}{r} 150 \\ 50 \\ 50 \end{array}$ | $\begin{array}{r} 300 \\ 50 \\ 100 \end{array}$ | 200 60 250 300 |
| $\begin{aligned} & \text { 2N3948 } \\ & \text { 2N3953 } \\ & \text { 2N3954 } \\ & \text { 2N3955 } \end{aligned}$ | NPN <br> NPN <br> NCH <br> NCH | $\begin{aligned} & \mathbf{R F} \\ & \mathbf{R F} \\ & \hline \mathbf{F E} \\ & \mathbf{F E} \end{aligned}$ | $\begin{aligned} & 2 N 3571 \\ & 2 N 5546 \end{aligned}$ | $\begin{aligned} & \text { 1W } \\ & \text { 200 } \\ & \text { SEE FET it } \\ & \text { SEE FET It } \end{aligned}$ | SEE FET INTERCHAMGEABUITY LIST SEE FET INTERCHANGEABHITY LIST |  |  | $\begin{array}{r} 50 \\ 2 \end{array}$ |  |  | 40 | 700 1.36 |
| $\begin{aligned} & \text { 2N3956 } \\ & \text { 2N3957 } \\ & \text { 2N3958 } \\ & \text { 2N3959 } \end{aligned}$ | NCH <br> NCH <br> NCH <br> NPN | FE <br> FE <br> FE <br> SW | $\begin{aligned} & \text { 2N5547 } \\ & \text { 2N5547 } \\ & \text { 2N5547 } \end{aligned}$ | SEE FET INTERCHANGEABMITY LIST SEE FET INTERCHANGEABUTYY LIST SEE FET INTERCHANGEABLITY LST |  |  |  |  | . 3 | 30 |  | 1.36 |

## TRANSISTOR INTERCHANGEABILITY <br> MASTER LIST OF REGISTERED TYPES

| TYPE NUMBER | $\begin{aligned} & \frac{\Sigma}{6} \\ & \frac{1}{\frac{1}{2}} \\ & \frac{1}{6} \end{aligned}$ | Z <br> 最 <br> $\mathbf{y}$ <br> $\frac{1}{2}$ <br> $\mathbf{3}$ | II REPLACEMENT OR NEAREST EQUIVALENT | MAXIMUM RATINGS |  |  | ELECTRICAL CHARACTERISTICS |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  | $\begin{gathered} \mathrm{T}_{\mathrm{A}}=25^{\circ} \mathrm{C} \\ { }^{\circ} \mathrm{T} \mathrm{C}=25^{\circ} \mathrm{C} \\ (\mathrm{~mW}) \end{gathered}$ | Vceo <br> (V) | $V_{C E O}$ <br> (V) | MFE | $\begin{gathered} \text { lc } \\ (\mathrm{mA}) \\ \hline \end{gathered}$ | VCE <br> MAX <br> (V) | $\begin{gathered} (\mathrm{sect}) \\ \hline \\ \hline(\mathrm{mA}) \\ \hline \end{gathered}$ | Mfo 1 kHz MIN | $\begin{gathered} \mathrm{f} \\ \mathrm{MIN} \\ (\mathrm{MHz}) \end{gathered}$ |
| $\begin{aligned} & \text { 2N3960 } \\ & \text { 2N3962 } \\ & \text { 2N3963 } \\ & \text { 2N3964 } \end{aligned}$ | NPN PNP PNP PNP | $\begin{aligned} & S W \\ & G P \\ & G P \\ & G P \end{aligned}$ | 2N3962 <br> 2N3963 <br> 2N3964 | $\begin{aligned} & 400 \\ & 360 \\ & 360 \\ & 360 \end{aligned}$ | $\begin{aligned} & 20 \\ & 60 \\ & 80 \\ & 45 \end{aligned}$ | $\begin{aligned} & 12 \\ & 60 \\ & 80 \\ & 45 \end{aligned}$ | $\begin{array}{r} 40-200 \\ 100-300 \\ 100-300 \\ 250-500 \end{array}$ | $\begin{aligned} & 10 \\ & .01 \\ & .01 \\ & .01 \end{aligned}$ | $\begin{array}{r} .3 \\ .25 \\ .25 \\ .25 \end{array}$ | 30 10 10 10 | $\begin{aligned} & 100 \\ & 100 \\ & 250 \end{aligned}$ | 1.6 G 40 40 50 |
| $\begin{aligned} & \text { 2N3965 } \\ & \text { 2N3966 } \\ & \text { 2N3967 } \\ & \text { 2N3968 } \end{aligned}$ | $\left\lvert\, \begin{aligned} & \mathrm{PNP} \\ & \mathrm{NCH} \\ & \mathrm{NCH} \\ & \mathrm{NCH} \end{aligned}\right.$ | $\begin{aligned} & \mathrm{GP} \\ & \mathrm{FE} \\ & \mathrm{FE} \\ & \mathrm{FE} \end{aligned}$ | $\begin{aligned} & \text { 2N3965 } \\ & \text { 2N3966 } \\ & \text { 2N3822 } \\ & \text { 2N3822 } \end{aligned}$ | 360 60 60 $250-500$ <br> SEE FET INTERCHANGEABHITY LIST    <br> SEE FET INTERCHANGEABILITY LIST <br> SEE FET NTERCHANGEABILITY LIST |  |  |  |  | . 25 | 10 | 250 | 50 |
| $\begin{aligned} & \text { 2N3969 } \\ & \text { 2N3970 } \\ & \text { 2N3971 } \\ & \text { 2N3972 } \end{aligned}$ | NCH NCH NCH NCH | $\begin{aligned} & \text { FE } \\ & \text { FE } \\ & \text { FE } \\ & \text { FE } \end{aligned}$ | $\begin{aligned} & \text { 2N3821 } \\ & \text { 2N3970 } \\ & \text { 2N3971 } \\ & \text { 2N3972 } \end{aligned}$ | SEE FET INTERCHANGEABILITY LIST SEE FET INTERCHANGEABILLTY LIST SEE FET INTERCHANGEABILITY LIST SEE FET INTERCHANGEABILITY LIST |  |  |  |  |  |  |  |  |
| $\begin{aligned} & \text { 2N3973 } \\ & \text { 2N3974 } \\ & \text { 2N3975 } \\ & \text { 2N3976 } \end{aligned}$ | NPN <br> NPN <br> NPN <br> NPN | $\begin{aligned} & s w \\ & s w \\ & s w \\ & s w \end{aligned}$ | TIS 133 <br> TIS133 <br> TIS133 <br> TIS 133 | $\begin{aligned} & 360 \\ & 360 \\ & 360 \\ & 360 \end{aligned}$ | 60 60 60 60 | 30 30 30 30 | $\begin{aligned} & 35-100 \\ & 55-200 \\ & 35-100 \\ & 55-200 \end{aligned}$ | $\begin{aligned} & 10 \\ & 10 \\ & 10 \\ & 10 \end{aligned}$ | .3 .3 .3 .3 | 150 150 150 150 |  | 200 200 200 200 |
| $\begin{aligned} & \text { 2N3977 } \\ & \text { 2N3978 } \\ & \text { 2N3979 } \\ & \text { 2N3980 } \end{aligned}$ | PNP PNP PNP P-N | SW SW SW UJ | $\begin{aligned} & \text { 2N2944 } \\ & \text { 2N2944 } \\ & \text { 2N2944 } \\ & \text { 2N3980 } \end{aligned}$ | $\begin{aligned} & 400 \\ & 400 \\ & 400 \end{aligned}$ <br> SEE UNI | $\begin{aligned} & 15 \\ & 25 \\ & 40 \end{aligned}$ <br> JUNCTIO | $\begin{aligned} & 10 \\ & 20 \\ & 35 \end{aligned}$ <br> N INTERCI | $\begin{aligned} & 40- \\ & 30- \\ & 20- \end{aligned}$ <br> ANGEABILITY | $\begin{array}{r} 5 \\ 5 \\ 5 \\ \text { LIST } \quad \end{array}$ | .1 .15 .15 | 5 |  | 1 1 1 |
| $\begin{aligned} & \text { 2N3981 } \\ & \text { 2N3982 } \\ & \text { 2N3983 } \\ & \text { 2N3984 } \end{aligned}$ | NPN <br> NPN <br> NPN <br> NPN | $\begin{aligned} & \text { GP } \\ & \text { GP } \\ & \text { RF } \\ & \text { RF } \end{aligned}$ | $\begin{aligned} & \text { 2N2219 } \\ & \text { 2N2218 } \\ & \text { TIS62 } \\ & \text { TIS63 } \end{aligned}$ | 800 800 200 200 | 60 50 30 30 | 30 20 12 12 | $30-120$ $40-140$ $30-$ $20-$ | 150 150 4 4 | . 4 | 150 150 |  | 250 250 500 400 |
| 2N3985 <br> 2N3993 <br> 2N3994 <br> 2N4006 | NPN PCH PCH PNP | RF <br> FE <br> FE <br> SW | TIS64 <br> 2N3993 <br> 2N3994 <br> 2N2944A | 200 30 12 $20-$ <br> SEE FET INTERCHANGEABILITY LIST    <br> SEE FET    <br> INTERCHANGEABILITY LIST    <br> 400 10 6  |  |  |  |  |  |  | 40 | 300 20 |
| 2N4007 <br> 2N4008 <br> 2N4009 <br> 2N4010 | PNP PNP PNP PNP | $\begin{aligned} & s w \\ & s w \\ & s w \\ & s w \end{aligned}$ | $\begin{aligned} & \text { 2N2945A } \\ & \text { 2N2946A } \end{aligned}$ | 400 400 400 400 | 20 35 10 20 | 15 30 6 15 |  |  |  |  | 30 20 40 30 | 15 15 20 15 |
| 2N4011 <br> 2N4013 <br> 2N4014 <br> 2N4015 | PNP <br> NPN <br> NPN <br> PNP | $\begin{aligned} & s w \\ & s w \\ & s w \\ & D U \end{aligned}$ | 2N4O13 <br> 2N4014 <br> 2N3350 | $\begin{aligned} & 400 \\ & 360 \\ & 360 \\ & 400 \end{aligned}$ | 35 60 80 60 | $\begin{aligned} & 30 \\ & 40 \\ & 50 \\ & 60 \end{aligned}$ | $\begin{array}{r} 60-150 \\ 60-150 \\ 135-350 \end{array}$ | $\begin{array}{r} 100 \\ 100 \\ 1 \end{array}$ | . 25 | 50 | $\begin{array}{r} 20 \\ 135 \end{array}$ | 15 <br> 300 <br> 300 <br> 200 |
| 2N4016 <br> 2N4017 <br> 2N4018 <br> 2N4019 | $\begin{array}{\|l} \text { PNP } \\ \text { PNP } \\ \text { PNP } \\ \text { PNP } \end{array}$ | DU <br> DU <br> DU <br> DU | $\begin{aligned} & \text { 2N3350 } \\ & \text { 2N3352 } \\ & \text { 2N3352 } \\ & \text { 2N3350 } \end{aligned}$ | 600 600 400 400 | 60 80 60 45 | 60 80 60 45 | $135-350$ $100-500$ | 1 | . 25 | 50 | 135 100 250 | 200  <br>  40 <br> 7  |

## TRANSISTOR INTERCHANGEABILITY MASTER LIST OF REGISTERED TYPES



## TRANSISTOR INTERCHANGEABILITY MASTER LIST OF REGISTERED TYPES

| TYP NUMEM |  | $\begin{aligned} & 8 \\ & 8 \\ & 8 \\ & 8 \end{aligned}$ | $\begin{gathered} \text { II } \\ \text { RIPMACAMNT } \\ \text { OR NLARMST } \\ \text { COUVALINT } \end{gathered}$ | MAXMMUM RATINOS |  |  | CLCHRLCA CMANACTLESTICS |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  |  |  |  |  | $\mathbf{V}_{\mathbf{C}}(\text { (wat) }$ |  |  |  |
| $\begin{aligned} & \text { 2N4086 } \\ & \text { 2N4087 } \\ & \text { 2N4087A } \\ & \text { 2N408B } \end{aligned}$ | NPN <br> NPN <br> NPN <br> PCH | OP 0 OP FE | 71398 <br> 71597 <br> 71897 <br> 2N3331 | $\begin{gathered} 200 \\ 200 \\ 200 \\ \text { SEE FET } \end{gathered}$ | $\begin{array}{r} 12 \\ 12 \\ 12 \\ \text { NTERCH } \end{array}$ | $\begin{array}{r} 12 \\ 12 \\ 12 \end{array}$ | $\begin{aligned} & 150-300 \\ & 250-500 \\ & 250-500 \\ & \text { TY LIST } \end{aligned}$ | $\begin{aligned} & 2 \\ & 2 \\ & 2 \end{aligned}$ |  |  | $\begin{aligned} & 150 \\ & 250 \\ & 250 \end{aligned}$ |  |
| $\begin{aligned} & \text { 2N4089 } \\ & \text { 2N4090 } \\ & \text { 2N4091 } \\ & \text { 2N4092 } \end{aligned}$ | $\begin{aligned} & \mathrm{PCH} \\ & \mathrm{PCH} \\ & \mathrm{NCH} \\ & \mathrm{NCH} \end{aligned}$ | $\begin{aligned} & \text { FE } \\ & \text { FE } \\ & \text { FE } \\ & \text { FE } \end{aligned}$ | $\begin{aligned} & \text { 2N3330 } \\ & \text { 2N3329 } \\ & \text { 2N4091 } \\ & \text { 2N4092 } \end{aligned}$ | SEE PRT <br> SEE FET <br> SEE FET <br> SEE HET |  | NOEABLIT <br> NGEABLITY <br> NGEABHIT <br> NGEABLLT | $\begin{aligned} & \text { Y LIST } \\ & \text { YY LST } \\ & \text { YY LST } \\ & \text { IY LIS } \end{aligned}$ |  |  |  |  |  |
| $\begin{aligned} & \text { 2N4093 } \\ & \text { 2N4094 } \\ & \text { 2N4095 } \\ & \text { 2N4099 } \end{aligned}$ | $\begin{aligned} & \mathrm{NCH} \\ & \mathrm{NCH} \\ & \mathrm{NCH} \\ & \mathrm{NPN} \end{aligned}$ | F FE <br> FE DU | $\begin{aligned} & \text { 2N4093 } \\ & \text { 2N4856 } \\ & \text { 2N4857 } \end{aligned}$ | $\begin{gathered} \text { SEE PET } \\ \text { SEE PLT } \\ \text { SEE FET } \\ 300 \end{gathered}$ | NTERCH <br> NTERCH <br> NTERCH <br> 53 | NOEABLIT NOEABILT NGEABILIT 55 | Y List <br> Y LIST <br> Y LIST <br> 175. | 1 |  |  |  | 150 |
| 2NA100 <br> 2N4104 <br> 2N4117 <br> 2N4117A | NPN NPN NCH NCH | $\begin{aligned} & \text { DU } \\ & \text { GP } \\ & \text { FE } \\ & \text { FE } \end{aligned}$ | 2N4104 | $\begin{aligned} & 400 \\ & 300 \\ & \text { SEE FEI } \\ & \text { SEE FEI } \end{aligned}$ |  | $\left.\begin{array}{r}35 \\ 60\end{array} \right\rvert\,$ | 175. <br> TY LIST <br> TY LIST | 1 |  |  | 1400 | 150 540 |
| $\begin{aligned} & \text { 2N4117A } \\ & \text { 2N4118 } \\ & 2 N 4119 \\ & 2 N 4120 \end{aligned}$ | $\begin{aligned} & \mathrm{NCH} \\ & \mathrm{NCH} \\ & \mathrm{NCH} \\ & \mathrm{PCH} \end{aligned}$ | $\begin{aligned} & \mathrm{FE} \\ & \mathrm{FE} \\ & \mathrm{FE} \\ & \mathrm{FE} \\ & \mathrm{FE} \end{aligned}$ | 3N174 | SEE FET <br> SEE FE <br> SEE PE <br> SEE FE | NTERC NTERC NTERC NTERCH | NGEABILI NGEABLIT NGEABILI NGEABILIT | TIST TY LIST TY LIST TY LIST |  |  |  |  |  |
| 2N4120A <br> 2N4121 <br> 2N4122 <br> 2N4123 | PCH <br> PNP <br> PNP <br> NPN | FE <br> GP <br> GP <br> SW | A5T2907 <br> A5T2907 <br> 2N4123 | $\begin{gathered} \text { SEE FE1 } \\ 200 \\ 200 \\ 310 \end{gathered}$ | $\begin{aligned} & \text { VTERC1 } \\ & 40 \\ & 40 \\ & 40 \end{aligned}$ | $\begin{aligned} & \text { NGEABILI } \\ & 40 \\ & 40 \\ & 30 \end{aligned}$ | $\begin{array}{\|l} \text { TY LIST } \\ 70-200 \\ 150-300 \\ 50-150 \end{array}$ | $\begin{array}{r} 10 \\ 10 \\ 2 \end{array}$ | $\begin{array}{r} .14 \\ .3 \end{array}$ | $\begin{aligned} & 10 \\ & 50 \end{aligned}$ | 50 | 450 250 |
| 2NA124 <br> 2N4125 <br> 2N4126 <br> 2N4134 | NPN <br> PNP <br> PNP <br> NPN | SW <br> SW <br> SW <br> RF | 2N4124 <br> 2N4125 <br> 2N4126 <br> 2N4252 | $\begin{aligned} & 310 \\ & 310 \\ & 310 \\ & 200 \end{aligned}$ | $\begin{aligned} & 40 \\ & 30 \\ & 25 \\ & 30 \end{aligned}$ | $\begin{aligned} & 30 \\ & 30 \\ & \mathbf{2 5} \\ & \mathbf{3 0} \end{aligned}$ | 120-300 50-150 120-360 | 2 2 2 | .3 .4 .4 | $\begin{aligned} & 50 \\ & 50 \\ & 50 \end{aligned}$ | $\begin{array}{r} 120 \\ 50 \\ 120 \\ 200 \end{array}$ | 300 200 250 350 |
| 2N4135 <br> 2N4138 <br> 2N4139 <br> 2N4140 | NPN NPN NCH NPN | RF <br> SW <br> FE <br> GP | 2N4252 <br> 2N4138 <br> 2N3458 <br> TIS 110 | $\begin{gathered} 200 \\ 300 \\ \text { SEE FE1 } \\ 210 \end{gathered}$ | $\begin{gathered} 30 \\ 30 \\ \text { NTERCH } \\ 60 \end{gathered}$ | $\begin{gathered} 30 \\ 30 \\ \text { NNGEABILI } \\ 30 \end{gathered}$ | $\begin{aligned} & 50- \\ & \text { iTY LIST } \\ & 40-120 \end{aligned}$ | $\begin{array}{r} 1 \\ 150 \end{array}$ | . 4 | 150 | 200 | 425 20 250 |
| 2N4141 <br> 2N4142 <br> 2N4143 <br> 2N4207 | NPN PNP PNP PNP | GP GP GP SW | A.5T2222 <br> A.5T2907 <br> AST2907 | $\begin{aligned} & 200 \\ & 200 \\ & 200 \\ & 300 \end{aligned}$ | $\begin{array}{r} 60 \\ 60 \\ 60 \\ 6 \end{array}$ | 30 40 40 6 | $\begin{array}{r} 100-300 \\ 40-120 \\ 100-300 \\ 50-120 \end{array}$ | $\begin{array}{r} 150 \\ 150 \\ 150 \\ 10 \end{array}$ | . 4 | $\begin{aligned} & 150 \\ & 150 \\ & 150 \end{aligned}$ |  | 250 200 200 650 |
| $\begin{aligned} & \text { 2N4208 } \\ & \text { 2N4209 } \\ & \text { 2N4220 } \\ & \text { 2N4220A } \end{aligned}$ | $\begin{array}{\|l} \text { PNP } \\ \text { PNP } \\ \mathrm{NCH} \\ \mathrm{NCH} \end{array}$ | SW <br> SW <br> FE <br> FE | 2N4220 | $\begin{gathered} 300 \\ 300 \\ \text { SEE FE } \\ \text { SEEEE } \end{gathered}$ |  | $\begin{gathered} 12 \\ 15 \\ \text { ANGEABILI } \\ \text { ANGEABILI } \end{gathered}$ | $\begin{array}{r} 30.120 \\ 50-120 \end{array}$ <br> ITY LIST ITY LIST | $\begin{aligned} & 10 \\ & 10 \end{aligned}$ |  |  |  | 700 850 |

## TRANSISTOR INTERCHANGEABILITY MASTER LIST OF REGISTERED TYPES



| TYPE NUMEER |  | $\begin{aligned} & 3 \\ & \frac{8}{8} \\ & 8 \\ & \frac{5}{4} \\ & 8 \end{aligned}$ | TIREPLACEMENTOR NEARESTECUYMALENT | MAXIMUM RATINOS |  |  | EAECTRICAL CHARAGTEMSTICS |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  | $\begin{gathered} P_{T} \\ T_{A}=25^{\circ} \mathrm{C} \\ { }^{{ }^{\circ}{ }^{\prime} \mathrm{C}=25^{\circ} \mathrm{C}} \\ (\mathrm{~mW}) \end{gathered}$ | Veno <br> (V) | VCEO <br> (V) | her | $\begin{gathered} c \\ (\mathrm{~mA}) \end{gathered}$ |  | set (mA) | $\left\lvert\, \begin{gathered} \mathrm{h}_{\mathrm{f}} \\ 6 \\ 1 \mathrm{kdz} \\ \text { MAN } \end{gathered}\right.$ | Min |
| $\begin{aligned} & 2 N 4343 \\ & 2 N 4351 \\ & 2 N 4352 \\ & 2 N 4353 \end{aligned}$ | $\begin{aligned} & \mathrm{PCH} \\ & \mathrm{NCH} \\ & \mathrm{NCH} \\ & \mathrm{PCH} \end{aligned}$ | $\begin{aligned} & \mathrm{FE} \\ & \mathrm{FE} \\ & \mathrm{FE} \\ & \mathrm{FE} \\ & \mathrm{FE} \end{aligned}$ | 2N3993 <br> 3N169 <br> 3N160 <br> 3N161 | SEE FET INTERCHANGEABILITY LIST SEE FET MTERCHANGEABBLTY LIST SEE FET INTERCHANGEABILITY LIST SEE FET INTERCHANGEABILTTY LIST |  |  |  |  |  |  |  |  |
| 2N4354 <br> 2N4355 <br> 2N4356 <br> 2N4357 |  | $\begin{aligned} & G P \\ & G P \\ & G P \\ & G P \end{aligned}$ | AST2907 A5T2907 AST2907 | $\begin{aligned} & 350 \\ & 350 \\ & 350 \\ & 400 \end{aligned}$ | $\begin{array}{r} 60 \\ 60 \\ 80 \\ 240 \end{array}$ | $\begin{array}{r} 60 \\ 60 \\ 60 \\ 240 \end{array}$ | $\begin{array}{r} 50-500 \\ 100-400 \\ 50-250 \\ 80-300 \end{array}$ | $\begin{aligned} & 10 \\ & 10 \\ & 10 \\ & 10 \end{aligned}$ | 1 1 1 .5 | $\begin{aligned} & 1 A \\ & 1 A \\ & 1 A \\ & 10 \end{aligned}$ | 100 | $\begin{array}{r} 100 \\ 100 \\ 100 \\ 40 \end{array}$ |
| $\begin{aligned} & 2 \mathrm{~N} 4358 \\ & 2 \mathrm{~N} 4359 \\ & 2 \mathrm{~N} 4360 \\ & 2 \mathrm{~N} 4381 \end{aligned}$ | $\begin{aligned} & \text { PNP } \\ & \text { PNP } \\ & \text { PCH } \\ & \text { PCH } \end{aligned}$ | $\begin{aligned} & \text { GP } \\ & \text { GP } \\ & \text { FE } \\ & \text { FE } \end{aligned}$ | $\begin{aligned} & \text { 2N3798 } \\ & \text { A5T5462 } \end{aligned}$ | SEE FET INTERCHANGEABILITY LIST SEE FET INTERCHANGEABILITY LIST |  |  |  |  | . 5 | 10 10 | $\begin{array}{r} 100 \\ 50 \end{array}$ | 40 |
| $\begin{aligned} & \text { 2N4382 } \\ & 2 N 4383 \\ & 2 \mathrm{~N} 4384 \\ & 2 \mathrm{~N} 4385 \end{aligned}$ | PCH <br> NPN <br> NPN <br> NPN | FE <br> GP <br> GP <br> GP | 2N2484 | $\begin{array}{ccc}\text { SEE FET INTERCHANGEABLL } \\ \mathbf{8 0 0} & 40 & 30 \\ 500 & 40 & 30 \\ 800 & 40 & 30\end{array}$ |  |  | $\begin{aligned} & \text { TY LIST } \\ & 100-500 \\ & 100-500 \\ & 40-500 \end{aligned}$ | .01 .01 .01 | .2 .2 .2 | $\begin{aligned} & 10 \\ & 10 \\ & 10 \end{aligned}$ | $\begin{aligned} & 100 \\ & 100 \\ & 100 \end{aligned}$ | 30 30 30 |
| $\begin{aligned} & \text { 2N4386 } \\ & \text { 2N4389 } \\ & \text { 2N4390 } \\ & \text { 2N4391 } \end{aligned}$ | NPN PNP NPN NCH | GP SW GP FE | 2N2483 <br> 2N4423 <br> 2N3114 <br> 2N4391 | $\begin{gathered} 500 \\ 200 \\ 500 \\ \text { SEE FET } \end{gathered}$ | $\begin{array}{r} 40 \\ 12 \\ 120 \\ \text { INTERCH } \end{array}$ | $\begin{array}{r} 30 \\ 12 \\ 120 \\ \text { NGEABIL } \end{array}$ | $\begin{aligned} & 40-500 \\ & 30-180 \\ & 20- \\ & \text { TY LIST } \end{aligned}$ | .01 10 2 | .2 .15 .3 | 10 10 20 | 100 | 30 50 |
| $\left\lvert\, \begin{aligned} & \text { 2N4392 } \\ & \text { 2N4393 } \\ & \text { 2N } 4397 \\ & 2 N 4400 \end{aligned}\right.$ | NCH <br> NCH <br> NPN <br> NPN | FE <br> FE <br> RF <br> SW | 2N4392 <br> 2N4393 <br> 2N4252 <br> TSS 110 | SEE FET INTERCHANGEABILITY LIST SEE FET INTERCHANGEABILITY LIST |  |  |  |  | . 4 | 150 | 40 20 | 600 200 |
| 2 N 4 Cl <br> 2 N 4402 <br> 2N4403 <br> 2 N 404 | NPN PNP PNP PNP | sw <br> SW <br> SW <br> GP | TISIII AST2907 A.5T2907 | $\begin{array}{r} 310 \\ 310 \\ 310 \\ +5 W \end{array}$ | $\begin{aligned} & 60 \\ & 40 \\ & 40 \\ & 80 \end{aligned}$ | $\begin{aligned} & 40 \\ & 40 \\ & 40 \\ & 80 \end{aligned}$ | $\begin{array}{r} 100-300 \\ 50-150 \\ 100-300 \\ 40-120 \end{array}$ | $\begin{aligned} & 150 \\ & 150 \\ & 150 \\ & 150 \end{aligned}$ | $\begin{array}{r} .4 \\ .4 \\ .4 \\ .15 \end{array}$ | $\begin{array}{r} 150 \\ 150 \\ 150 \\ 10 \end{array}$ | 40 30 60 | 250 150 200 200 |
| 2N4405 <br> 2N406 <br> 2N4407 <br> 2N4409 | PNP <br> PNP <br> PNP <br> NPN | $\begin{aligned} & G P \\ & G P \\ & G P \\ & G P \end{aligned}$ | 2N4409 | $\begin{array}{r} 4 \mathrm{~W} \\ +5 \mathrm{~W} \\ +5 \mathrm{~W} \\ 310 \end{array}$ | 80 80 80 80 | 80 80 80 50 | $\begin{array}{r} 100-300 \\ 30-100 \\ 80-250 \\ 60-400 \end{array}$ | 150 500 500 1 | 15 .2 .2 .2 | 10 150 150 1 |  | 200 150 150 60 |
| 2N4A10 <br> 2N4411 <br> 2N4412 <br> 2N4412A | NPN PNP PNP PNP | GP <br> RF <br> GP <br> GP | 2N4410 | $\begin{aligned} & 310 \\ & 150 \\ & 600 \\ & 600 \end{aligned}$ | $\begin{array}{r} 120 \\ 15 \\ 40 \\ 60 \end{array}$ | $\begin{aligned} & 80 \\ & 12 \\ & 30 \\ & 60 \end{aligned}$ | $\begin{aligned} & 60-400 \\ & 40- \\ & 100-500 \\ & 100-500 \end{aligned}$ | $\begin{array}{r} 1 \\ .5 \\ .01 \\ .01 \end{array}$ | $\begin{aligned} & .2 \\ & .2 \\ & .2 \end{aligned}$ | $\begin{array}{r} 1 \\ 10 \\ 10 \end{array}$ | 120 120 | 60 400 20 20 |
| 2 NA 413 <br> 2N443A <br> 2 N 4414 <br> 2N4414A | $\begin{array}{\|l\|l\|} \text { PNP } \\ \text { PNP } \\ \text { PNP } \\ \text { PNP } \end{array}$ | GP <br> GP <br> GP <br> GP | $\begin{aligned} & \text { 2N3964 } \\ & \text { 2N3965 } \end{aligned}$ | $\begin{aligned} & 400 \\ & 400 \\ & 600 \\ & 600 \end{aligned}$ | $\begin{aligned} & 40 \\ & 60 \\ & 40 \\ & 60 \end{aligned}$ | $\begin{aligned} & 30 \\ & 60 \\ & 30 \\ & 60 \end{aligned}$ | $\begin{array}{r} 100-500 \\ 100-500 \\ 40-500 \\ 40-500 \end{array}$ | .01 <br> .01 <br> .01 <br> .01 | .2 .2 .2 .2 | $\begin{aligned} & 10 \\ & 10 \\ & 10 \\ & 10 \end{aligned}$ | 120 120 120 120 | 20 20 20 20 |



## TRANSISTOR INTERCHANGEABILITY MASTER LIST OF REGISTERED TYPES

|  | $E$38 | $\begin{aligned} & \mathbf{z} \\ & 0 \\ & 8 \\ & 8 \\ & 8 \\ & 8 \end{aligned}$ | $\begin{aligned} & \text { TI } \\ & \text { REPLACEMENT } \\ & \text { OR NEAREST } \\ & \text { EQUVALENT } \end{aligned}$ | MAXIMUM RATINOS |  |  | EECTRICAL CHARACTEIUSIICS |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| TYPE Numben |  |  |  | $\begin{array}{ccc} \hline P_{T} & & \\ T_{A}=25^{\circ} \mathrm{C} & V_{C=O} & V_{C E O} \\ { }^{{ }^{\circ} \mathrm{T} C=25^{\circ} \mathrm{C}} & & \\ (\mathrm{~mW}) & \text { (V) } & \text { (V) } \\ \hline \end{array}$ |  |  | $\qquad$ | $\begin{gathered} k c \\ (\mathrm{~mA}) \end{gathered}$ |  | $\begin{aligned} & \mathrm{nel}) \\ & \mathrm{k} \\ & (\mathrm{~mA}) \end{aligned}$ | $\begin{gathered} h_{f 0} \\ 1 \mathrm{kdzz} \\ \text { MiN } \end{gathered}$ |  |
| 2N4859A <br> 2N4860 <br> 2N4860A <br> 2N4861 | $\begin{aligned} & \mathrm{NCH} \\ & \mathrm{NCH} \\ & \mathrm{NCH} \\ & \mathrm{NCH} \end{aligned}$ | $\begin{array}{\|l\|} \mathbf{F E} \\ \text { FE } \\ \hline \mathbf{F E} \\ \mathbf{F E} \end{array}$ | $\begin{aligned} & \text { 2N4859A } \\ & \text { 2N4860 } \\ & \text { 2N4860A } \\ & \text { 2N486) } \end{aligned}$ | SEE FET INTERCHANGEABLLTY LIST <br> SEE FET INTERCHANGEABILTY UST <br> SEE FET NTERCHANGEABILTY UST <br> SEE FET NTERCHANGEABHITY LIST |  |  |  |  |  |  |  |  |
| 2N4861A <br> 2N4867 <br> 2N4868 <br> 2NA869 | $\begin{aligned} & \mathrm{NCH} \\ & \mathrm{NCH} \\ & \mathrm{NCH} \\ & \mathrm{NCH} \end{aligned}$ | $\begin{aligned} & \text { FE } \\ & \text { FE } \\ & F E \\ & \text { FE } \end{aligned}$ | 2N4861A | SEE FET INTERCHANGEABLITY LIST SEE FET NTERCHANGEABLLTY LIST SEE FET INTERCHANGEABILTY UST SEE FET INTERCHANGEABLLTY LIST |  |  |  |  |  |  |  |  |
| $\begin{aligned} & \text { 2N4870 } \\ & \text { 2N4871 } \\ & \text { 2N4872 } \\ & \text { 2N4873 } \end{aligned}$ | P-N P-N PNP NPN | $\begin{aligned} & \text { UJ } \\ & \text { UJ } \\ & \text { SW } \\ & \text { SW } \end{aligned}$ | 2N4891 <br> 2N4891 | SEE UNUUNCTION INTERCHANGEABILTTY LIST SEE UNIJUNCTION INTERCHANGEABILITY LIST |  |  |  |  | .13 .2 | 1 10 |  | 900 900 |
| $\begin{aligned} & \text { 2N4874 } \\ & \text { 2N4875 } \\ & \text { 2N4876 } \\ & \text { 2N4878 } \end{aligned}$ | NPN <br> NPN <br> NPN <br> NPN | $\begin{aligned} & \text { RF } \\ & \text { RF } \\ & \text { RF } \\ & \text { DU } \end{aligned}$ | 2N4874 <br> 2N4875 <br> 2N4876 | 720 720 720 300 | 30 40 40 60 | 20 25 30 60 | 200-600 | . 01 | . 35 | 1 | 200 200 200 | 900 800 650 200 |
| $\begin{aligned} & \text { 2N4879 } \\ & \text { 2N4880 } \\ & \text { 2N4881 } \\ & \text { 2N4882 } \end{aligned}$ | NPN <br> NPN <br> NCH <br> NCH | DU <br> DU <br> FE <br> FE | 2N6449 <br> 2N6449 | SEE FET INTERCHANGEABILITY LIST SEE FET INTERCHANGEABELITY LIST |  |  |  |  | . 35 | $\begin{aligned} & 1 \\ & 1 \end{aligned}$ |  | 150 150 |
| 2N4883 <br> 2N4884 <br> 2N4885 <br> 2N4886 | NCH <br> NCH <br> NCH <br> NCH | FE <br> FE <br> FE <br> FE | 2N6450 <br> 2N6450 <br> 2N6450 <br> 2N6450 | SEE FET INTERCHANGEABHLTY LIST SEE FET INTERCHANGEABILLTY LIST SEE FET INTERCHANGEABIETY LIST SEE FET NTERCHANGEABLITY LIST |  |  |  |  |  |  |  |  |
| 2N4888 <br> 2N4889 <br> 2N4890 <br> 2N4891 | $\begin{aligned} & \text { PNP } \\ & \text { PNP } \\ & \text { PNP } \\ & \text { P-N } \end{aligned}$ | GP <br> GP <br> GP <br> UJ | A5T5401 <br> A5T5401 <br> 2N2905 <br> 2N4891 | $\begin{gathered} 300 \\ 300 \\ \text { IW } \\ \text { SEE UN } \end{gathered}$ | $\begin{array}{r} 150 \\ 150 \\ 60 \\ \text { UUNCTIO } \end{array}$ | $\begin{array}{r} 150 \\ 150 \\ 40 \end{array}$ <br> N INTERCH | $\begin{aligned} & 30- \\ & 70 . \\ & 50-250 \end{aligned}$ <br> HANGEABLITY | $\begin{array}{r} 1 \\ 1 \\ 150 \\ \hline \end{array}$ | .5 .5 1.4 | 10 10 150 |  | 30 40 100 |
| 2N4892 <br> 2N4893 <br> 2N4894 <br> 2N4916 | $\begin{aligned} & \text { P-N } \\ & P-N \\ & P-N \\ & \text { PNP } \end{aligned}$ | $\begin{aligned} & \text { UJ } \\ & \text { UJ } \\ & \text { UJ } \\ & \text { GP } \end{aligned}$ | 2N4892 <br> 2N4893 <br> 2N4894 <br> A5T3905 | SEE UNLUUNCTION INTERCHANGEABILITY LIST <br> SEE UNUUNCTION INTERCHANGEABLITY LIST SEE UNIUUNCTION INTERCHANGEABILITY LIST |  |  |  |  | . 14 | 10 |  | 400 |
| 2 N 4917 <br> 2N4924 <br> 2N4925 <br> 2N4926 | PNP <br> NPN <br> NPN <br> NPN | GP GP GP GP | A5T3906 <br> 2N3114 <br> 2N3114 <br> 2N5059 | $\begin{aligned} & 200 \\ & 10 \\ & \text { iw } \\ & \text { iw } \end{aligned}$ | $\begin{array}{r} 30 \\ 100 \\ 150 \\ 200 \end{array}$ | $\begin{array}{r} 30 \\ 100 \\ 150 \\ 200 \end{array}$ | $\begin{array}{r} 150-300 \\ 40-200 \\ 40-200 \\ 20-200 \end{array}$ | 10 150 150 30 | .14 .4 .4 2 | 10 50 50 30 | 25 | 450 <br> 100 <br> 100 <br> 30 |
| $\begin{aligned} & \text { 2N4927 } \\ & \text { 2N492B } \\ & \text { 2N4929 } \\ & \text { 2N4930 } \end{aligned}$ | NPN PNP PNP PNP | GP GP GP GP | $\begin{aligned} & \text { 2N5059 } \\ & \text { 2N3634 } \\ & \text { 2N3634 } \end{aligned}$ | $\begin{aligned} & 1 W \\ & 600 \\ & 600 \\ & 600 \end{aligned}$ | $\begin{aligned} & 250 \\ & 100 \\ & 150 \\ & 200 \end{aligned}$ | 250 100 150 200 | $\begin{aligned} & 20-200 \\ & 25-200 \\ & 25-200 \\ & 20-200 \end{aligned}$ | 30 10 10 10 | 2 .5 .5 5 | 30 10 10 10 | 25 | 30 <br> 100 <br> 100 <br> 20 |

## TRANSISTOR INTERCHANGEABILITY MASTER LIST OF REGISTERED TYPES



TRANSISTOR INTERCHANGEABILITY
MASTER LIST OF REGISTERED TYPES

| TYPENUMBER |  | $\begin{aligned} & z \\ & \frac{z}{8} \\ & \frac{8}{3} \\ & 3 \\ & 3 \end{aligned}$ | $\begin{gathered} \text { TI } \\ \text { REPLACEMENT } \\ \text { OR NEAREST } \\ \text { EOUVALENT } \end{gathered}$ | MAXINUM RATINES |  |  | ELECTRICAL CHARACTERISTICS |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  | $\begin{gathered} \mathrm{P}_{\mathrm{T}} \\ \mathrm{~T}_{A}=25^{\circ} \mathrm{C} \\ { }^{\circ} \mathrm{T}_{\mathrm{C}}=25^{\circ} \mathrm{C} \\ (\mathrm{~mW}) \\ \hline \end{gathered}$ | VCBO <br> (V) | - Vceo <br> (V) | $\begin{aligned} & \text { hre } \\ & \hline \operatorname{MiN} \operatorname{Max} \end{aligned}$ | $\begin{gathered} \mathrm{k} \\ (\mathrm{~mA}) \\ \hline \end{gathered}$ | $\mathbf{V C E}$ <br> MaX <br> (V) | $\begin{aligned} & \text { (sot) } \\ & \hline 6 \mathrm{IC} \\ & \text { (mA) } \\ & \hline \end{aligned}$ | $\begin{array}{\|c\|} \hline \mathrm{h}_{\mathrm{fe}} \\ \hline 1 \mathrm{kftz} \\ \mathrm{MiN} \\ \hline \end{array}$ |  |
| 2N4979 <br> 2N4980 <br> 2N4981 <br> 2N4982 | $\begin{array}{\|l} \mathrm{NCH} \\ \text { PNP } \\ \text { PNP } \\ \text { PNP } \end{array}$ | FE SW SW SW | 2N2946A | SEE FET INTERCHANGEABILITY LIST |  |  |  |  |  |  |  | 10 5 3 |
| 2N4994 <br> 2 N 4995 <br> 2N4996 <br> 2N4997 | $\begin{aligned} & \text { NPN } \\ & \text { NPN } \\ & \text { NPN } \\ & \text { NPN } \end{aligned}$ | $\begin{aligned} & \text { RF } \\ & \hline R F \\ & \text { RF } \\ & \text { RF } \end{aligned}$ | 2N4994 <br> 2N4995 <br> 2N4996 <br> 2N4997 | 360 360 250 250 | 60 60 30 30 | 45 45 18 18 | $40-160$ $100-400$ 50 30 | 10 10 2 2 |  |  |  | $\begin{aligned} & 200 \\ & 200 \\ & 600 \\ & 600 \end{aligned}$ |
| $\begin{aligned} & \text { 2N5010 } \\ & \text { 2N5011 } \\ & \text { 2N5012 } \\ & \text { 2N5013 } \end{aligned}$ | NPN NPN NPN NPN | $\begin{aligned} & G P \\ & G P \\ & G P \\ & G P \end{aligned}$ |  | *2W *2W *2W *2W | $\begin{aligned} & 500 \\ & 600 \\ & 700 \\ & 800 \end{aligned}$ |  | $30-180$ $30-180$ $30-180$ $30-180$ | 25 25 25 20 | 1.4 1.5 1.6 1.6 | $\begin{aligned} & 25 \\ & 25 \\ & 25 \\ & 20 \end{aligned}$ |  |  |
| $\begin{aligned} & \text { 2N5014 } \\ & \text { 2N5015 } \\ & \text { 2N5018 } \\ & \text { 2N5019 } \end{aligned}$ | NPN NPN PCH PCH | GP <br> GP <br> FE <br> FE | 2N3993 | $\begin{aligned} & \cdot 2 W \\ & \cdot 2 W \end{aligned}$ <br> SEE FET <br> SEE FET | $\begin{gathered} 900 \\ 1 \mathrm{~K} \\ \text { INTERCH } \\ \text { INTERCH } \end{gathered}$ | ANGEABLL ANGEABIL | $\begin{aligned} & 30-180 \\ & 30-180 \end{aligned}$ <br> TY LIST Y LIST | 20 | 1.6 1.8 | 20 20 |  |  |
| $\begin{aligned} & \text { 2N5020 } \\ & \text { 2N5021 } \\ & \text { 2N5022 } \\ & \text { 2N5023 } \end{aligned}$ | $\begin{aligned} & \text { PCH } \\ & \text { PCH } \\ & \text { PNP } \\ & \text { PNP } \end{aligned}$ | FE <br> FE <br> SW <br> SW |  | SEE FET <br> SEE FET <br> 1W <br> iW | $\begin{gathered} \text { INTERCH. } \\ \text { INTERCH } \\ 50 \\ 30 \end{gathered}$ | ANGEABIL ANGEABIL <br> 50 30 | $\begin{aligned} & \text { TY LIST } \\ & \text { TY LIST } \\ & 25-100 \\ & 40-100 \end{aligned}$ | $\begin{aligned} & 500 \\ & 500 \end{aligned}$ | .2 .17 | 100 100 |  |  |
| $\begin{aligned} & \text { 2N5024 } \\ & \text { 2N5027 } \\ & \text { 2N5028 } \\ & \text { 2N5029 } \end{aligned}$ | NPN <br> NPN <br> NPN <br> NPN | RF SW SW SW | 2N3570 | $\begin{aligned} & 200 \\ & \mathbf{3 2 0} \\ & \mathbf{3 2 0} \\ & 320 \end{aligned}$ | $20$ | $\begin{aligned} & 10 \\ & 30 \\ & 30 \\ & 15 \end{aligned}$ | $\begin{aligned} & 25- \\ & 50-150 \\ & 100-300 \\ & 40-120 \end{aligned}$ | $\begin{array}{r} 10 \\ 150 \\ 150 \\ 10 \end{array}$ | .45 .45 .25 | $\begin{array}{r} 150 \\ 150 \\ 10 \end{array}$ | 13 | 13 C |
| $\begin{aligned} & \text { 2N5030 } \\ & \text { 2N5031 } \\ & \text { 2N5032 } \\ & \text { 2N5033 } \end{aligned}$ | NPN <br> NPN <br> NPN <br> PCH | SW <br> RF <br> RF <br> FE | $\begin{aligned} & \text { 2N3571 } \\ & \text { 2N3571 } \\ & \text { A5T5460 } \end{aligned}$ | $\begin{gathered} 320 \\ 200 \\ 200 \\ \text { SEE FET } \end{gathered}$ |  | $\begin{array}{r} 12 \\ 10 \\ 10 \\ \text { HANGEABILI } \end{array}$ | $\begin{array}{\|l} 30 \\ 25-300 \\ 25-300 \\ \text { TY LIST } \end{array}$ | 10 1 1 | . 25 | 10 |  |  |
| 2N5040 <br> 2N5041 <br> 2N5042 <br> 2N5045 | $\begin{aligned} & \text { PNP } \\ & \text { PNP } \\ & \text { PNP } \\ & \text { NCH } \end{aligned}$ | GP GP GP FE | A5T4026 <br> A5T4026 <br> 2N4030 <br> 2N5045 | $\begin{gathered} 300 \\ 300 \\ 800 \\ \text { SEE FET } \end{gathered}$ | $\begin{gathered} 25 \\ 40 \\ 40 \\ \text { INTERCH } \end{gathered}$ | $\begin{array}{r} 25 \\ 40 \\ 40 \end{array}$ <br> IANGEABIL | $30$ $40-150$ $40-150$ <br> TY LIST | 150 150 150 | 1 .5 1.1 | 500 500 500 |  | 80 100 100 |
| $\begin{aligned} & \text { 2N5046 } \\ & \text { 2N5047 } \\ & \text { 2N5053 } \\ & \text { 2N5054 } \end{aligned}$ | NCH <br> NCH <br> NPN <br> NPN | $\begin{aligned} & \mathrm{FE} \\ & \hline \mathbf{F E} \\ & \text { RF } \\ & \mathbf{R F} \end{aligned}$ | $\begin{aligned} & \text { 2N5046 } \\ & \text { 2N5047 } \\ & \text { 2N3572 } \\ & \text { 2N3572 } \end{aligned}$ | $\begin{gathered} \text { SEE FET } \\ \text { SEE FET } \\ 200 \\ 200 \end{gathered}$ | $\begin{gathered} \text { INTERCH } \\ \text { INTERCH } \\ 30 \\ 30 \end{gathered}$ | ANGEABIL ANGEABIL 15 15 | $\begin{aligned} & \text { TY LIST } \\ & \text { TY LIST } \\ & \begin{array}{r} 25-150 \\ 25-150 \end{array} \end{aligned}$ | $\begin{aligned} & 2 \\ & 2 \end{aligned}$ | - | , |  | 13 C 13 C |
| $\begin{aligned} & \text { 2N5055 } \\ & \text { 2N5056 } \\ & \text { 2N5057 } \\ & \text { 2N5058 } \end{aligned}$ | $\begin{aligned} & \text { PNP } \\ & \text { PNNP } \\ & \text { PNP } \\ & \text { NPN } \end{aligned}$ | $\begin{aligned} & S W \\ & S W \\ & S W \\ & G P \end{aligned}$ | 2N4423 <br> 2N3829 <br> 2N3829 <br> 2N5058 | $\begin{aligned} & 200 \\ & 360 \\ & 360 \\ & 1 W \end{aligned}$ | $\begin{array}{r} 12 \\ 15 \\ 15 \\ 300 \end{array}$ | 12 15 15 300 | $\begin{aligned} & 30-100 \\ & 30-100 \\ & 40-100 \\ & 35-150 \end{aligned}$ | 30 30 30 30 | .19 .13 .13 | $\begin{array}{r} 30 \\ \times \quad 1 \\ \times \quad 1 \end{array}$ |  | 550 |

## TRANSISTOR INTERCHANGEABILITY MASTER LIST OF REGISTERED TYPES

| nymer |  |  |  | maximum ratines |  |  | Elctical chatactindics |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  | $\begin{array}{\|ccc} \hline P_{T} & & \\ T_{A}=25^{\circ} \mathrm{C} & v_{C 20} & v_{C=O} \\ { }^{*} T_{C}=25^{\circ} \mathrm{C} & & \\ (\mathrm{~mW}) & \text { (V) } & \text { (V) } \\ \hline \end{array}$ |  |  | $h_{\text {F }}$ |  | $\mathbf{V C l}_{\text {(mat) }}$ |  | $\left\{\begin{array}{l} \mathrm{m}_{10} \\ 1 \mathrm{kdz} \\ \mathrm{miN} \end{array}\right.$ | $\begin{gathered} \text { tT } \\ \text { MiN } \\ \text { (Mhz) } \end{gathered}$ |
|  |  |  |  |  |  |  | $\min \max$ | $\begin{gathered} \mathrm{IC} \\ (\mathrm{~mA}) \end{gathered}$ | $\begin{array}{\|l\|} \hline \max \\ \text { (V) } \\ \hline \end{array}$ | $\begin{aligned} & \quad \mathrm{C} \\ & (\mathrm{ma}) \end{aligned}$ |  |  |
| $\begin{aligned} & \text { 2N5059 } \\ & \text { 2N5060 } \\ & \text { 2N5061 } \\ & \text { 2N5062 } \end{aligned}$ | NPN | $\begin{aligned} & G P \\ & C R \\ & C R \\ & C R \\ & C R \end{aligned}$ | 2N5059 2N5060 2N5061 2N5062 | SCR - SEE POWER DATA BOO SCR - SEE POWER DATA BOO SCR - SEE POWER DATA BOO |  |  | $30-150$ | $30$ |  |  |  |  |
| $\begin{aligned} & \text { 2N5063 } \\ & \text { 2N5064 } \\ & \text { 2NS5065 } \\ & \text { 2N5066 } \end{aligned}$ | $\begin{array}{\|l\|l\|} \hline N P N \\ \text { NFN } \end{array}$ | $\begin{aligned} & C R \\ & C R \\ & \mathrm{SW} \\ & \mathrm{SW} \end{aligned}$ | 2N5063 <br> 2N5064 <br> 2N2432A | $\begin{gathered} \text { SCR }- \text { SI } \\ \text { SR }-31 \\ 600 \\ 400 \\ \hline \end{gathered}$ | SCR - SEE POWER DATA BOOK SCR - SEE POWER DATA BOOK |  |  | 300 | . 23 | 100 |  | 550 5 |
| $\left\lvert\, \begin{aligned} & \text { 2N5078 } \\ & \text { 2N5079 } \\ & \text { 2N50e0 } \\ & \text { 2N50e1 } \end{aligned}\right.$ | $\begin{array}{\|l\|l\|} \hline N C H \\ \text { NPN } \\ \text { NPN } \\ \text { NPN } \end{array}$ | FE <br> GP <br> GP <br> OP | 2N4416 2N956 2N2484 | $\begin{gathered} \text { SEE FET } \\ 400 \\ 400 \\ 360 \end{gathered}$ | $\begin{gathered} \text { NTERCMA } \\ 60 \\ 60 \\ 70 \end{gathered}$ | $\begin{gathered} \text { NGEABL } \\ 30 \\ 30 \\ 50 \end{gathered}$ | $\begin{aligned} & \text { Tr ust } \\ & 100-300 \\ & 200-500 \\ & 100-400 \end{aligned}$ | $\begin{array}{r} 150 \\ 150 \\ 1 \end{array}$ | .2 .2 .2 | $\begin{array}{r} 150 \\ 150 \\ 10 \end{array}$ | 100 | 400 500 600 |
| 2N5082 2NS086 2N5087 2NS03 |  | GP <br> GP <br> GP <br> GP | $\begin{aligned} & \text { 2N2484 } \\ & \text { 2N5086 } \\ & \text { 2N5007 } \\ & \text { Tis94 } \end{aligned}$ | $\begin{aligned} & 360 \\ & 310 \\ & 310 \\ & 310 \end{aligned}$ | $\begin{aligned} & 60 \\ & 50 \\ & 50 \\ & 35 \end{aligned}$ | $\begin{aligned} & 30 \\ & 50 \\ & 50 \\ & 30 \end{aligned}$ | $100-400$ <br> 150.500 <br> 250-800 <br> $300-900$ | $\begin{aligned} & 1 \\ & .1 \\ & .1 \\ & .1 \end{aligned}$ | $\begin{aligned} & .2 \\ & .3 \\ & .3 \\ & .3 \end{aligned}$ | 10 10 10 10 | $\begin{aligned} & 100 \\ & 150 \\ & 250 \\ & 350 \end{aligned}$ | 600 40 40 50 |
| 2N5089 2N5103 2N5104 2NS105 | NPN <br> NCH <br> NCH <br> NCH | $\begin{aligned} & \mathrm{GP} \\ & \mathrm{FE} \\ & \mathrm{FE} \\ & \mathrm{FE} \\ & \hline \end{aligned}$ | T1594 <br> 2N4:16 | SEE PLT INTERCHANGEABMITY LIST sei fet interchangeamuty ust SEE FET INTERCHANGEAMUTY LST |  |  |  |  | . 5 | 10 | 450 | 50 |
| 2NS106 2NS107 2NSI14 2N5115 | NPN <br> NPN <br> NPN <br> PCH <br> PCH | $\begin{aligned} & \mathbf{G P} \\ & \mathbf{G P} \\ & \mathbf{F E} \\ & \mathbf{F E} \\ & \hline \end{aligned}$ |  | $\begin{aligned} & 800 \\ & 360 \\ & \text { SEE FET } \\ & \text { SEE FET } \end{aligned}$ | SEE FET INTERCHANGEABHITY LIST SEE FET INTERCHANGEABMUTY UST |  |  | $\begin{aligned} & 150 \\ & 150 \end{aligned}$ | $\begin{array}{\|l} .22 \\ .22 \end{array}$ | $\begin{aligned} & 150 \\ & 150 \end{aligned}$ |  | 250 250 |
| 2N5116 2N5117 2NS118 2N5119 | $\begin{aligned} & \mathrm{PCH} \\ & \mathrm{PNP} \\ & \mathrm{PNP} \\ & \mathrm{PNP} \end{aligned}$ | $\begin{aligned} & \text { FE } \\ & \text { DU } \\ & \text { DU } \\ & \text { DU } \end{aligned}$ |  | $\begin{gathered} \text { SEE FET } \\ 400 \\ 400 \\ 400 \end{gathered}$ | NTERCHA 45 45 45 | MGEABH 45 45 45 |  | $\begin{aligned} & .01 \\ & .01 \\ & .01 \end{aligned}$ |  |  |  | 100 100 100 |
| 2N5120 2N5121 2N5122 | $\begin{aligned} & \text { PNP } \\ & \text { PNP } \\ & \text { PNP } \\ & \text { PNP } \end{aligned}$ | $\begin{aligned} & \text { DU } \\ & \text { DU } \\ & \text { DU } \\ & \text { DU } \end{aligned}$ |  | $\begin{aligned} & 300 \\ & 300 \\ & 300 \\ & 400 \end{aligned}$ | $\begin{aligned} & 45 \\ & 45 \\ & 45 \\ & 45 \end{aligned}$ | $\begin{aligned} & 45 \\ & 45 \\ & 45 \\ & 45 \end{aligned}$ | $\begin{array}{r} 100-300 \\ 100-300 \\ 50-800 \\ 100-300 \end{array}$ | $\begin{aligned} & .01 \\ & .01 \\ & .01 \\ & .01 \end{aligned}$ |  |  |  | 100 100 100 100 |
| 2N5124 2N5123 2NS126 2N5127 |  | $\begin{aligned} & \mathrm{DU} \\ & \mathrm{DU} \\ & \mathrm{RF} \\ & \mathrm{RF} \\ & \hline \end{aligned}$ | $\begin{aligned} & \mathrm{Tis98} \\ & \mathrm{TS9} \mathrm{\%} \end{aligned}$ | $\begin{aligned} & 400 \\ & 400 \\ & 200 \\ & 200 \end{aligned}$ | $\begin{aligned} & 45 \\ & 45 \\ & 20 \\ & 20 \end{aligned}$ | $\begin{aligned} & 45 \\ & 45 \\ & 20 \\ & 12 \end{aligned}$ | $\begin{array}{r} 100-300 \\ 50-800 \\ 20-350 \\ 15-300 \end{array}$ | $\begin{array}{r} .01 \\ .01 \\ 4 \\ 2 \end{array}$ | $\begin{aligned} & 2 \\ & .3 \end{aligned}$ | $\begin{aligned} & 10 \\ & 10 \end{aligned}$ |  | 100 100 300 150 |
| 2NS128 2N5129 2N5130 2N5131 | NPN NPN NPN NWN | $\begin{aligned} & \text { RF } \\ & \text { RF } \\ & \text { RF } \\ & \text { GP } \end{aligned}$ | 2N5451 <br> 2N5451 <br> 2N5451 <br> 71598 | $\begin{aligned} & 300 \\ & 200 \\ & 200 \\ & 200 \end{aligned}$ | $\begin{aligned} & 15 \\ & 15 \\ & 30 \\ & 20 \end{aligned}$ | $\begin{aligned} & 12 \\ & 12 \\ & 12 \\ & 15 \end{aligned}$ | $\begin{aligned} & 35-350 \\ & 35-350 \\ & 15-250 \\ & 30-500 \end{aligned}$ | $\begin{array}{r} 50 \\ 50 \\ 8 \\ 10 \end{array}$ | .25 .25 .6 1 | $\begin{array}{r} 150 \\ 150 \\ 10 \\ 10 \end{array}$ |  | 200 200 450 100 |

TRANSISTOR INTERCHANGEABILITY
MASTER LIST OF REGISTERED TYPES

| TYP: NUMEER |  | $\begin{aligned} & 8 \\ & \frac{8}{2} \\ & 8 \\ & 8 \\ & 8 \end{aligned}$ |  | MAXIMUM RATINOS |  |  | EPCRICAL CHANACTERISTICS |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  | $\begin{gathered} T_{A}=25^{\circ} \mathrm{C} \\ { }^{\circ} \mathrm{T}_{\mathrm{C}}=25^{\circ} \mathrm{C} \\ (\mathrm{~mW}) \end{gathered}$ | $V_{C E O}$ | Veso <br> (V) |  | $\begin{gathered} C C \\ (m A) \end{gathered}$ | max <br> (V) | sail) (ma | $\begin{gathered} h_{0} \\ 1 \mathrm{kdtz} \\ \text { MiN } \end{gathered}$ | fit |
| 2N5132 <br> 2N5133 <br> 2N5134 <br> 2N5135 | NPN NPN NPN NPN | Rf <br> SW <br> GP | 2N5451 <br> AST3708 <br> A5T3903 <br> AST3708 | 200 200 200 300 | 20 20 20 30 | 20 18 10 25 | $\begin{aligned} & 30-400 \\ & 60-1000 \\ & 60-150 \\ & 50-600 \end{aligned}$ | 10 1 10 10 | 2 .4 .25 1 | 10 1 10 100 |  | 200 40 250 40 |
| 2N5136 <br> 2N5137 <br> 2N5138 <br> 2N5139 | $\begin{aligned} & \text { NPN } \\ & \text { NPN } \\ & \text { PNP } \\ & \text { PNP } \end{aligned}$ | $\begin{aligned} & G P \\ & G P \\ & G P \\ & S W \end{aligned}$ | 2N5451 <br> 2N5451 <br> A5T4058 <br> A5T4126 | $\begin{aligned} & 300 \\ & 220 \\ & 200 \\ & 200 \end{aligned}$ | 30 30 30 20 | 20 20 30 20 | $\begin{aligned} & 20-400 \\ & 20-400 \\ & 50-800 \\ & 40 . \end{aligned}$ | 150 150 .1 10 | .25 .25 .3 .2 | 150 150 10 10 |  | 40 40 30 300 |
| $\begin{aligned} & \text { 2N5140 } \\ & \text { 2N5141 } \\ & \text { 2N5142 } \\ & \text { 2N5143 } \end{aligned}$ | $\begin{aligned} & \text { PNP } \\ & \text { PNP } \\ & \text { PNP } \\ & \text { PNP } \end{aligned}$ | $\begin{aligned} & s w \\ & s w \\ & s w \\ & s w \end{aligned}$ | 2N4423 <br> A.5T3644 <br> A.5T3644 | 200 200 300 200 | 5 6 20 20 | 5 6 20 20 | $\begin{aligned} & 20-140 \\ & 25- \\ & 30- \\ & 30- \end{aligned}$ | 10 10 50 50 | .2 .2 .5 .5 | 10 10 50 50 |  | 400 300 100 100 |
| 2N5144 <br> 2N5145 <br> 2N5158 <br> 2N5159 | $\left\lvert\, \begin{aligned} & \text { NPN } \\ & \text { NPN } \\ & \text { NCH } \\ & \text { NCH } \end{aligned}\right.$ | $\begin{aligned} & \mathrm{SW} \\ & \mathrm{SW} \\ & \mathrm{FE} \\ & \mathrm{FE} \end{aligned}$ |  | $\begin{aligned} & 360 \\ & 800 \end{aligned}$ <br> SEE FET SEE FET |  | 30 30 NGEABILIT NGEABLIT | $\begin{array}{r} 60-150 \\ 60-150 \\ \text { TY LIST } \\ \text { TY LIST } \end{array}$ | $\begin{aligned} & 100 \\ & 100 \end{aligned}$ | . 2 | 100 100 |  | 300 300 |
| $\begin{aligned} & \text { 2N5163 } \\ & \text { 2N5172 } \\ & \text { 2NSi74 } \\ & \text { 2N5175 } \end{aligned}$ | $\begin{aligned} & \text { NCH } \\ & \text { NPN } \\ & \text { NPN } \\ & \text { NPN } \end{aligned}$ |  | $\begin{aligned} & \text { 2N5246 } \\ & \text { ATT5172 } \\ & \text { 2N5550 } \\ & \text { 2N5550 } \end{aligned}$ | $\begin{gathered} \text { SEE FET } \\ 360 \\ 360 \\ 200 \end{gathered}$ | $\begin{gathered} \text { NTERCHA } \\ 25 \\ 90 \\ 130 \end{gathered}$ | $\begin{gathered} \text { NGEABH } \\ 25 \\ 75 \\ 100 \end{gathered}$ | $\begin{array}{\|l} \hline \text { TY LIST } \\ 100-500 \\ 40-600 \\ 55-160 \end{array}$ | $\begin{aligned} & 10 \\ & 10 \\ & 10 \end{aligned}$ | $\begin{aligned} & .25 \\ & .95 \\ & .95 \end{aligned}$ | $\begin{aligned} & 10 \\ & 10 \\ & 10 \end{aligned}$ | $\begin{array}{r} 100 \\ 40 \\ 35 \end{array}$ |  |
| $\begin{aligned} & \text { 2N5176 } \\ & \text { 2N5179 } \\ & \text { 2N5180 } \\ & \text { 2N5181 } \end{aligned}$ | $\begin{aligned} & \mathbf{N P N} \\ & \mathbf{N P N} \\ & \mathbf{N P N} \\ & \mathbf{N P N} \end{aligned}$ | $\begin{aligned} & \mathbf{G P} \\ & R F \\ & R F \\ & R F \end{aligned}$ | $\begin{aligned} & \text { 2N5550 } \\ & \text { 2N3572 } \\ & \text { 2N3572 } \end{aligned}$ | 200 200 180 180 | 130 20 30 45 | 100 12 15 | $140-300$ $25-250$ $20-200$ 27. | 10 3 2 1 | .95 .4 | 10 10 | 140 25 | 900 650 400 |
| $\begin{aligned} & \text { 2N5182 } \\ & \text { 2N5183 } \\ & \text { 2N5184 } \\ & \text { 2N5185 } \end{aligned}$ | NPN NPN NPN NPN | RF <br> GP <br> GP <br> GP | $\begin{aligned} & \text { 2N956 } \\ & \text { 2N5059 } \end{aligned}$ | 180 500 500 $1 W$ | 35 18 | 18 120 120 | 27 75 10 10 | 1 10 50 50 |  |  | 70 | 400 62 50 |
| $\begin{array}{\|l} \text { 2N5186 } \\ \text { 2N5187 } \\ \text { 2NS188 } \\ \text { 2N5189 } \end{array}$ | NPN NPN NPN NPN | $\begin{aligned} & \text { sw } \\ & \text { sw } \\ & \text { sw } \\ & \text { sw } \end{aligned}$ | $\begin{aligned} & \text { 2N2537 } \\ & \text { 2N3724 } \end{aligned}$ | 300 <br> 1W <br> 800 <br> IW | 10 25 60 60 |  | 25. $30-$ $25-$ 15. | 10 10 150 14 | .3 .25 .5 1 | $\begin{array}{r} 10 \\ 10 \\ 150 \\ 14 \end{array}$ |  |  |
| $\begin{aligned} & \text { 2N5196 } \\ & \text { 2NS197 } \\ & \text { 2NS198 } \\ & \text { 2N5199 } \end{aligned}$ | NCH <br> NCH <br> NCH <br> NCH | FE <br> FE <br> FE <br> FE | $\begin{aligned} & \text { 2N5545 } \\ & \text { 2N5546 } \\ & \text { 2N5547 } \end{aligned}$ | SEE FET <br> SEE FET <br> SEE FET <br> SEE FET | NTERCH <br> NTERCH <br> NTERCH <br> NTERCH | ANGEABIL <br> angeabilit <br> aNGEABIL <br> ANGEABIL | TY LIST <br> TY LIST <br> ITY LIST <br> ITY LIST |  |  |  |  |  |
| $\begin{aligned} & \text { 2N5200 } \\ & \text { 2N5201 } \\ & \text { 2N5208 } \\ & \text { 2N5209 } \end{aligned}$ | NPN <br> NPN <br> PNP <br> NPM | GP <br> GP <br> RF <br> GP | 2N5209 | $\begin{aligned} & 300 \\ & 300 \\ & 310 \\ & 310 \end{aligned}$ | $\begin{aligned} & 20 \\ & 20 \\ & 30 \\ & 50 \end{aligned}$ | $\begin{aligned} & 20 \\ & 20 \\ & 25 \\ & 50 \end{aligned}$ | $\begin{array}{r} 50-150 \\ 75-150 \\ 20-120 \\ 100-300 \end{array}$ | $\begin{array}{r} 10 \\ 10 \\ 2 \\ .1 \end{array}$ | $\begin{aligned} & .5 \\ & .5 \\ & .7 \end{aligned}$ | $\begin{array}{r} 50 \\ 50 \\ 10 \end{array}$ | 150 | 900 1.16 300 30 |

## TRANSISTOR INTERCHANGEABILITY MASTER LIST OF REGISTERED TYPES

| TYP Numanix |  |  |  | MAXLMUM RATMEOS |  |  | ELECTICAL CHARACTERISTICS |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  | $\begin{gathered} \mathrm{P}_{\mathrm{T}} \\ \mathrm{~T}_{\mathrm{A}}=25^{\circ} \mathrm{C} \\ { }^{{ }^{\circ} \mathrm{T}_{\mathrm{C}}=25^{\circ} \mathrm{C}} \\ (\mathrm{~mW}) \end{gathered}$ | Vceo(V) | Veso <br> (V) | $h_{\text {Fere }}$ |  | Ven(uat) |  | $\begin{gathered} \text { hos } \\ 1 \mathrm{kdta} \\ \text { ANM } \end{gathered}$ | 4 <br> MIN <br> (MM3) |
|  |  |  |  |  |  |  | MIN MAXIC <br> $(\mathrm{mA})$ |  | $\begin{array}{\|lll\|} \hline \operatorname{MAX} & \mathrm{IC} \\ \mathrm{IV}) & \text { (mA) } \\ \hline \end{array}$ |  |  |  |
| 2 N 210 | NPN | GP | 2N5210 | 310 | 50 | 50 | 200-600 . 1 |  | . 710 |  | 250 | 30 |
| 2N5219 | NPN | GP | 2N5219 | 310 | 20 | 15 | $35-500$ | 2 | . 4 | 10 | 35 | 150 |
| 2N5220 | NPN | GP | 2N5220 | 310 | 15 | 15 | 30-600 50 |  | . 5150 |  | 30 | 100100 |
| 2N5221 | PNP | $G P$ | 2N522 1 | 310 | 15 | 15 | 30-600 | 50 | . 5 | 150 | 30 |  |
| $\begin{aligned} & \text { 2N5222 } \\ & \text { 2N5223 } \\ & \text { 2N5224 } \\ & \text { 2N5225 } \end{aligned}$ | $\begin{aligned} & \text { NPN } \\ & \text { NPN } \\ & \text { NPN } \\ & \text { NPN } \end{aligned}$ | $\left\lvert\, \begin{aligned} & R F \\ & G P \\ & S W \\ & O P \end{aligned}\right.$ | $\begin{aligned} & \text { 2N5222 } \\ & \text { 2N5223 } \\ & \text { 2N3903 } \\ & \text { 2N522S } \end{aligned}$ | $\begin{aligned} & 310 \\ & 310 \\ & 310 \\ & 310 \end{aligned}$ | $\begin{aligned} & 20 \\ & 25 \\ & 25 \\ & 25 \end{aligned}$ | $\begin{aligned} & 15 \\ & 20 \\ & 12 \\ & 25 \end{aligned}$ | $\begin{aligned} & 50-1500 \\ & 50-800 \\ & 40-400 \\ & 30-600 \end{aligned}$ | 421050 | $\begin{array}{r} 1 \\ .7 \\ .35 \\ .8 \end{array}$ | 4 | $\begin{aligned} & 20 \\ & 50 \\ & 30 \end{aligned}$ | $\begin{array}{r} 450 \\ 150 \\ 250 \\ 50 \end{array}$ |
|  |  |  |  |  |  |  |  |  |  | 10 |  |  |
|  |  |  |  |  |  |  |  |  |  | 10 |  |  |
|  |  |  |  |  |  |  |  |  |  | 100 |  |  |
| $\begin{aligned} & \text { 2N5226 } \\ & \text { 2N5227 } \\ & \text { 2N5228 } \\ & \text { 2N5230 } \end{aligned}$ | $\begin{aligned} & \text { PNP } \\ & \text { PNP } \\ & \text { PNP } \\ & \text { PNP } \end{aligned}$ | $\left\lvert\, \begin{aligned} & G P \\ & G P \\ & S W \\ & S W \end{aligned}\right.$ | $\begin{aligned} & \text { 2N5226 } \\ & \text { 2N5227 } \\ & \text { 2N2945A } \end{aligned}$ | $\begin{aligned} & 310 \\ & 310 \\ & 310 \\ & 400 \end{aligned}$ | $\begin{array}{r} 25 \\ 30 \\ 5 \\ 30 \end{array}$ | $\begin{array}{r} 25 \\ 30 \\ 5 \\ 20 \end{array}$ | $\begin{aligned} & 30-600 \\ & 50-700 \\ & 30- \\ & 50- \end{aligned}$ | $\begin{array}{r} 50 \\ 2 \\ 10 \\ .1 \end{array}$ | $\begin{array}{rr}.8 & 100 \\ .4 & 10 \\ .4 & 10\end{array}$ |  | $\begin{aligned} & 30 \\ & 50 \end{aligned}$ | $\begin{array}{r} 50 \\ 100 \\ 300 \end{array}$ |
|  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |
| $\begin{aligned} & \text { 2N5231 } \\ & \text { 2N5232 } \\ & \text { 2N5232A } \\ & \text { 2N5233 } \end{aligned}$ | PNP <br> NPN <br> NPN <br> NPN | $\begin{aligned} & S W \\ & G P \\ & G P \\ & G P \end{aligned}$ | 2N2940A <br> T1895 <br> TIS95 <br> TIS95 | $\begin{aligned} & 400 \\ & 360 \\ & 360 \\ & 330 \end{aligned}$ | $\begin{aligned} & 50 \\ & 70 \\ & 70 \\ & 80 \end{aligned}$ | $\begin{aligned} & 30 \\ & 50 \\ & 50 \\ & 60 \end{aligned}$ | $\begin{aligned} & 50- \\ & 250-500 \\ & 250-500 \\ & 100-300 \end{aligned}$ | $\begin{array}{r} .1 \\ 2 \\ 2 \\ 10 \end{array}$ | $\begin{aligned} & .125 \\ & .125 \\ & .125 \end{aligned}$ |  | $\begin{aligned} & 250 \\ & 250 \\ & 100 \end{aligned}$ |  |
|  |  |  |  |  |  |  |  |  |  | 10 |  |  |
|  |  |  |  |  |  |  |  |  |  | 10 |  |  |
|  |  |  |  |  |  |  |  |  |  | 10 |  |  |
| $\begin{aligned} & \text { 2N5234 } \\ & \text { 2N5235 } \\ & \text { 2N5236 } \\ & \text { 2N5242 } \end{aligned}$ | NPN <br> NPN <br> NPN <br> PNP | $\begin{aligned} & G P \\ & G P \\ & \text { RF } \\ & S W \end{aligned}$ | 71594 | 330 | 80 | 60 | $250-500$ | 10 | . 125 | 10 | $\begin{aligned} & 250 \\ & 400 \end{aligned}$ | $\begin{aligned} & 500 \\ & 170 \end{aligned}$ |
|  |  |  |  | 330 | 80 | 60 | 400-800 | 10 | . 125 | 10 |  |  |
|  |  |  |  | 600 | 40 | 20 | 30.120 | 50 | . 2 | 50 |  |  |
|  |  |  |  | 500 | 20 |  | 25-100 | 500 | . 2 | 100 |  |  |
| $\begin{aligned} & \text { 2N5243 } \\ & \text { 2N5244 } \\ & \text { 2N5246 } \\ & \text { 2N5246 } \end{aligned}$ | $\begin{array}{\|l\|l} \text { PNP } \\ \text { PNP } \\ \text { NCH } \\ \text { NCH } \end{array}$ | SW <br> SW <br> FE <br> FE | $\begin{aligned} & \text { 2N5245 } \\ & \text { 2N5246 } \end{aligned}$ | 50030 |  |  | $\begin{aligned} & 25-100 \\ & 150-300 \\ & \text { uSt } \\ & \text { UST } \end{aligned}$ | $\begin{array}{r} 500 \\ 10 \end{array}$ | . 212 | $\begin{array}{r} 100 \\ 10 \end{array}$ |  | $\begin{aligned} & 170 \\ & 450 \end{aligned}$ |
|  |  |  |  | 360 |  | 40 |  |  |  |  |  |  |
|  |  |  |  | SEE FET INTERCHANGEAELLTY LST <br> SEE FET INTERCHANGEABLITY UST |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| $\begin{aligned} & \text { 2N5247 } \\ & \text { 2N5248 } \\ & \text { 2N5249 } \\ & \text { 2N5249A } \end{aligned}$ | $\begin{aligned} & \mathrm{NCH} \\ & \mathrm{NCH} \\ & \mathrm{NPN} \\ & \mathrm{NPN} \end{aligned}$ | FE <br> FE <br> GP <br> GP | $\begin{aligned} & \text { 2N5247 } \\ & \text { 2N5248 } \\ & \text { T1594 } \\ & \text { TiS94 } \end{aligned}$ | SEE FET INTERCHANGEABHLTY LIST SEE PET INTERCHANGEABLLTY LIST |  |  |  |  | .125 10 <br> .125 10 |  | $\begin{aligned} & 400 \\ & 400 \end{aligned}$ |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  | 360 | 70 | 50 | 400-800 | 2 |  |  |  |  |  |
|  |  |  |  | 360 | 70 | 50 | 400-800 | 2 |  |  |  |  |  |
| $\begin{aligned} & \text { 2N5252 } \\ & \text { 2N5253 } \\ & \text { 2N5262 } \\ & \text { 2N5265 } \end{aligned}$ | $\begin{aligned} & \text { NPN } \\ & \text { NPN } \\ & \text { NPN } \\ & \text { PCH } \end{aligned}$ | $\begin{aligned} & G P \\ & G P \\ & G P \\ & \text { GP } \\ & \text { FE } \end{aligned}$ | 2N5058 | ${ }^{*} 7 \mathrm{w}$ | 300 | 300 | 40.120 | 100 | $\begin{array}{rr} 1 & 200 \\ 1 & 200 \\ .8 & 14 \end{array}$ |  |  | 30 30 |
|  |  |  |  | $\begin{gathered} * W \\ \text { IW } \end{gathered}$ | 30075 | 300 | 80-25035- | 100100 |  |  | 30 |  |
|  |  |  |  |  |  | 50 |  |  | $.8 \quad 14$ |  |  |  |
|  |  |  |  | SEE FET INTERCHANGEABLITY LIST |  |  |  |  |  |  |  |  |  |
| $\begin{array}{\|l\|} \hline \text { 2N5266 } \\ \text { 2N5267 } \\ \text { 2N5268 } \\ \text { 2N5269 } \end{array}$ | $\begin{aligned} & \mathrm{PCH} \\ & \mathrm{PCH} \\ & \mathrm{PCH} \\ & \mathrm{PCH} \end{aligned}$ | $\begin{aligned} & \text { FE } \\ & \text { FE } \\ & \text { FE } \\ & \text { FE } \end{aligned}$ |  | SEE FET INTERCHANGEABILTTY LIST SEE FET INTERCHANGEABLITY LIST SEE FET INTERCHANGEABILTY LIST SEE FET INTERCHANGEABILTTY LIST |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 2N5270 | PCH <br> NPN <br> NPN <br> NCH | $\begin{aligned} & \text { FE } \\ & \text { SW } \\ & \text { SW } \\ & \text { FE } \end{aligned}$ |  | SEE FET INTERCHANGEARHL |  |  | Y LIST |  | $\begin{array}{rrr}.25 & 10 \\ .2 & 20\end{array}$ |  |  |  |
| 2N5272 |  |  |  | 360 | 40 | 20 | 100-400 | 10 |  |  |  | 500 |
| 2N5276 |  |  |  | 360 | 25 | 15 | 30-90 | 1 |  |  |  | 600 |
| 2N5277 |  |  |  | SEE PET INTERCHANGEABHITY LIST |  |  |  |  |  |  |  |  |

## TRANSISTOR INTERCHANGEABILITY <br> MASTER LIST OF REGISTERED TYPES



## TRANSISTOR INTERCHANGEABILITY <br> MASTER LIST OF REGISTERED TYPES

| TYPE NUMBER |  | $\begin{aligned} & Z \\ & \frac{8}{2} \\ & \frac{3}{3} \\ & \frac{1}{Z} \\ & \frac{4}{4} \end{aligned}$ | $\begin{gathered} \text { II } \\ \text { REPACEMENT } \\ \text { OR NEAREST } \\ \text { ECUNAIENT } \end{gathered}$ | MAXIMUM RATMVES |  |  | EECTRICAL CHARACTERISTICS |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  | $\begin{gathered} \mathrm{PT} \\ \mathrm{~T}_{\mathrm{A}}=25^{\circ} \mathrm{C} \\ { }^{\circ} \mathrm{T}_{\mathrm{C}}=25^{\circ} \mathrm{C} \\ (\mathrm{~mW}) \end{gathered}$ | VCBO <br> (V) | $\mathbf{V}_{\mathrm{CEO}}$(V) | $h_{\text {Pre }}$ |  | VCE(sot) |  | $\begin{gathered} h_{f_{0}} \\ 1 \\ 1 \mathrm{kftz} \\ \text { MiN } \end{gathered}$ | $\begin{gathered} \text { fit } \\ \text { Min } \\ \text { (MHz) } \end{gathered}$ |
|  |  |  |  |  |  |  | MiN MA | $\begin{gathered} C \\ (\mathrm{~mA}) \end{gathered}$ | $\begin{aligned} & \text { MaX } \\ & (V) \end{aligned}$ | $\begin{array}{r} \mathrm{L} \\ (\mathrm{~mA}) \end{array}$ |  |  |
| 2N5380 | NPN | SW | A573903 | 310 | 60 | 40 | 50.150 | 10 | . 2 | 10 |  | 250 |
| 2N5381 | NPN | SW | A573904 | 310 | 60 | 40 | 100-300 | 10 | . 2 | 10 |  | 300 |
| 2N5382 | PNP | SW | A5T3905 | 310 | 40 | 40 | 50.150 | 10 |  | 10 |  | 200 |
| 2N5383 | PNP | SW | A573906 | 310 | 40 | 40 | 100.300 | 10 | . 25 | 10 |  | 250 |
| 2N5391 | NCH | FE | 2N5359 | SEE FET INTERCHANGEABLITY LIST SEE FET INTERCHANGEABLITY LIST SEE FET INTERCHANGEABLLTY LIST SEE FET NTERCHANGEABLLITY LIST |  |  |  |  |  |  |  |  |
| 2N5392 | NCH | FE | 2N5361 |  |  |  |  |  |  |  |  |  |
| 2N5393 | NCH | FE | 2N5362 |  |  |  |  |  |  |  |  |  |
| 2N5394 | NCH | FE | 2N5362 |  |  |  |  |  |  |  |  |  |
| 2N5395 | NCH | FE | 2N5362 | SEE FET INTERCHANGEABUTYY LST SEE FET INTERCHANGEABLITY LIST SEE FET INTERCHANGEABLLTY LIST SEE FET INTERCHANGEABLLTY LIST |  |  |  |  |  |  |  |  |
| 2N5396 | NCH | FE | 2N5363 |  |  |  |  |  |  |  |  |  |
| 2N5397 | NCH | FE | 2N5397 |  |  |  |  |  |  |  |  |  |
| 2N5398 | NCH | FE | 2N5398 |  |  |  |  |  |  |  |  |  |
| 2N5399 | NPN | SW |  | 360 | 25 | 15 |  |  |  |  |  | 600 |
| 2N5400 | PNP | GP | 2N5400 | 310 | 130 | 120 | 40.180 | 10 | . 2 | 10 | 30 | 100 |
| 2N5401 | PNP | GP | 2N5401 | 310 | 160 | 150 | 60-240 | 10 | . 2 | 10 | 40 | 100 |
| 2N5413 | NPN | SW | 2N3724 | IW | 60 | 40 | 25-100 | 24 | . 25 | 150 |  |  |
| 2N5414 | NPN | SW | 2N3725 | 1w |  |  | 25-100 |  | . 25 | 150 |  |  |
| 2N5415 | PNP | GP | 2N3636 | IW | 200 | 200 | 30-1.50 | 50 |  |  |  | 15 |
| 2N5416 | PNP | GP |  | IW | 350 | 300 | 30-120 | 50 |  |  |  | 15 |
| 2N5417 | NPN | SW |  | 500 | 40 | 35 | 80-250 | 150 | . 55 | 150 |  | 250 |
| 2N5418 | NPN | GP | 2N3705 | 400 | 25 |  | 40-120 |  |  |  |  |  |
| 2N5419 | NPN | GP | 2N3704 | 400 | 25 | 25 | 100-300 | 50 | . 25 | 50 |  |  |
| 2N5420 | NPN | GP | 2N3706 | 400 | 25 | 25 | 250-500 | 50 |  | 50 |  |  |
| 2N5431 | P-N | UJ |  | SEE UNIJUNCTION INTERCHANGEABHITY LIST |  |  |  |  |  |  |  |  |
| 2N5432 | NCH | FE |  | SEE FET INTERCHANGEABHLTTY LIST <br> SEE FET INTERCHANGEABHLITY LIST <br> SEE FET INTERCHANGEABILITY LIST |  |  |  |  |  |  |  |  |
| 2N5433 | NCH | FE |  |  |  |  |  |  |  |  |  |  |
| 2N5434 | NCH | FE |  |  |  |  |  |  |  |  |  |  |
| 2N5447 | PNP | GP | 2N5447 |  |  |  |  |  | . 25 | 50 |  | 100 |
| 2N5448 | PNNP | GP | 2N5448 | 360 | 50 | 30 | 30-150 | 50 | . 25 | 50 |  | 100 |
| 2N5449 | NPN | GP | 2N5449 | 360 | 50 | 30 | 100-300 | 50 | . 6 | 100 |  | 100 |
| 2N5450 | NPN | GP | 2N5450 | 360 | 50 | 30 | 50-150 | 50 | . 8 | 100 |  | 100 |
| 2N5451 | NPN | GP | 2N5451 | 360 | 40 | 20 | 30-600 | 50 | 1 | 100 |  | 100 |
| 2N5452 | NCH | FE | 2N5545 | SEE FET INTERCHANGEABLITY LST SEE FET INTERCHANGEablLTY LST SEE FET INTERCHANGEABLITY LIST |  |  |  |  |  |  |  |  |
| 2N5453 | NCH | FE | 2N5545 |  |  |  |  |  |  |  |  |  |
| 2N5454 | NCH | FE | 2N5546 |  |  |  |  |  |  |  |  |  |
| 2N5455 | PNP | SW |  | 340 | 15 | 15 | 30-120 | 30 | . 5 | 300 |  | 450 |
| 2N5456 | PNP | SW |  | 340 | 25 | 25 | 30-120 | 30 | . 55 | 300 |  | 450 |
| 2N5457 | NCH | FE | 2N5953 | SEE FET INTERCHANGEABHITY LIST SEE FET INTERCHANGEABILTTY LIST SEE FET INTERCHANGEABILITY LIST |  |  |  |  |  |  |  |  |
| 2N5458 | NCH | FE | 2N5952 |  |  |  |  |  |  |  |  |  |
| 2N5459 | NCH | FE | 2N5951 |  |  |  |  |  |  |  |  |  |



## TRANSISTOR INTERCHANGEABILITY MASTER LIST OF REGISTERED TYPES

| TYP: mumet | E <br>  | 3$\frac{2}{2}$3333 | TIREPLACEMENTOR MBARESTEOUYALENT | MAXIMUM RATMES |  |  | EECTIUCAL CHARACTERISTICS |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  | $\begin{gathered} \mathrm{T}_{\mathrm{A}}=25^{\circ} \mathrm{C} \\ { }^{\circ} \mathrm{T}_{\mathrm{C}}=25^{\circ} \mathrm{C} \\ (\mathrm{~mW}) \end{gathered}$ | $V_{\text {CBO }}$(V) | $\mathbf{V}_{\mathrm{CEO}}$$(\mathrm{V})$ | hre |  | Vces(ant) |  | $\begin{gathered} h_{0} \\ 1 \mathrm{klts} \\ \text { MiN } \end{gathered}$ | TMN(Mtz) |
|  |  |  |  |  |  |  | MWN Max | - k <br> (mA) | MAX (V) | $\begin{array}{r} \mathrm{IC} \\ (\mathrm{~mA}) \end{array}$ |  |  |
| 2N5550 | NPN | GP | 2N5550 | 310 | 160 | 140 | 60-250 | 10 | . 15 | 10 | 50 | 100 |
| 2N5551 | NPN | GP | 2N5551 | 310 | 180 | 160 | 80.250 | 10 | . 15 | 10 | 50 | 100 |
| 2N5555 | NCH | FE | 2N5949 | SEE FET INTERCHANGEARUTY LIST SEE FET INTERCHANGEAGUTY LIST |  |  |  |  |  |  |  |  |
| 2N5558 | NCH |  |  |  |  |  |  |  |  |  |  |  |
| 2N5556 | NCH | FE | 2N3821 | SEE FET INTERCHANGEABLTY LIST SEE FET INTERCMANGEABUTY LST SEE FET INTERCHANGEABUTTY UST SEE FET INTERCHANGEABLITY LST |  |  |  |  |  |  |  |  |
| 2N5557 | NCH | FE | 2N5361 |  |  |  |  |  |  |  |  |  |
| 2N5561 | NCH | FE |  |  |  |  |  |  |  |  |  |  |
| 2N5562 | NCH | FE | 2N5545 |  |  |  |  |  |  |  |  |  |
| 2N5563 | NCH | FE | 2N5547 | SEE FET INTERCHANGEABMTY UST SEE FET INTERCHANGEABHITY UST SEE FET INTERCHANGEABILTY LST SEE FET INTERCHANGEABLITY LST |  |  |  |  |  |  |  |  |
| 2N5564 | NCH | FE |  |  |  |  |  |  |  |  |  |  |
| 2N5565 | NCH | FE |  |  |  |  |  |  |  |  |  |  |
| 2N15566 | NCH | FE |  |  |  |  |  |  |  |  |  |  |
| 2N5581 | NPN | GP | 2N2221A | *2W | 75 | 40 | 40-120 | 150 | . 3 | 150 |  | 250 |
| 2N5582 | NPN | GP | 2N2222A | *2W | 75 | 40 | 100-300 | 150 |  | 150 |  | 300 |
| 2N5583 | PNNP | RF |  | *5W | 30 | 30 | 25-100 | 100 |  | 100 |  | 1.36 |
| 2N5592 | NCH | FE |  | SEE FET INTERCHANGEABHITY LIST |  |  |  |  |  |  |  |  |
| 2N5593 | NCH | FE |  | see fet interchangeabluty list <br> SEE FET INTERCHANGEABLITY UST <br> SEE FET INTERCHANGEABLITY LST <br> SEE FET INTERCHANGEAELITY LST |  |  |  |  |  |  |  |  |
| 2N5594 | NCH | FE |  |  |  |  |  |  |  |  |  |  |
| 2N5638 | NCH | FE | TIS73 |  |  |  |  |  |  |  |  |  |
| 2N5639 | NCH | FE | T1574 |  |  |  |  |  |  |  |  |  |
| 2N5640 | NCH | FE | T1575 | SEE FET INTERCHANGEABHITY LIST SEE FET INTERCHANGEABLITY LIST SEE FET INTERCHANGEABLITY LIST SEE FET INTERCHANGEABLITY UST |  |  |  |  |  |  |  |  |
| 2N5647 | NCH | FE |  |  |  |  |  |  |  |  |  |  |
| 2N5648 | NCH | FE |  |  |  |  |  |  |  |  |  |  |
| 2N5649 | NCH | FE |  |  |  |  |  |  |  |  |  |  |
| 2N5651 | NPN | RF | 2N3570 |  | 20 | 15 | 30.300 | 3 |  |  |  | 20 |
| 2N5652 | NPN | RF | 2N3570 | 150 | 20 | 15 | 30-300 | 3 |  |  |  | 26 |
| 2N5653 | NCH | \|FE | TIS74 | SEE FET INTERCHANGEABMITY LIST SEE FET INTERCHANGEABLITY LIST |  |  |  |  |  |  |  |  |
| 2N5654 | NCH | \|FE | T1575 |  |  |  |  |  |  |  |  |  |
| 2N5668 | NCH | FE | 2N5953 | SEE FET INTERCHANGEABLITY UST <br> SEE FET INTERCHANGEABLITY LST <br> SEE FET INTERCHANGEABUTY LIST <br> 150 20 15 $30-300$ |  |  |  |  |  |  |  |  |
| 2N5669 | NCH | FE | 2N5952 |  |  |  |  |  |  |  |  |  |
| 2N5670 | NCH | FE | 2N5950 |  |  |  |  |  |  |  |  |  |
| 2N5690 | NPN | RF | 2N3570 |  |  |  |  |  |  |  |  | 20 |
| 2N5716 | NCH | FE |  | SEE FET INTERCHANGEABHLTY LIST SEE FET INTERCHANGEAELLTY UST SEE FET INTERCHANGEARLITY LIST |  |  |  |  |  |  |  |  |
| 2N5717 | NCH | FE |  |  |  |  |  |  |  |  |  |  |
| 2N5718 | NCH | FE | 2N5953 |  |  |  |  |  |  |  |  |  |
| 2N5769 | NPN | SW |  | 625 | 40 | 15 | 40.120 | 10 | . 5 | 10 |  | 500 |
| 2N5770 | NPN | RF | 2N4996 | 625 | 30 | 15 | 20. | 3 | . 4 | 10 |  | 900 |
| 2N5771 | PNP | SW |  | 625 | 15 | 15 | 50.120 | 10 |  | 10 |  | 850 |
| 2N5772 | MPN | SW |  | 625 | 40 | 15 | 30.120 | 30 |  | 30 |  | 350 |
| 2N5777 | NPN | DA |  | 200 | 25 | 25 | 2500. |  |  |  |  |  |

## TRANSISTOR INTERCHANGEABILITY MASTER LIST OF REGISTERED TYPES

|  | $\begin{aligned} & \frac{y}{k} \\ & \frac{1}{6} \\ & \frac{1}{2} \end{aligned}$ | $z$2$\mathbf{3}$$\mathbf{3}$$\frac{1}{2}$33 | n <br> REPLACEMENT OR NEAREST EQUIVALENT | MAXIMUM RATINES |  |  | EECTRICAL CHARACTERISTICS |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| TYPE NUMEER |  |  |  | $\begin{gathered} P_{T} \\ T_{A}=25^{\circ} \mathrm{C} \\ { }^{{ }^{2} T_{C}=25^{\circ} \mathrm{C}} \\ (\mathrm{~mW}) \end{gathered}$ | $V_{C B O}$ <br> (V) | VCEO <br> (V) |  | $\begin{gathered} \mathrm{I} C \\ (\mathrm{~mA}) \end{gathered}$ |  | (sat) (mA) |  |  |
| $\begin{aligned} & \text { 2N5778 } \\ & \text { 2N5779 } \\ & \text { 2N5780 } \\ & \text { 2N5793 } \end{aligned}$ | NPN NPN NPN NPN | $\left\lvert\, \begin{aligned} & D A \\ & D A \\ & D A \\ & D U \end{aligned}\right.$ |  | $\begin{aligned} & 200 \\ & 200 \\ & 200 \\ & 500 \end{aligned}$ | $\begin{aligned} & 40 \\ & 25 \\ & 40 \\ & 75 \end{aligned}$ | $\begin{aligned} & 40 \\ & 25 \\ & 40 \\ & 40 \end{aligned}$ | $\begin{aligned} & 2500 \\ & 5000- \\ & 5000 \\ & 40-120 \end{aligned}$ | $150$ | . 9 | 300 |  |  |
| $\begin{aligned} & \text { 2N5794 } \\ & \text { 2N5795 } \\ & \text { 2N5796 } \\ & \text { 2N5797 } \end{aligned}$ | NPN <br> NPN <br> NPN <br> PCH | $\begin{array}{\|l} D U \\ D U \\ D U \\ F E \end{array}$ |  | $\begin{gathered} 500 \\ 500 \\ 500 \\ \text { SEE FET } \end{gathered}$ | 75 <br> 60 <br> 60 <br> NTERCHA | $\begin{array}{r} 40 \\ 60 \\ 60 \end{array}$ | $\begin{array}{r} 100-300 \\ 40-120 \\ 100-300 \end{array}$ <br> TY UST | 150 150 150 | .9 1.6 1.6 | 300 $\mathbf{5 0 0}$ $\mathbf{5 0 0}$ |  |  |
| 2N5798 <br> 2N5799 <br> 2N5800 <br> 2N5801 | $\begin{aligned} & \mathrm{PCH} \\ & \mathrm{PCH} \\ & \mathrm{PCH} \\ & \mathrm{NCH} \end{aligned}$ | $\begin{aligned} & \text { FE } \\ & \text { FE } \\ & \text { FE } \\ & \text { FE } \end{aligned}$ | 2N4858 | SEE FET <br> SEE FET <br> SEE FET <br> SEE FET | NTERCH <br> NTERCHA <br> NTERCHA <br> NTERCHA | NGEABHIT NGEABILI NGEABILI NGEABHIT | TY LIST <br> TY LIST <br> TY LIST <br> TY LIST |  |  |  |  |  |
| 2N5802 <br> 2N5803 <br> 2N5810 <br> 2N5811 | $\begin{aligned} & \mathrm{NCH} \\ & \mathrm{NCH} \\ & \mathrm{NPN} \\ & \text { PNP } \end{aligned}$ | $\begin{aligned} & \text { FE } \\ & \text { FE } \\ & \text { GP } \\ & \text { GP } \end{aligned}$ | $\begin{aligned} & \text { 2N5549 } \\ & \text { 2N5549 } \\ & \text { A5T2222 } \\ & \text { A5T2907 } \end{aligned}$ | SEE FET SEE FET 500 500 | $\begin{gathered} \text { NTERCHA } \\ \text { NTERCHA } \\ 35 \\ 35 \end{gathered}$ | NGEABHIT NGEABILI 25 25 | $\begin{aligned} & \text { TY LIST } \\ & \text { TY LIST } \\ & \begin{array}{r} 60-200 \\ 60-200 \end{array} \end{aligned}$ | 2 | .75 .75 | 500 500 |  | $\begin{aligned} & 100 \\ & 100 \end{aligned}$ |
| $\begin{aligned} & \text { 2N5812 } \\ & \text { 2N5813 } \\ & \text { 2N5814 } \\ & \text { 2N5815 } \end{aligned}$ | $\left\lvert\, \begin{aligned} & \text { NPN } \\ & \text { PNP } \\ & \text { NPN } \\ & \text { PNP } \end{aligned}\right.$ | $\begin{aligned} & G P \\ & G P \\ & G P \\ & G P \end{aligned}$ | A5T2222 A5T2907 | $\begin{aligned} & 500 \\ & 500 \\ & 500 \\ & 500 \end{aligned}$ | $\begin{aligned} & 35 \\ & 35 \\ & 50 \\ & 50 \end{aligned}$ | $\begin{aligned} & 25 \\ & 25 \\ & 40 \\ & 40 \end{aligned}$ | $\begin{array}{r} 150-500 \\ 150-500 \\ 60-120 \\ 60-120 \end{array}$ | 2 2 2 2 | .75 .75 .75 .75 | $\begin{aligned} & 500 \\ & 500 \\ & 500 \\ & 500 \end{aligned}$ |  | $\begin{aligned} & 135 \\ & 135 \\ & 100 \\ & 100 \end{aligned}$ |
| $\begin{aligned} & \text { 2N5816 } \\ & \text { 2N5817 } \\ & \text { 2N5818 } \\ & \text { 2N5819 } \end{aligned}$ | $\begin{array}{\|l} \text { NPN } \\ \text { PNP } \\ \text { NPN } \\ \text { PNP } \end{array}$ | $\begin{aligned} & \text { GP } \\ & \text { GP } \\ & \text { GP } \\ & \text { GP } \end{aligned}$ | A5T2222 <br> A5T2907 | $\begin{aligned} & 500 \\ & 500 \\ & 500 \\ & 500 \end{aligned}$ | $\begin{aligned} & 50 \\ & 50 \\ & 50 \\ & 50 \end{aligned}$ | $\begin{aligned} & 40 \\ & 40 \\ & 40 \\ & 40 \end{aligned}$ | $\begin{aligned} & 100-200 \\ & 100-200 \\ & 150-300 \\ & 150-300 \end{aligned}$ | $\begin{aligned} & 2 \\ & 2 \\ & 2 \\ & 2 \end{aligned}$ | .75 .75 .75 .75 | $\begin{aligned} & 500 \\ & 500 \\ & 500 \\ & 500 \end{aligned}$ |  | $\begin{aligned} & 120 \\ & 120 \\ & 135 \\ & 135 \end{aligned}$ |
| $\begin{aligned} & \text { 2N5820 } \\ & \text { 2N5821 } \\ & \text { 2N5822 } \\ & \text { 2N5823 } \end{aligned}$ | NPN PNP NPN PNP | $\begin{aligned} & G P \\ & G P \\ & G P \\ & G P \end{aligned}$ | A5T2907 <br> A5T2907 | $\begin{aligned} & 500 \\ & 500 \\ & 500 \\ & 500 \end{aligned}$ | $\begin{aligned} & 70 \\ & 70 \\ & 70 \\ & 70 \end{aligned}$ | $\begin{aligned} & 60 \\ & 60 \\ & 60 \\ & 60 \end{aligned}$ | $\begin{array}{r} 60-120 \\ 60-120 \\ 100-200 \\ 100-200 \end{array}$ | $\begin{aligned} & 2 \\ & 2 \\ & 2 \\ & 2 \end{aligned}$ | $\begin{aligned} & .75 \\ & .75 \\ & .75 \\ & .75 \end{aligned}$ | $\begin{aligned} & 500 \\ & 500 \\ & 500 \\ & 500 \end{aligned}$ |  | $\begin{aligned} & 100 \\ & 100 \\ & 120 \\ & 120 \end{aligned}$ |
| $\begin{aligned} & \text { 2N5824 } \\ & \text { 2N5825 } \\ & \text { 2N5826 } \\ & \text { 2N5827 } \end{aligned}$ | NPN <br> NPN <br> NPN <br> NPN | GP <br> GP <br> GP <br> GP | TIS99 <br> TIS98 <br> TIS98 <br> TIS97 | $\begin{aligned} & 360 \\ & 360 \\ & 360 \\ & 360 \end{aligned}$ | $\begin{aligned} & 50 \\ & 50 \\ & 50 \\ & 50 \end{aligned}$ | $\begin{aligned} & 40 \\ & 40 \\ & 40 \\ & 40 \end{aligned}$ | $\begin{array}{r} 60-120 \\ 100-200 \\ 150-300 \\ 250-500 \end{array}$ | $\begin{aligned} & 2 \\ & 2 \\ & 2 \\ & 2 \end{aligned}$ | $\begin{aligned} & .125 \\ & .125 \\ & .125 \\ & .125 \end{aligned}$ | $\begin{aligned} & 10 \\ & 10 \\ & 10 \\ & 10 \end{aligned}$ | $\begin{array}{r} 60 \\ 100 \\ 150 \\ 250 \end{array}$ | 90 90 90 90 |
| $\begin{array}{\|l\|} \text { 2N5828 } \\ \text { 2N5829 } \\ \text { 2N5830 } \\ \text { 2N5831 } \end{array}$ | $\begin{aligned} & \text { NPN } \\ & \text { PNP } \\ & \text { NPN } \\ & \text { NPN } \end{aligned}$ | GP RF GP GP | TIS97 <br> 2N4260 <br> A.5T2243 | $\begin{aligned} & 360 \\ & 200 \\ & 310 \\ & 310 \end{aligned}$ | $\begin{array}{r} 50 \\ 30 \\ 120 \\ 160 \end{array}$ | $\begin{array}{r} 40 \\ 30 \\ 100 \\ 140 \end{array}$ | $\begin{array}{r} 400-800 \\ 20-150 \\ 80-500 \\ 80-250 \end{array}$ | $\begin{array}{r} 2 \\ 2 \\ 10 \\ 10 \end{array}$ | $\begin{aligned} & .125 \\ & .25 \\ & .25 \end{aligned}$ | $\begin{aligned} & 10 \\ & 50 \\ & 50 \end{aligned}$ | $\begin{array}{r} 400 \\ 60 \\ 60 \end{array}$ | 90 |
| $\begin{array}{\|l} \text { 2N5832 } \\ \text { 2N5833 } \\ \text { 2N5835 } \\ \text { 2N5836 } \end{array}$ | NPN <br> NPN <br> NPN <br> NPN | GP <br> GP <br> SW <br> SW |  | $\begin{array}{r} 310 \\ 310 \\ 200 \\ * 2 W \end{array}$ | $\begin{array}{r} 160 \\ 200 \\ 15 \\ 15 \end{array}$ | 140 180 10 10 | $\begin{aligned} & 175-500 \\ & 50-250 \\ & 25- \\ & 25- \end{aligned}$ | $\begin{aligned} & 10 \\ & 10 \\ & 10 \\ & 50 \end{aligned}$ | $\begin{aligned} & .25 \\ & .25 \end{aligned}$ | $\begin{aligned} & 50 \\ & 50 \end{aligned}$ | 125 50 |  |

## TRANSISTOR INTERCHANGEABILITY MASTER LIST OF REGISTERED TYPES

| TYP MUMC |  |  |  | MAXIMUM RATMVOS |  |  | HECTRICAL CHARACTERSTICS |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  | $\begin{gathered} { }_{1 A}=25^{\circ} \mathrm{C} \\ { }^{\circ} \mathrm{T}_{\mathrm{C}}=25^{\circ} \mathrm{C} \\ (\mathrm{~mW}) \end{gathered}$ | VCBO(V) | $V_{\mathrm{cEO}}$$(V)$ | h- |  | VCE(sat) |  |  | $\left\{\begin{array}{c} \mathrm{T} \\ \mathrm{MNN} \\ \text { (MNX) } \end{array}\right.$ |
|  |  |  |  |  |  |  | M M M | $\begin{aligned} & \mathrm{lc} \\ & (\mathrm{ma}) \\ & \hline \end{aligned}$ | $\begin{aligned} & \text { MAX } \\ & \text { (V) } \end{aligned}$ | $\begin{aligned} & 16 \\ & (\mathrm{man}) \end{aligned}$ |  |  |
| $\begin{aligned} & 2 N 5837 \\ & 2 N 5841 \\ & 2 N 5842 \\ & 2 N 5843 \end{aligned}$ | $\begin{aligned} & \text { NPN } \\ & \text { NPN } \\ & N P N+ \\ & \text { PN: } \end{aligned}$ | $\begin{aligned} & \text { SW } \\ & \text { RF } \\ & \text { RF } \\ & \text { DU } \end{aligned}$ | 2N3347 | $*$ $*$ 350 350 500 | 10 20 20 50 | 5 10 10 40 | 25- 25-200 25-250 50-150 | 100 25 25 .1 |  |  |  |  |
| $\begin{aligned} & \text { 2N5844 } \\ & \text { 2N5845 } \\ & \text { 2N5845A } \\ & \text { 2N5851 } \end{aligned}$ | $\begin{aligned} & \text { PNP } \\ & \text { NPN } \\ & \text { NPN } \\ & \text { NPN } \end{aligned}$ | $\begin{aligned} & \text { DU } \\ & \text { SW } \\ & \text { SW } \\ & \text { RF } \end{aligned}$ | 2N3350 <br> 2N3572 | $\begin{aligned} & 500 \\ & 500 \\ & 500 \\ & 200 \end{aligned}$ | $\begin{aligned} & 50 \\ & 50 \\ & 50 \\ & 30 \end{aligned}$ | $\begin{aligned} & 40 \\ & 40 \\ & 40 \\ & 15 \end{aligned}$ | $\begin{aligned} & 100-300 \\ & 25-150 \\ & 35-150 \\ & 40- \end{aligned}$ | $\begin{array}{r} .1 \\ 500 \\ 500 \\ 10 \end{array}$ | . 6 | $\begin{aligned} & 500 \\ & 500 \end{aligned}$ |  | $\begin{aligned} & 200 \\ & 250 \\ & 800 \end{aligned}$ |
| $\begin{aligned} & \text { 2N5852 } \\ & \text { 2N5855 } \\ & \text { 2N5856 } \\ & \text { 2N5857 } \end{aligned}$ | NPN PNP NPN PNP | $\begin{aligned} & \text { RF } \\ & \text { GP } \\ & \text { GP } \\ & \text { GP } \end{aligned}$ | 2N3571 <br> A.5T4030 <br> AST2192 <br> AST4030 | $\begin{aligned} & 200 \\ & 750 \\ & 750 \\ & 750 \end{aligned}$ | 30 60 60 80 | 15 60 60 80 | $\begin{aligned} & 40- \\ & 50-300 \\ & 50-300 \\ & 50-300 \end{aligned}$ | $\begin{array}{r} 10 \\ 150 \\ 150 \\ 150 \end{array}$ | . 4 | $\begin{aligned} & 150 \\ & 150 \\ & 150 \end{aligned}$ |  | 1.16 |
| $\begin{aligned} & \text { 2M5858 } \\ & \text { 2N5902 } \\ & \text { 2N5903 } \\ & \text { 2N5904 } \end{aligned}$ | $\begin{aligned} & \mathrm{NPN} \\ & \mathrm{NCH} \\ & \mathrm{NCH} \\ & \mathrm{NCH} \end{aligned}$ | GP <br> FE <br> FE <br> FE | A.512243 | $750$ <br> SEE FET SEE FET SEE FET | $80$ <br> NTERCH VIERCH TERCH | 80 NGEABM NGEAB: NGEAOH | $\begin{aligned} & 50-300 \\ & \text { ITY LST } \\ & \text { ITY LST } \\ & \text { TY LST } \end{aligned}$ | $150$ | 4 | 150 |  |  |
| $\begin{aligned} & \text { 2N5905 } \\ & \text { 2N5906 } \\ & \text { 2N5907 } \\ & 2 \mathrm{~N} 5908 \end{aligned}$ | $\begin{aligned} & \mathrm{NCH} \\ & \mathrm{NCH} \\ & \mathrm{NCH} \\ & \mathrm{NCH} \end{aligned}$ | FE <br> FE <br> FE <br> FE |  | SEZ FET <br> SEE FET <br> SEE FET <br> SEE FET | NTERCH ITERCH NTERCH VTERCH | NGEABL NGEABL VGEABLI NGEABIL | TY LIST TY LIST TY LIST TY LIST |  |  |  |  |  |
| $\begin{aligned} & \text { 2N5909 } \\ & \text { 2N5910 } \\ & \text { 2N5911 } \\ & \text { 2N5912 } \end{aligned}$ | $\begin{aligned} & \mathrm{NCH} \\ & \text { PNP } \\ & \mathrm{NCH} \\ & \mathrm{NCH} \end{aligned}$ | FE <br> SW <br> FE <br> FE |  | SEE FET <br> 200 <br> SEE FET <br> SEE FET | NTERCH <br> 20 <br> NTERCH <br> NTERCH | NGEABL <br> 20 NGEABIL NGEABM | TY LST $30.120$ <br> TY LIST TY LIST | 10 | . 5 | 50 |  | 700 |
| $\begin{aligned} & \text { 2N5943 } \\ & \text { 2N5949 } \\ & \text { 2N5950 } \\ & \text { 2N5951 } \end{aligned}$ | NPN <br> NCH <br> NCH <br> NCH | $\begin{aligned} & \text { RF } \\ & \text { FE } \\ & \text { FE } \\ & F E \end{aligned}$ | $\begin{aligned} & \text { 2N5949 } \\ & \text { 2N5950 } \\ & \text { 2N5951 } \end{aligned}$ | IW <br> SEE FET <br> SEE FET <br> SEE FET | $40$ <br> NTERCH TIERCH TERCH | 30 VGEABLI VEABLI vGEABLIT | $25-300$ <br> IY LIST TY UST TY UST | 50 | . 2 | 100 | 25 |  |
| $\begin{aligned} & \text { 2N5952 } \\ & 2 \mathrm{~N} 5953 \\ & 2 \mathrm{~N} 5961 \\ & 2 \mathrm{~N} 5962 \end{aligned}$ | NCH <br> NCH <br> NPN <br> NPN | $\begin{aligned} & F E \\ & \text { FE } \\ & \text { GP } \\ & \text { GP } \end{aligned}$ | 2N5952 2N5953 TIS94 | $\begin{aligned} & \text { SEE FET } \\ & \text { SEE FET } \\ & 200 \\ & 200 \end{aligned}$ | TERCH NTERCH |  | $\begin{aligned} & \text { TY LIST } \\ & \text { TY LST } \\ & \begin{array}{l} 150.950 \\ 600.1550 \end{array} \end{aligned}$ | $\begin{aligned} & 10 \\ & 10 \end{aligned}$ |  |  |  |  |
| 2N5963 <br> 2N5998 <br> 2N5999 <br> 2N6000 | NPN <br> NPN <br> PNP <br> NPN | GP <br> GP <br> GP Sw | $\begin{aligned} & \text { 2N3710 } \\ & \text { 2N4061 } \\ & \text { A573904 } \end{aligned}$ | $\begin{array}{r} 200 \\ 400 \\ 400 \\ 400 \end{array}$ | $\begin{aligned} & 35 \\ & 35 \\ & 35 \end{aligned}$ | $\begin{aligned} & 30 \\ & 25 \\ & 25 \\ & 25 \end{aligned}$ | $\begin{gathered} 1200-2200 \\ 150-300 \\ 150-300 \\ 100-300 \end{gathered}$ | $\begin{aligned} & 10 \\ & 10 \\ & 10 \\ & 10 \end{aligned}$ | $\begin{aligned} & .25 \\ & .25 \\ & .08 \end{aligned}$ | $\begin{aligned} & 50 \\ & 50 \\ & 10 \end{aligned}$ | $\begin{array}{r} 150 \\ 150 \\ 70 \end{array}$ | 140 140 150 |
| $\begin{aligned} & \text { 2N6001 } \\ & \text { 2N6002 } \\ & \text { 2N6003 } \\ & \text { 2N6004 } \end{aligned}$ | $\begin{aligned} & \text { PNP } \\ & \text { NPN } \\ & \text { PNP } \\ & \text { NPN } \end{aligned}$ | $\begin{aligned} & s w \\ & s w \\ & s w \\ & o p \end{aligned}$ | A.573906 <br> T\$111 | $\begin{array}{r} 400 \\ 400 \\ 400 \\ 400 \end{array}$ | $\begin{aligned} & 35 \\ & 35 \\ & 35 \\ & 50 \end{aligned}$ | $\begin{aligned} & 25 \\ & 25 \\ & 25 \\ & 40 \end{aligned}$ | $\begin{aligned} & 100.300 \\ & 250.500 \\ & 250.500 \\ & 100.300 \end{aligned}$ | $\begin{aligned} & 10 \\ & 10 \\ & 10 \\ & 10 \end{aligned}$ | $\begin{array}{r} .1 \\ .08 \\ .1 \\ .08 \end{array}$ | $\begin{aligned} & 10 \\ & 10 \\ & 10 \\ & 10 \end{aligned}$ | $\begin{array}{r} 85 \\ 175 \\ 235 \\ 70 \end{array}$ | $\begin{aligned} & 225 \\ & 165 \\ & 250 \\ & 150 \end{aligned}$ |


| $\begin{gathered} \text { TYPR } \\ \text { NUMBER } \end{gathered}$ |  | $\begin{aligned} & \mathbf{8} \\ & \frac{8}{2} \\ & \frac{8}{8} \\ & 8 \\ & 8 \end{aligned}$ | $\begin{gathered} \text { TI } \\ \text { REPLACMMENT } \\ \text { OR NGAREST } \\ \text { ECUYALENT } \end{gathered}$ | MAXIMMM RATINOS |  |  | EMCTRICAL CHARACTERISTICS |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  |  |  | Mre |  | $\mathrm{VCE}_{\text {(sen) }}$ |  | $\begin{gathered} \mathrm{h}_{\mathrm{f}} \\ 1 \mathrm{ldta} \\ \operatorname{MiN} \end{gathered}$ | MT <br> MN <br> (MH2) |
| 2N6005 <br> 2N6006 <br> 2N6007 <br> 2N6008 | $\begin{aligned} & \text { PNP } \\ & \text { NPN } \\ & \text { PNP } \\ & \text { NPN } \end{aligned}$ | $\begin{aligned} & G P \\ & G P \\ & G P \\ & G P \end{aligned}$ | A5T2907 2N3711 | $\begin{array}{r} 400 \\ 400 \\ 400 \\ 400 \end{array}$ | $\begin{aligned} & 50 \\ & 50 \\ & 50 \\ & 35 \end{aligned}$ | $\begin{aligned} & 40 \\ & 40 \\ & 40 \\ & 25 \end{aligned}$ | $\begin{aligned} & 100-300 \\ & 250-500 \\ & 250-500 \\ & 250-500 \end{aligned}$ | $\begin{aligned} & 10 \\ & 10 \\ & 10 \\ & 10 \end{aligned}$ | $\begin{array}{r} .1 \\ .08 \\ .1 \\ .25 \end{array}$ | $\begin{aligned} & 10 \\ & 10 \\ & 10 \\ & 50 \end{aligned}$ | $\begin{array}{r} 85 \\ 175 \\ 235 \\ 250 \end{array}$ | $\begin{aligned} & 225 \\ & 165 \\ & 250 \\ & 140 \end{aligned}$ |
| $\begin{aligned} & \text { 2N6009 } \\ & \text { 2N6010 } \\ & \text { 2N6011 } \\ & \text { 2N6012 } \end{aligned}$ | PNP <br> NPN <br> PNP <br> NPN | $\begin{aligned} & G P \\ & G P \\ & G P \\ & G P \end{aligned}$ | 2N4062 <br> AST2222 <br> A5T2907 | $\begin{aligned} & 400 \\ & 500 \\ & 500 \\ & 500 \end{aligned}$ | $\begin{aligned} & 35 \\ & 50 \\ & 50 \\ & 50 \end{aligned}$ | $\begin{aligned} & 25 \\ & 40 \\ & 40 \\ & 40 \end{aligned}$ | $\begin{aligned} & 250-500 \\ & 100-300 \\ & 100-300 \\ & 250-500 \end{aligned}$ | $\begin{aligned} & 10 \\ & 10 \\ & 10 \\ & 10 \end{aligned}$ | $\begin{aligned} & .25 \\ & .05 \\ & .08 \\ & .05 \end{aligned}$ | $\begin{aligned} & 50 \\ & 10 \\ & 10 \\ & 10 \end{aligned}$ | $\begin{array}{r} 250 \\ 65 \\ 90 \\ 155 \end{array}$ | $\begin{array}{r} 140 \\ 350 \\ 75 \\ 500 \end{array}$ |
| $\begin{aligned} & \text { 2N6013 } \\ & \text { 2N6014 } \\ & \text { 2N6015 } \\ & \text { 2N6016 } \end{aligned}$ | $\begin{aligned} & \text { PNP } \\ & \text { NPN } \\ & \text { PNP } \\ & \text { NPN } \end{aligned}$ | $\begin{aligned} & G P \\ & G P \\ & G P \\ & G P \end{aligned}$ | A572907 | $\begin{aligned} & 500 \\ & 500 \\ & 500 \\ & 500 \end{aligned}$ | $\begin{aligned} & 50 \\ & 70 \\ & 70 \\ & 70 \end{aligned}$ | $\begin{aligned} & 40 \\ & 60 \\ & 60 \\ & 60 \end{aligned}$ | $\begin{aligned} & 250-500 \\ & 100-300 \\ & 100-300 \\ & 250-500 \end{aligned}$ | $\begin{aligned} & 10 \\ & 10 \\ & 10 \\ & 10 \end{aligned}$ | $\begin{aligned} & .08 \\ & .05 \\ & .08 \\ & .05 \end{aligned}$ | $\begin{aligned} & 10 \\ & 10 \\ & 10 \\ & 10 \end{aligned}$ | $\begin{array}{r} 225 \\ 65 \\ 90 \\ 155 \end{array}$ | $\begin{array}{r} 120 \\ 105 \\ 75 \\ 150 \end{array}$ |
| $\begin{aligned} & \text { 2N6017 } \\ & \text { 2N6027 } \\ & \text { 2N6028 } \\ & \text { 2N6067 } \end{aligned}$ | $\left\lvert\, \begin{aligned} & \text { PNP } \\ & \text { PUT } \\ & \text { PUT } \\ & \text { PNP } \end{aligned}\right.$ | $\begin{aligned} & \text { GP } \\ & \text { UJ } \\ & \text { UJ } \\ & \text { SW } \end{aligned}$ | $\begin{aligned} & \text { ATT6027 } \\ & \text { ATT6087 } \end{aligned}$ | 500 SEE UNLU SEE UNIJ 625 | 70 UNCTIO UNCTIO 50 | $\begin{gathered} 60 \\ N \text { INTERCH } \\ \text { N INTERCH } \\ 40 \end{gathered}$ | $\begin{aligned} & 250-500 \\ & \text { IANGEABLIT } \\ & \text { IANGEABLIT } \\ & 25-150 \end{aligned}$ | 10 $500$ | .08 <br> .6 | $\begin{array}{r} 10 \\ 500 \end{array}$ | $\begin{aligned} & 225 \\ & 150 \end{aligned}$ | 120 |
| $\begin{aligned} & \text { 2N6076 } \\ & \text { 2N608s } \\ & \text { 2N6086 } \\ & \text { 2N6087 } \end{aligned}$ | $\begin{aligned} & \text { PNP } \\ & \mathbf{N P N} \\ & \mathbf{N P N} \\ & \text { NPN } \end{aligned}$ | $\begin{aligned} & G P \\ & D U \\ & D U \\ & D U \end{aligned}$ | 2N4061 <br> 2N2917 <br> 2N2918 <br> 2N2915 | $\begin{array}{r} 360 \\ 300 \\ 300 \\ 300 \end{array}$ | $\begin{aligned} & 25 \\ & 45 \\ & 45 \\ & 45 \end{aligned}$ | $\begin{aligned} & 25 \\ & 45 \\ & 45 \\ & 45 \end{aligned}$ | $\begin{array}{r} 100-500 \\ 60-240 \\ 150-600 \\ 60-240 \end{array}$ | 10 .01 .01 .01 | .25 .35 .35 .35 | $\begin{array}{r} 10 \\ 1 \\ 1 \\ 1 \end{array}$ | 100 | 60 60 60 |
| $\begin{aligned} & \text { 2N6098 } \\ & \text { 2N6089 } \\ & \text { 2N6090 } \\ & \text { 2N6091 } \end{aligned}$ | NPN <br> NPN <br> NPN <br> NPN | DU <br> DU <br> DU <br> DU | 2N2916 <br> 2N2917 <br> 2N2918 <br> 2N2919 | $\begin{aligned} & 300 \\ & 300 \\ & 300 \\ & 300 \end{aligned}$ | $\begin{aligned} & 45 \\ & 45 \\ & 45 \\ & 60 \end{aligned}$ | $\begin{aligned} & 45 \\ & 45 \\ & 45 \\ & 60 \end{aligned}$ | $\begin{array}{r} 150-600 \\ 60-240 \\ 150-600 \\ 60-240 \end{array}$ | .01 .01 .01 .01 | .35 .35 .35 .35 | $\begin{aligned} & 1 \\ & 1 \\ & 1 \\ & 1 \end{aligned}$ |  | 60 60 60 60 |
| $\begin{aligned} & \text { 2N6092 } \\ & \text { 2N6027 } \\ & \text { 2N6028 } \\ & \text { 2N6!14 } \end{aligned}$ | NPN PUT PUT P-N | $\begin{aligned} & \text { DU } \\ & \text { UJ } \\ & \text { UJ } \\ & \text { UJ } \end{aligned}$ | 2N2920 ATt6027 AT6028 | 300 <br> SEE UNI <br> SEE UNIJ <br> SEE UNL | 60 UNCTIO UUNCTIO UNCTIO | $\begin{array}{r} 60 \\ \text { N INTERCK } \\ \text { N INTERCH } \\ \text { N INTERCF } \end{array}$ | $150-600$ HANGEABLLIT HANGEABMI HANGEABLLIT | $\begin{aligned} & .01 \\ & \text { IST } \\ & \text { IST } \\ & \text { IST } \end{aligned}$ | . 35 |  |  | 60 |
| $\begin{aligned} & \text { 2N6115 } \\ & \text { 2N6116 } \\ & \text { 2N6117 } \\ & \text { 2N6118 } \end{aligned}$ | $\left\lvert\, \begin{aligned} & \text { P-N } \\ & \text { PUT } \\ & \text { PUT } \\ & \text { PUT } \end{aligned}\right.$ | UJ <br> UJ <br> UJ <br> UJ | 2N6116 <br> 2N6117 <br> 2N6118 | SEE UNL <br> sEE DATA <br> sEE DATA <br> SEE DATA | JUNCTIO <br> A 3HEET <br> A SHEET <br> A SHEET | N INTERC <br> ON 2N6 <br> ON 2N6 <br> ON 2N6 | hanceanlit <br> 116 <br> 117 <br> 118 |  |  |  |  |  |
| $\begin{aligned} & \text { 2N6119 } \\ & \text { 2N6120 } \\ & 2 \mathrm{~N} 6137 \\ & 2 \mathrm{~N} 6138 \end{aligned}$ | $\begin{array}{\|l} \text { PUT } \\ \text { PUT } \\ \text { PUT } \\ \text { PUT } \end{array}$ | $\begin{aligned} & \text { UJ } \\ & \text { UJ } \\ & \text { UJ } \\ & \mathbf{U J} \end{aligned}$ |  | SEE UNI <br> set UNI <br> SEE UNI <br> SEE UNU | JUNCTIO JUNCTIO JUNCTIO JUNCTIO | N INTERC N INTERC N INTERC N INTERC | HANGEABHIT HANGEABIIT HANGEABILTY HANOEABLIT |  |  |  |  |  |
| $\begin{aligned} & \text { 2N6218 } \\ & \text { 2N6219 } \\ & \text { 2N6220 } \\ & \text { 2N6221 } \end{aligned}$ | NPN <br> NPN <br> NPN <br> NPN | GP GP GP GP | A.575058 <br> AST5058 <br> TIS100 <br> TIS 101 | $\begin{aligned} & 500 \\ & 500 \\ & 500 \\ & 500 \end{aligned}$ | $\begin{aligned} & 300 \\ & 250 \\ & 200 \\ & 150 \end{aligned}$ | $\begin{aligned} & 300 \\ & 250 \\ & 200 \\ & 150 \end{aligned}$ | $\begin{aligned} & 20- \\ & 20- \\ & 20- \\ & 20- \end{aligned}$ | $\begin{aligned} & 20 \\ & 20 \\ & 20 \\ & 20 \end{aligned}$ | 1 1 2 2.3 | $\begin{aligned} & 10 \\ & 10 \\ & 20 \\ & 20 \end{aligned}$ | 20 20 20 20 | 50 <br> 50 <br> 50 <br> 50 |

## TRANSISTOR INTERCHANGEABILITY MASTER LIST OF REGISTERED TYPES



## TRANSISTOR INTERCHANGEABILITY <br> MASTER LIST OF REGISTERED TYPES

| TYPE NUME |  |  | $\begin{aligned} & \text { II } \\ & \text { REPLCUMENT } \\ & \text { OR NBAREST } \\ & \text { EQUVALENT } \end{aligned}$ | MNXIMUM RATMNOS |  | EETRICAL CHMRACILMSTCS |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  | $\begin{gathered} \mathbf{T}_{A}=23^{\circ} \mathrm{C} \\ { }^{\bullet} \mathrm{T}_{\mathrm{C}}=25^{\circ} \mathrm{C} \\ (\mathrm{~mW}) \\ \hline \end{gathered}$ | $V_{\text {cso }} \quad V_{\text {cso }}$ <br> (V) <br> (V) | hre | VCl(ent) <br> Max erc <br> (V) (ma) | $\begin{gathered} \mathrm{M}_{1} \\ 1 \mathrm{kNHz} \\ \text { MiN } \end{gathered}$ |  |
| 3N95 <br> 3N96 <br> 3N97 <br> 3N98 | $\begin{aligned} & \mathrm{PNP} \\ & \mathrm{PCH} \\ & \mathrm{PCH} \\ & \mathrm{NCH} \end{aligned}$ | SW <br> PE <br> FE <br> FE | 3N109 | 300 <br> SEE FET IN <br> SEE FET 1 <br> SEE FET | 50 <br> NTERCHANGEAEM NTERCMANGEABL NTERCHANGEAEL | Y LIST <br> TY LST <br> N LIST |  |  |  |
| 3N99 <br> 3N100 <br> 3N101 <br> 3N102 | $\begin{aligned} & \mathrm{NCH} \\ & \text { PNP } \\ & \text { PNP } \\ & \text { PNP } \end{aligned}$ | FE <br> SW <br> SW <br> SW | 3N128 <br> 3N110 <br> 3NI 10 <br> 3N1 10 | $\begin{aligned} & \text { SEE FET IT } \\ & 300 \\ & 300 \\ & 300 \end{aligned}$ | NTERCHANGEAB 20 30 40 | LIST |  |  |  |
| $\begin{aligned} & 3 N 103 \\ & 3 N 104 \\ & 3 N 105 \\ & 3 N 106 \end{aligned}$ | $\left\lvert\, \begin{aligned} & \text { PNP } \\ & \text { PNP } \\ & \text { PNP } \\ & \text { PNP } \end{aligned}\right.$ | $\begin{aligned} & \text { SW } \\ & \text { SW } \\ & \text { SW } \\ & \text { sW } \end{aligned}$ | 3N111 <br> 3N111 <br> 3N111 <br> 3NIII | $\begin{aligned} & 300 \\ & 300 \\ & 300 \\ & 300 \end{aligned}$ | $\begin{aligned} & 50 \\ & 60 \\ & 20 \\ & 40 \end{aligned}$ |  |  |  |  |
| $\begin{aligned} & 3 N 107 \\ & 3 N 108 \\ & 3 N 109 \\ & 3 N 110 \end{aligned}$ | $\left\{\begin{array}{l} P N P \\ P N P \\ P N P \\ P N P \end{array}\right.$ | $\begin{aligned} & s w \\ & s w \\ & s w \\ & s w \end{aligned}$ | $\begin{aligned} & \text { 3N109 } \\ & \text { 3N108 } \\ & \text { 3N109 } \\ & \text { 3N1 } 10 \end{aligned}$ | $\begin{aligned} & 300 \\ & 300 \\ & 300 \\ & 300 \end{aligned}$ | $\begin{aligned} & 60 \\ & 50 \\ & 50 \\ & 50 \end{aligned}$ |  |  |  | 12 12 12 |
| $\text { 3N111 } \begin{aligned} & 3 N 112 \\ & 3 N 113 \\ & 3 N 114 \end{aligned}$ | PNP <br> PNP <br> PNP <br> PNP | $\begin{aligned} & \text { sw } \\ & \text { SW } \\ & \text { Sw } \\ & \text { SW } \end{aligned}$ | 3N111 <br> 3NI 10 | $\begin{aligned} & 300 \\ & 200 \\ & 200 \\ & 200 \end{aligned}$ | $\begin{aligned} & 50 \\ & 50 \\ & 50 \\ & 30 \end{aligned}$ |  |  |  | 12 6 6 12 |
| $\begin{aligned} & 3 N 117 \\ & 3 N 116 \\ & 3 N 118 \\ & 3 N 119 \end{aligned}$ | PNP <br> PNP <br> PNP <br> PNP | SW SW SW sw | 3NI 10 <br> 3N111 <br> 3N111 <br> 3N111 | $\begin{aligned} & 300 \\ & 300 \\ & 300 \\ & 300 \end{aligned}$ | $\begin{aligned} & 50 \\ & 30 \\ & 50 \\ & 50 \end{aligned}$ |  |  |  | 12 12 12 12 |
| 3N120 <br> 3N121 <br> 3N123 <br> 3N124 | NPN <br> NPN <br> PNP <br> NCH | $\begin{aligned} & \text { SW } \\ & \text { SW } \\ & \text { SW } \\ & \text { FE } \end{aligned}$ | . | $\begin{aligned} & 200 \\ & 200 \\ & 100 \\ & \text { SEE FRT } \end{aligned}$ | $\begin{aligned} & 30 \\ & 30 \\ & 30 \end{aligned}$ <br> NTERCHANGEAD | Y LST |  |  | 40 |
| $\begin{aligned} & 3 N 125 \\ & 3 N 126 \\ & 3 N 127 \\ & 3 N 128 \end{aligned}$ | NCH NCH NPN NCH | FE <br> FE <br> SW <br> FE | $\begin{aligned} & \text { 3N206 } \\ & \text { 3N128 } \end{aligned}$ | SEE FET <br> SEE FET 200 SEE FET | NTERCMANOEAE INTERCHANCEA $30$ | ITY LIST ITY LST TTY LIST |  |  | 40 |
| $\begin{aligned} & 3 N 129 \\ & 3 N 130 \\ & 3 N 131 \\ & 3 N 132 \end{aligned}$ | PNP <br> PNP <br> PNP <br> PNP | $\begin{aligned} & \text { SW } \\ & \text { SW } \\ & \text { SW } \\ & \text { SW } \end{aligned}$ | 3N1 10 <br> 3N110 <br> 3N110 <br> 3N108 | $\begin{aligned} & 300 \\ & 300 \\ & 300 \\ & 300 \end{aligned}$ | $\begin{aligned} & 20 \\ & 30 \\ & 40 \\ & 50 \end{aligned}$ |  |  |  |  |
| $\begin{aligned} & 3 N 133 \\ & 3 N 134 \\ & 3 N 135 \\ & 3 N 136 \end{aligned}$ | PNP <br> PNP <br> PNP <br> PNP | $\begin{aligned} & \text { Sw } \\ & \text { Sw } \\ & \text { Sw } \\ & s w \end{aligned}$ | 3N108 <br> 3N110 <br> 3NI 10 <br> 3N108 | $\begin{aligned} & 300 \\ & 300 \\ & 300 \\ & 300 \end{aligned}$ | $\begin{aligned} & 60 \\ & 20 \\ & 40 \\ & 60 \end{aligned}$ |  |  |  |  |

> TRANSISTOR INTERCHANGEABILITY MASTER LIST OF REGISTERED TYPES

| TYPENUMOER | 总88 | $\begin{aligned} & z \\ & \frac{0}{6} \\ & \mathbf{3} \\ & \frac{4}{4} \\ & \frac{3}{3} \end{aligned}$ | $\begin{gathered} \text { TI } \\ \text { REPLACEMENT } \\ \text { OR NEAREST } \\ \text { ECUVALENT } \end{gathered}$ | MAXIMUM RATNES | PIECTRICAL CHARACTERISTICS |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  | $\begin{array}{ccc} \mathrm{P}_{\mathbf{T}} \\ \mathbf{T}_{\mathbf{A}}=25^{\circ} \mathrm{C} & \mathbf{V}_{\mathrm{CBO}} \quad \mathbf{V}_{\mathrm{CEO}} \end{array}$ | hre | VCE(set) | $h_{6}$ | 4 |
|  |  |  |  | $\begin{align*} & { }^{*} \mathrm{~T} \mathrm{C}=25^{\circ} \mathrm{C} \\ & (\mathrm{~mW}) \quad(\mathrm{V}) \tag{V} \end{align*}$ | Min MAXIc <br> $(\mathrm{ma})$ | $\begin{array}{llr} \hline \operatorname{MAX} & \mathrm{C} \\ \mathrm{LV}) & (\mathrm{mA}) \\ \hline \end{array}$ | MNT | Mins <br> (MHz) |
| 3N138 | NCH | FE |  | SEE FET INTERCHANGEABLITY LIST SEE FET NTERCHANGEABLITY LIST SEE FET NNTERCHANGEABLLTY LIST SEE FET INTERCHANGEABILTY LIST |  |  |  |  |
| 3N139 | NCH | FE | 3N203 |  |  |  |  |  |
| 3N140 | NCH | FE | 3N201 |  |  |  |  |  |
| 3N141 | NCH |  | 3N201 |  |  |  |  |  |
| 3N142 | NCH | FE | 3N201 | See fet interchangeablity list SEE FET INTERCHANGEABLITY UST SEE FET INTERCHANGEABILTY LLST SEE FET INTERCHANGEABUTY LUST |  |  | - |  |
| 3N143 | NCH | FE | 3N128 |  |  |  |  |  |
| 3N145 | PCH | fe | 3NI74 |  |  |  |  |  |
| 3N146 | PCH | FE | 3N174 |  |  |  |  |  |
| 3N147 | PCH | FE | 3N208 | SEE FET INTERCHANGEABLITY LIST <br> SEE FET INTERCHANGEABLITY LST <br> SEE FET INTERCHANGEABILITY LIST <br> SEE FET INTERCHANGEABNLTY LST |  |  |  |  |
| 3N148 | PCH | FE | 3N208 |  |  |  |  |  |
| 3N149 | PCH | FE | 3N161 |  |  |  |  |  |
| 3N150 | PCH | FE | 3N161 |  |  |  |  |  |
| 3N151 | PCH | FE |  | SEE FET INTERCHANGEABLITY UST SEE FET INTERCHANGEABLLTY LIST SEE FET INTERCHANGEABLITY LST SEE FET INTERCHANGEABIITY UST |  |  |  |  |
| 3N152 | NCH | FE | 3N128 |  |  |  |  |  |
| 3N153 | NCH | FE | 3N153 |  |  |  |  |  |
| 3N154 | NCH |  | 3N128 |  |  |  |  |  |
| 3N155 | PCH | FE | 3N155 | SEE FET INTERCHANGEABLITY LIST SEE FET INTERCHANGEABLITY LIST SEE FET INTERCHANGEABLITY UST SEE FET INTERCHANGEABLLTY LIST |  |  |  |  |
| 3N155A | PCH | FE | 3N155A |  |  |  |  |  |
| 3N156 | PCH | FE | 3N156 |  |  |  |  |  |
|  |  |  | 3N156A |  |  |  |  |  |
| 3N157 | PCH | FE | 3N157 | SEE FET INTERCHANGEABRLTTY LIST SEE FET INTERCHANGEABLITY LIST SEE FET INTERCHANGEABHLTY LIST SEE FET INTERCHANGEABIITY LST. |  |  |  |  |
| 3N157A | PCH | FE | 3N157A |  |  |  |  |  |
| $\text { 3N1 } 58$ | PCH | FE | 3N158 |  |  |  |  |  |
| 3N158A |  |  |  |  |  |  |  |  |
| 3N159 | NCH | FE |  | SEE FET INTERCHANGEABLITY LIST SEE FET INTERCHANGEABLITY LIST SEE FET INTERCHANGEAOHLTY LST SEE FET INTERCHANGEABHITY LST |  |  |  |  |
| 3N160 | PCH | FE |  |  |  |  |  |  |
| 3N161 | PCH | $F E$ | 3N161 |  |  |  |  |  |
| 3N162 | PCH |  |  |  |  |  |  |  |
| 3N163 | PCH | FE | 3N163 | SEE FET INTERCHANGEABMITY UST SEE FET INTERCHANGEABLITY UST SEE FET INTERCHANGEABUTY UST SEE FET INTERCHANGEABULTY LIST |  |  |  |  |
| 3N164 | PCH | FE | 3N164 |  |  |  |  |  |
| 3N165 | PCH | FE |  |  |  |  |  |  |
| 3N166 | PCH | FE |  |  |  |  |  |  |
| 3N167 | PCH | FE |  | SEE FET INTERCHANGEABIUTY LIST <br> SEE FET INTERCHANGEABILTY LIST <br> SEE FET INTERCHANGEABLITY UST <br> SEE FET INTERCHANGEABLITY LIST |  |  |  |  |
| 3N168 | PCH | FE | 3N160 |  |  |  |  |  |
| 3N169 | NCH | FE | 3N169 |  |  |  |  |  |
| 3N170 | NCH | FE |  |  |  |  |  |  |
| 3N171 | NCH | FE | 3N171 | SEE FET interchangeablity list SEE FET INTERCHANGEABMITY LIST SEE FET INTERCHANGEABILTY UST SEE FET INTERChANGEABILTY LUST |  |  |  |  |
| 3N172 | PCH | FE | 3N161 |  |  |  |  |  |
| 3N173 | PCH | FE | 3N161 |  |  |  |  |  |
| 3N174 | PCH | FE |  |  |  |  |  |  |



## TRANSISTOR INTERCHANGEABILITY MASTER LIST OF NONREGISTERED TYPES

| TYPE |  | $\begin{aligned} & \frac{\zeta}{2} \\ & \frac{2}{8} \\ & \hline \end{aligned}$ |  |  | maximum ratinos |  |  | EECTRICAL CHARACTERISTICS |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  | $\begin{gathered} P_{T} \\ T_{A}=25^{\circ} \mathrm{C} \\ { }^{*} \mathrm{~T}=25^{\circ} \mathrm{C} \\ (\mathrm{~mW}) \\ \hline \end{gathered}$ | $V_{\text {ceo }}$ <br> (V) | $\mathbf{V}_{\text {Ceo }}$ <br> (V) | hat |  | $\mathbf{V}_{\text {CE(set) }}$ |  | $\begin{gathered} h_{60} \\ 1 \mathrm{kltz} \\ \text { miv } \end{gathered}$ | $\begin{gathered} \text { ft } \\ \text { min } \\ \text { (Mintx) } \end{gathered}$ |
|  |  |  |  |  |  |  |  | min max | $\begin{array}{cc} \hline & \mathrm{IC} \\ (\mathrm{ma}) \\ \hline \end{array}$ | $\begin{array}{\|l} \hline \max \\ \text { (v) } \\ \hline \end{array}$ | $\begin{aligned} & 1 \mathrm{l} \\ & (\mathrm{~mA}) \end{aligned}$ |  |  |
| 2243TP | T | NPN | GP | ${ }^{\text {A }}$ - 572243 | 625 | 120 | 80 | 40.120 | 150 | . 35 | 150 |  | 50 |
| 2484TP | $\pi$ | NPN | GP | A 453707 | 360 | 60 | 60 | 100-500 | . 01 | . 35 | 1 | 150 | 60 |
| 2925TP | $\pi$ | NPN | GP | AST3711 | 360 | 25 | 25 |  |  |  |  | 235 |  |
| 3245TP |  | PNP | sw |  | 625 | 50 | 50 | 30.90 | 500 | . 6 | 500 |  | 150 |
| 33901P | $\pi$ | NPN | GP | 11597 | 360 | 18 | 18 | 400-800 | 2 |  |  | 400 |  |
| 3391TP | 7 | NPN | GP | AST3391 | 360 | 25 | 25 | $250-500$ | 2 |  |  |  |  |
| 33927P | $\pi$ | NPN | GP | AST3392 | 360 | 25 | 25 | 150-300 | 2 |  |  |  |  |
| 3405TP | $\pi$ | NPN | GP | 2N5449 | 360 | 50 | 50 | 180-540 | 2 | . 3 | 50 | 180 |  |
| 34157 P | $\pi$ | NPN | GP | 2N5449 | 360 | 25 | 25 | 180-540 | 2 | . 3 | 50 | 180 |  |
| 3417 P | $\pi$ | NPN | GP | 2N5449 | 360 | 50 | 50 | 180-540 | 2 | . 3 | 50 | 180 |  |
| 35047 P | $\pi$ | PNP | GP | AST2907 | 360 | 45 | 45 | 100-300 | 150 | . 4 | 150 | 135 |  |
| 3563TP | $\pi$ | NPN | RF | Tis62 | 360 | 30 | 12 | 20-200 | 8 |  |  | 20 | 600 |
| 35647 P |  | NPN | RF | 2N4996 | 360 | 30 | 15 | 20. | 15 | . 3 | 20 | 20 |  |
| 3565TP | $\pi$ | NPN | GP | A573565 | 360 | 30 | 25 | 150.600 | 1 | . 35 | 1 |  | 40 |
| ${ }^{3566 T P}$ | $\pi$ | NPN | GP | A.5T2222 | 360 | 40 | 30 | 150.600 | 10 | 1 | 100 |  | 40 |
| 3567P | $\pi$ | NPN | GP | AST2222 | 360 | 80 | 40 | 40-120 | 150 | . 25 | 150 |  | 60 |
| 35687P 35707P | $\pi$ | NPN | GP | AST2222 | 300 | 80 | 60 | 40.120 | 150 | . 25 | 150 |  | 60 |
| ${ }^{35701 P}$ | T1 | NPN | RF | A AT3571 $^{\text {S }}$ | 350 | 30 | 15 | 20-150 | 5 |  |  | 20 | 1500 |
| ${ }^{35717 P}$ | $\pi$ | NPN | RF | A5T3571 | 360 | 25 | 15 | 20-200 | 5 |  |  | 20 | 1200 |
| 36387P | TI | PNP | SW | A.5T3638 | 300 | 25 | 25 | 30. | 50 | . 25 | 50 |  | 100 |
| 36407 P |  | PNP | sw | 2N4423 | 360 | 12 | 12 | 30-120 | 10 | . 2 | 10 |  | 500 |
| 3641TP | $\pi$ | NPN | RF | 2N5449 | 360 | 60 | 30 | 40.120 | 150 | . 22 | 150 |  | 250 |
| 3643 PP | T1 | NPN | ${ }_{\text {RF }}$ | 2N5449 | 360 | 60 | 30 | 100.300 | 150 | . 22 | 150 |  | 250 |
| 3646TP |  | NPN | sw | AST3903 | 360 | 40 | 15 | 30.120 | 30 | . 3 | 30 |  | 350 |
| 3663TP |  | NPN | RF | TIS62 | 200 | 30 | 12 | 20. | 8 | . 6 | 10 |  |  |
| 37247P | $\pi$ | NPN | sw | 715133 | 625 | 50 | 30 | 80.150 | 100 | . 3 | 100 |  | 300 |
| 40082 | RC | NPN | ${ }^{\text {RF }}$ |  | -5w |  |  |  |  |  |  |  |  |
| 40084 | RC | NPN | GP | 2N2222 | 500 | $\infty$ | 40 | 50-250 | 150 | 1.4 | 150 |  |  |
| 40231 | RC | NPN | GP | 2N2221 | 500 | 18 | 18 |  |  |  |  | 55 |  |
| 40232 | RC | NPN | GP | 2N2222 | 500 | 18 | 18 |  |  |  |  | 90 |  |
| 40233 | RC | NPN | GP | 2N2222 | 500 | 18 | 18 |  |  |  |  | 90 |  |
| 40234 | RC | NPN | GP | 2N2221 | 500 | 18 | 18 |  |  | . 2 | 50 | 35 |  |
| 40235 | ${ }^{\text {RC }}$ | NPN | ${ }_{\text {RF }}$ | 2N4252 | 180 | 45 |  | 40.170 | 1 |  |  |  |  |
| 40236 | RC | NPN | RF | 2N4252 | 180 | 45 |  | 40-275 | 1 |  |  |  |  |
| 40237 | RC | NPN | RF | 2N4252 | 180 | 45 |  | 27-275 | 1 |  |  |  |  |
| 40238 | RC | NPN | RF | 2N4252 | 180 | 45 |  | 40-170 | , |  |  |  |  |
| 40239 | RC | NPAN | ${ }^{\text {ar }}$ | 2N4252 | 180 | 45 |  | 27-100 | 1 |  |  |  |  |
| 40240 | RC | NPN | RF | 2N4252 | 180 | 45 |  | 27-275 | 1 |  |  |  |  |
| 40242 | RC | NPN | RF | 2N4252 | 180 | 45 |  | 40.170 | 1 |  |  |  |  |
| 40243 | RC | NPN | RF | 2 N 4252 | 180 | 45 |  | 40.170 | 1 |  |  |  |  |

TRANSISTOR INTERCHANGEABILITY
MASTER LIST OF NONREGISTERED TYPES

| TYPE NUMEER | $\qquad$ | $\begin{aligned} & \frac{\Sigma}{N} \\ & \frac{y}{k} \\ & \frac{8}{8} \end{aligned}$ | $\begin{aligned} & \frac{z}{6} \\ & \frac{0}{2} \\ & \frac{0}{i n} \\ & \frac{4}{4} \end{aligned}$ | 7 <br> REPLACEMENT <br> OR NEAREST ECUIVALENT | maximum ratmics |  |  | ELECTRICAL CHARACTERISTICS |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  | $\begin{gathered} \mathrm{P}_{\mathrm{T}} \\ \mathrm{~T}_{\mathrm{A}}=25^{\circ} \mathrm{C} \\ { }^{\mathrm{T}_{\mathrm{C}}=25^{\circ} \mathrm{C}} \\ (\mathrm{~mW}) \end{gathered}$ | $\mathrm{V}_{\mathrm{CBO}}$ <br> (V) | $\mathbf{V}_{\text {CEO }}$ <br> (v) | hat | $\begin{gathered} \mathrm{IC} \\ (\mathrm{~mA}) \end{gathered}$ | $\begin{array}{\|l} \mid \text { VCE } \\ \hline \begin{array}{l} \text { MAX } \\ \text { (V) } \end{array} \\ \hline \end{array}$ |  |  | $\begin{gathered} \mathbf{f}_{\boldsymbol{T}} \\ \mathrm{MiN} \\ \text { (MHzz)} \end{gathered}$ |
| $\begin{aligned} & 40244 \\ & 40245 \\ & 40246 \\ & 40290 \end{aligned}$ | RC RC RC RC | NPN <br> NPN <br> NPN <br> NPN | $\begin{aligned} & \text { RF } \\ & R F \\ & R F \\ & R F \end{aligned}$ | 2N4252 <br> 2N4252 <br> 2N4252 <br> 2N4252 | 180 <br> 180 <br> 180 <br> $7 W$ | 45 45 45 | 45 45 45 15 | $27-170$ $70-275$ $27-90$ | 1 1 1 |  |  |  |  |
| $\begin{aligned} & 40294 \\ & 40295 \\ & 40296 \\ & 40305 \end{aligned}$ | $\left\lvert\, \begin{aligned} & R C \\ & R C \\ & R C \\ & R C \end{aligned}\right.$ | NPN <br> NPN <br> NPN <br> NPN | $\begin{aligned} & R F \\ & R F \\ & R F \\ & R F \\ & R F \end{aligned}$ | $\begin{aligned} & \text { 2N3571 } \\ & \text { 2N918 } \\ & \text { 2N3571 } \end{aligned}$ | 200 200 200 $* / W$ | 30 35 30 65 | 15 20 15 40 | $\begin{aligned} & 30-150 \\ & 30-200 \\ & 30-150 \\ & 10 \end{aligned}$ | $\begin{array}{r} 3 \\ 2 \\ 3 \\ 150 \end{array}$ | 1 | 250 |  |  |
| 4030TP 40309 40311 40314 | $\left\|\begin{array}{l} \mathrm{T} \\ \mathrm{R} C \\ \mathrm{RC} \\ \mathrm{RC} \end{array}\right\|$ | PNP <br> NPN <br> NPN <br> NPN | $\begin{aligned} & \text { GP } \\ & \text { GP } \\ & \text { GP } \\ & \text { GP } \end{aligned}$ | $\begin{aligned} & \text { A5T4026 } \\ & \text { 2N2270 } \\ & \text { 2N2270 } \\ & \text { 2N2102 } \end{aligned}$ | $\begin{aligned} & 625 \\ & 1 W \\ & 1 W \\ & 1 W \end{aligned}$ | $60$ | $\begin{aligned} & 60 \\ & 18 \\ & 30 \\ & 40 \end{aligned}$ | $\begin{aligned} & 40-120 \\ & 70-350 \\ & 70-350 \\ & 35-150 \end{aligned}$ | $\begin{array}{r} 100 \\ 50 \\ 50 \\ 50 \end{array}$ | $.5$ <br> 1.4 | $500$ $150$ |  | 100 |
| $\begin{aligned} & 40315 \\ & 40317 \\ & 40319 \\ & 40320 \end{aligned}$ | $\begin{aligned} & R C \\ & R C \\ & R C \\ & R C \\ & R C \end{aligned}$ | NPN <br> NPN <br> PNP <br> NPN | $\begin{aligned} & G P \\ & G P \\ & G P \\ & G P \end{aligned}$ | $\begin{aligned} & \text { 2N2270 } \\ & \text { 2N2270 } \\ & \text { 2N1030 } \\ & \text { 2N2270 } \end{aligned}$ | 1w 1w iw iw |  | 35 40 40 40 | $70-350$ $40-200$ $35-200$ $40-200$ | 50 10 50 10 |  |  |  |  |
| $\begin{aligned} & 40321 \\ & 40323 \\ & 40326 \\ & 40327 \end{aligned}$ | $\begin{aligned} & \mathrm{RC} \\ & \mathrm{RC} \\ & \mathrm{RC} \\ & \mathrm{RC} \end{aligned}$ | NPN <br> NPN <br> NPN <br> NPN | $\begin{aligned} & \text { GP } \\ & \text { GP } \\ & \text { GP } \\ & \text { GP } \end{aligned}$ | $\begin{aligned} & \text { 2N5058 } \\ & \text { 2N2270 } \\ & \text { 2N2270 } \\ & \text { 2N5058 } \end{aligned}$ | $\begin{aligned} & 1 w \\ & 1 w \\ & \text { iw } \\ & \text { iw } \end{aligned}$ |  | $\begin{array}{r} 300 \\ 18 \\ 40 \\ 300 \end{array}$ | $\begin{aligned} & 25-200 \\ & 70-350 \\ & 40-200 \\ & 40-250 \end{aligned}$ | $\begin{aligned} & 20 \\ & 50 \\ & 10 \\ & 20 \end{aligned}$ |  |  |  |  |
| $\begin{aligned} & 40346 \\ & 40347 \\ & 40348 \\ & 40349 \end{aligned}$ | $\begin{aligned} & \mathrm{RC} \\ & \mathrm{RC} \\ & \mathrm{RC} \\ & \mathrm{RC} \end{aligned}$ | NPN <br> NPN <br> NPN <br> NPN | GP <br> GP <br> GP <br> GP | $\begin{aligned} & \text { 2N3114 } \\ & \text { 2N2270 } \\ & \text { 2N2102 } \end{aligned}$ | $\begin{aligned} & 1 \mathrm{w} \\ & 1 \mathrm{w} \\ & 1 \mathrm{w} \\ & 1 \mathrm{w} \end{aligned}$ | $\begin{aligned} & 60 \\ & 90 \end{aligned}$ | $\begin{array}{r} 175 \\ 40 \\ 65 \\ 140 \end{array}$ | $\begin{aligned} & 25- \\ & 25-100 \\ & 30-100 \\ & 25-100 \end{aligned}$ | $\begin{array}{r} 10 \\ 450 \\ 300 \\ 150 \end{array}$ | .5 1 .75 .5 | $\begin{array}{r} 10 \\ 450 \\ 300 \\ 150 \end{array}$ |  | 10 |
| $\begin{array}{\|l} 40354 \\ 40355 \\ 40360 \\ 40361 \end{array}$ | $\begin{aligned} & \mathbf{R C} \\ & \mathbf{R C} \\ & \mathbf{R C} \\ & \mathbf{R C} \end{aligned}$ | NPN <br> NPN <br> NPN <br> NPN | GP <br> GP <br> GP <br> GP | $\begin{aligned} & \text { 2N5059 } \\ & \text { 2N2102 } \\ & \text { 2N2102 } \end{aligned}$ | $\begin{aligned} & 500 \\ & 1 w \\ & 1 w \\ & 1 w \end{aligned}$ |  | $\begin{array}{r} 150 \\ 150 \\ 70 \\ 70 \end{array}$ | $\begin{aligned} & 40-200 \\ & 70-350 \end{aligned}$ | $\begin{aligned} & 10 \\ & 50 \end{aligned}$ | 5 5 1.4 1.4 | $\begin{array}{r} 1 \\ 1 \\ 150 \\ 150 \end{array}$ |  | 50 50 |
| $\begin{aligned} & 40362 \\ & 40366 \\ & 40367 \\ & 40385 \end{aligned}$ | $\begin{aligned} & \mathbf{R C} \\ & \mathbf{R C} \\ & \mathbf{R C} \\ & \mathbf{R C} \end{aligned}$ | $\left\lvert\, \begin{aligned} & \text { PNP } \\ & \text { NPN } \\ & \text { NPN } \\ & \text { NPN } \end{aligned}\right.$ | GP <br> GP <br> GP <br> GP | 2N4032 2N2102 2N2102 | $\begin{aligned} & 16 \\ & 16 \\ & 10 \\ & 10 \end{aligned}$ | $\begin{array}{r} 100 \\ 450 \end{array}$ | $\begin{array}{r} 70 \\ 65 \\ 55 \\ 350 \end{array}$ | $\begin{aligned} & 35-200 \\ & 40-120 \\ & 35-100 \\ & 40-160 \end{aligned}$ | 50 150 200 20 | 1.4 .5 1.4 .5 | $\begin{array}{r} 150 \\ 150 \\ 200 \\ 4 \end{array}$ |  |  |
| $\begin{aligned} & 40397 \\ & 40398 \\ & 40399 \\ & 40400 \end{aligned}$ | $\begin{aligned} & R C \\ & R C \\ & R C \\ & R C \end{aligned}$ | $\begin{array}{\|l\|} \mathbf{N P N} \\ \mathbf{N P N} \\ \text { NPN } \\ \mathbf{N P N} \end{array}$ | GP GP GP GP | 2N2222 <br> 2N2222 | $\begin{aligned} & 500 \\ & 500 \\ & 500 \\ & 500 \end{aligned}$ |  | $\begin{aligned} & 25 \\ & 25 \\ & 18 \\ & 18 \end{aligned}$ | $\begin{array}{r} 165-600 \\ 175-300 \\ 165-600 \\ 75-300 \end{array}$ | $\begin{aligned} & 10 \\ & 10 \\ & 10 \\ & 10 \end{aligned}$ | .25 .25 .2 .2 | 10 10 5 5 | $\begin{array}{r} 165 \\ 75 \end{array}$ | 50 50 50 50 |
| $\begin{aligned} & 40405 \\ & 40406 \\ & 40407 \\ & 40408 \end{aligned}$ | $\begin{aligned} & R C \\ & R C \\ & R C \\ & R C \end{aligned}$ | $\begin{array}{\|l\|} \mathbf{N P N} \\ \text { PNP } \\ \text { NPN } \\ \text { NPN } \end{array}$ | RF <br> GP <br> GP <br> GP | 2N4030 2N2270 2N2102 | $\begin{aligned} & 300 \\ & 10 \\ & \text { iw } \\ & \text { iw } \end{aligned}$ |  | $\begin{aligned} & 16 \\ & 50 \\ & 50 \\ & 90 \end{aligned}$ | $\begin{aligned} & 20- \\ & 30-200 \\ & 40-200 \\ & 40-200 \end{aligned}$ | $\begin{array}{r} 100 \\ .1 \\ 1 \\ 10 \end{array}$ | 1.4 | 150 |  | 300 |

## TRANSISTOR INTERCHANGEABILITY MASTER LIST OF NONREGISTERED TYPES



## TRANSISTOR INTERCHANGEABILITY MASTER LIST OF NONREGISTERED TYPES

| TYPE NUMES |  | $\begin{aligned} & 8 \\ & 8 \\ & 8 \end{aligned}$ |  | 71 <br> REPLACEMENT OR NHAREST LCUIVALENT | maximum ratives |  |  | EECTRICAL CHARACTERISTICS |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  | $\begin{gathered} P_{T} \\ T_{A}=25^{\circ} \mathrm{C} \\ { }^{{ }^{-1} \mathrm{C}=25^{\circ} \mathrm{C}} \\ (\mathrm{~mW}) \\ \hline \end{gathered}$ | VCBO <br> (V) | VCEO <br> (V) | MIN MAX | $\begin{gathered} \mathrm{IC} \\ \text { (mA) } \\ \hline \end{gathered}$ | $V_{C E}$ <br> Max $(\mathrm{V})$ | $\begin{gathered} \text { (set) } \\ \hline \mathrm{LC} \\ \text { (mA) } \\ \hline \end{gathered}$ | $\mathrm{H}_{\mathrm{H}}$ 1 kdz MIN | $\begin{gathered} \mathrm{T} \\ \mathrm{MNN} \\ (\mathrm{MHz}) \end{gathered}$ |
| $\begin{aligned} & 40382 \\ & 40600 \\ & 40601 \\ & 40602 \end{aligned}$ | $\begin{array}{\|l\|} R C \\ R C \\ R C \\ R C \end{array}$ | NPN NCH NCH NCH | $\begin{aligned} & \text { RF } \\ & \text { FE } \\ & \text { FE } \\ & \text { FE } \end{aligned}$ | $\begin{aligned} & \text { 3N211 } \\ & \text { 3N211 } \\ & \text { 3N211 } \end{aligned}$ | $\qquad$ <br> SEE FET INTERCHANGEABILTY LIST <br> SEE FET INTERCHANGEABILITY LIST <br> SEE FET WTERCHANOEABILITY LIST |  |  |  |  |  |  |  |  |
| $\begin{aligned} & 40603 \\ & 40604 \\ & 40608 \\ & 40611 \end{aligned}$ | $\begin{aligned} & R C \\ & R C \\ & R C \\ & R C \\ & R C \end{aligned}$ | $\begin{aligned} & \text { NCH } \\ & \text { NCH } \\ & \text { NPN } \\ & \text { NPN } \end{aligned}$ | $\begin{aligned} & \text { FE } \\ & \text { FE } \\ & \text { RF } \\ & \text { GP } \end{aligned}$ | $\begin{aligned} & \text { 3N211 } \\ & \text { 3N211 } \\ & \text { 2N2270 } \end{aligned}$ | SEE FET INTERCHANGEABILITY LIST <br> SEE FET INTERCHANGEABILITY LIST |  |  |  |  | 1 | 50 |  | 700 |
| $\begin{aligned} & 40616 \\ & 40634 \\ & 40635 \\ & 40637 \end{aligned}$ | $\begin{aligned} & \text { RC } \\ & R C \\ & R C \\ & R C \\ & R C \end{aligned}$ | NPN PNP NPN NPN | GP GP GP RF | $\begin{aligned} & \text { 2N2270 } \\ & \text { 2N4030 } \\ & \text { 2N2270 } \end{aligned}$ | $\begin{aligned} & 16 \\ & 1 w \\ & 1 w \\ & 300 \end{aligned}$ |  | $\begin{aligned} & 32 \\ & 75 \\ & 95 \\ & 30 \end{aligned}$ | $70-500$ $50-250$ $50-250$ | 50 150 150 |  | 150 150 |  | 300 |
| $\begin{aligned} & 40673 \\ & 42487 P \\ & 4274 \mathrm{TP} \\ & 43605 \mathrm{P} \end{aligned}$ | $\begin{aligned} & \text { RC } \\ & \mathrm{TI} \\ & \mathrm{TI} \\ & \mathrm{TI} \end{aligned}$ | NCH <br> PNP <br> NPN <br> PCH | FE <br> GP <br> SW <br> FE | 3N211 <br> A5T4248 <br> A5T3903 <br> A5T5462 | SEE FET INTERCHANGEABILITY LIST   <br> 360 40 40 $50-$ <br> 360 30 12 $30-120$ <br> SEE FET    <br> INTERCHANGEABILITY UST    |  |  |  |  | .25 .2 | 10 10 | 50 | 40 400 |
| $\left\{\begin{array}{l} 400 T P \\ 44017 P \\ 4402 T P \\ 44097 P \end{array}\right.$ | $\begin{aligned} & T I \\ & \pi \\ & \pi \\ & T I \\ & \pi \end{aligned}$ | NPN NPN PNP NPN | $\begin{aligned} & s W \\ & S W \\ & S W \\ & G P \end{aligned}$ | A5T2222 <br> A5T2222 <br> A5T2907 <br> 2N4409 | $\begin{aligned} & 360 \\ & 360 \\ & 360 \\ & 360 \end{aligned}$ | $\begin{aligned} & 60 \\ & 60 \\ & 40 \\ & 80 \end{aligned}$ | $\begin{aligned} & 40 \\ & 40 \\ & 40 \\ & 50 \end{aligned}$ | $\begin{array}{r} 50-150 \\ 100-300 \\ 50-150 \\ 60-400 \end{array}$ | $\begin{array}{r} 150 \\ 150 \\ 150 \\ 1 \end{array}$ | .4 .4 .4 .2 | $\begin{array}{r} 150 \\ 150 \\ 150 \\ 1 \end{array}$ | 20 40 30 | 200 250 150 60 |
| $\begin{aligned} & 44107 P \\ & 4888 T P \\ & 4916 T P \\ & 4917 T P \end{aligned}$ | $\begin{aligned} & \pi 1 \\ & \pi 1 \\ & \pi 1 \\ & \pi 1 \end{aligned}$ | NPN PNP PNP PNP | $G P$ <br> GP <br> GP <br> GP | 2N4410 A5T5401 A573905 A.573906 | $\begin{aligned} & 360 \\ & 360 \\ & 360 \\ & 360 \end{aligned}$ | $\begin{array}{r} 120 \\ 150 \\ 30 \\ 30 \end{array}$ | $\begin{array}{r} 80 \\ 150 \\ 30 \\ 30 \end{array}$ | $\begin{aligned} & 60-400 \\ & 30- \\ & 70-200 \\ & 150-300 \end{aligned}$ | 1 1 10 10 | .2 .5 .14 .14 | $\begin{array}{r} 1 \\ 10 \\ 10 \\ 10 \end{array}$ |  | 60 30 400 450 |
| $\begin{aligned} & \text { 5033TP } \\ & \text { 5088TP } \\ & 50897 P \\ & 5172 T P \end{aligned}$ | $\begin{aligned} & \mathrm{TI} \\ & \mathrm{TI} \\ & \mathrm{TI} \\ & \mathrm{TI} \end{aligned}$ | PCH <br> NPN <br> NPN <br> NPN | FE <br> GP <br> GP <br> GP | A5T5460 <br> TIS94 <br> TISP4 <br> AST5172 |  SEE FET    INTERCHANGEABLITY LIST <br> 310 35 30 $300-900$   <br> 310 30 25 $400-1200$   <br> 360 25 25 $100-500$   |  |  |  | .1 .1 10 | .5 .5 .25 | 10 10 10 | 350 450 100 | (1) 50 |
| $\begin{aligned} & \text { 5209TP } \\ & 5210 T P \\ & 54007 P \\ & \text { A.5T404 } \end{aligned}$ | $\begin{aligned} & \pi \\ & \pi 1 \\ & 71 \\ & \pi 1 \end{aligned}$ | NPN <br> NPN <br> PNP <br> PNP | GP <br> GP <br> GP <br> SW | A5T5209 <br> A5T5210 <br> AST5400 <br> A5T404 | $\begin{aligned} & 360 \\ & 360 \\ & 360 \\ & 625 \end{aligned}$ | $\begin{array}{r} 50 \\ 50 \\ 130 \\ 25 \end{array}$ | 50 50 120 24 | $\begin{array}{r} 100-300 \\ 200-600 \\ 40-180 \\ 30-400 \end{array}$ | .1 .1 10 12 | .7 .7 .2 .15 | $\begin{aligned} & 10 \\ & 10 \\ & 10 \\ & 12 \end{aligned}$ | 150 250 30 | 30  <br> 0 30 <br> 0 100 |
| A5T404A <br> AST2192 <br> AST2193 <br> A.5T2222 | $\begin{aligned} & 71 \\ & 71 \\ & \pi \\ & 71 \end{aligned}$ | PNP NPN <br> NPN <br> NPN | SW GP GP GP | A5T404A A5T2192 A5T2193 A.5T2222 | $\begin{aligned} & 625 \\ & 625 \\ & 625 \\ & 625 \end{aligned}$ | $\begin{aligned} & 40 \\ & 60 \\ & 80 \\ & 60 \end{aligned}$ | $\begin{aligned} & 35 \\ & 40 \\ & 50 \\ & 30 \end{aligned}$ | $\begin{array}{r} 30-400 \\ 100-300 \\ 40-120 \\ 100-300 \end{array}$ | 12 150 150 150 | .15 .35 .35 .4 | $\begin{array}{r} 12 \\ 150 \\ 150 \\ 150 \end{array}$ |  | 50 50 250 |
| AST2243 <br> A5T2907 <br> A573391 <br> A573391A | TI <br> $\pi$ <br> $\pi$ <br> $\pi$ <br> 1 | NPN PNP NPN NPN | GP <br> GP <br> GP <br> GP | A5T2243 <br> A512907 <br> A.5T3391 <br> A5T3391A | 625 625 625 625 | 120 60 25 25 | 80 40 25 25 | $40-120$ 100.300 $250-500$ $250-500$ | 150 150 2 2 | .25 .4 | 150 150 |  | 200 |

## TRANSISTOR INTERCHANGEABILITY MASTER LIST OF NONREGISTERED TYPES

| TYFE |  |  |  |  | maximum ratmes |  |  | ELECTRICAL CHARACTERISTICS |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  | $\begin{gathered} P_{T} \\ T_{A}=25^{\circ} \mathrm{C} \\ { }^{\circ} \mathrm{T}^{\mathrm{C}}=25^{\circ} \mathrm{C} \\ (\mathrm{~mW}) \\ \hline \end{gathered}$ | $\mathrm{V}_{\mathrm{CHO}}$ <br> (V) | Veto <br> (v) | hft |  | $V_{\text {cle }}$ (set) |  |  | $\begin{gathered} \text { AT } \\ \text { Min } \\ \text { (MH3) } \end{gathered}$ |
|  |  |  |  |  |  |  |  | Min max | $\begin{aligned} & -\mathrm{IC} \\ & (\mathrm{~mA}) \end{aligned}$ | $\begin{array}{\|lll} \hline \max & \mathrm{IC} \\ \text { (V) } & \text { (ma) } \end{array}$ |  |  |  |
| AST3392 | $\pi$ | NPN | GP | A5T3392 | 625 | 25 | 25 | 150-300 | 2 |  |  |  | $\begin{array}{r}200 \\ 200 \\ \hline\end{array}$ |
| AST3504 | Ti | PNP | GP | AST3504 | 625 | 45 | 45 | 100.300 | 150 | . 4 | 150 | 135 |  |
| AST3505 | 11 | PNP | ${ }^{\text {OP }}$ | AST3505 | 625 | 60 | 60 | 100.300 | 150 | . 4 | 150 | 135 |  |
| A5T3565 | 7 | NPN | OP | AST3565 | 625 | 30 | 25 | 150-600 | 1 | . 35 | 1 | 120 |  |
| Ast3s71 |  | $\begin{aligned} & \text { NPN } \\ & \text { NPN } \\ & \text { PNP } \\ & \text { PNP } \end{aligned}$ | $\begin{aligned} & R P \\ & R P \\ & G P \\ & G P \\ & G P \end{aligned}$ | AST3571 <br> AST3572 <br> A573638 <br> AST3638A | $\begin{aligned} & 625 \\ & 625 \\ & 625 \\ & 625 \end{aligned}$ | $\begin{aligned} & 25 \\ & 25 \\ & 25 \\ & 25 \end{aligned}$ | $\begin{aligned} & 15 \\ & 13 \\ & 25 \\ & 25 \end{aligned}$ | $\begin{gathered} 20-200 \\ 20-350 \\ 30- \\ 100 . \end{gathered}$ | $\begin{array}{r} 5 \\ 5 \\ 50 \\ 50 \end{array}$ |   <br>   <br> .25 50 <br> .25 50 |  | $\begin{aligned} & 20 \\ & 20 \end{aligned}$ | $\begin{array}{r} 1200 \\ 10 \\ 100 \\ 150 \end{array}$ |
| A.573572 |  |  |  |  |  |  |  |  |  |  |  |  |  |
| A5T3638 |  |  |  |  |  |  |  |  |  |  |  |  |  |
| AST3638A |  |  |  |  |  |  |  |  |  |  |  |  |  |
| A5T3644 | $\left\lvert\, \begin{aligned} & \mathrm{m} \\ & \pi \\ & \pi \\ & \pi \\ & \pi \end{aligned}\right.$ | $\begin{array}{\|l\|l} \text { PNP } \\ \text { PNP } \\ \text { NPN } \\ \text { NPN } \end{array}$ | $\begin{aligned} & G P \\ & G P \\ & G P \\ & G P \end{aligned}$ | AST3644 A573645 A5T3707 A5T3708 | $\begin{aligned} & 625 \\ & 625 \\ & 625 \\ & 625 \end{aligned}$ | 45 <br> 60 <br> 30 <br> 30 | $\begin{aligned} & 45 \\ & 60 \\ & 30 \\ & 30 \end{aligned}$ | $\begin{array}{r} 100-300 \\ 100-300 \\ 100.400 \\ 45-660 \end{array}$ | $\begin{array}{r} 150 \\ 150 \\ .1 \\ 1 \end{array}$ | .4411 | $\begin{array}{r\|} \hline 150 \\ 150 \\ 10 \\ 10 \end{array}$ | $\begin{array}{r} 100 \\ 100 \\ 100 \\ 45 \end{array}$ | 200 |
| A573645 |  |  |  |  |  |  |  |  |  |  |  |  |  |
| AST3707 |  |  |  |  |  |  |  |  |  |  |  |  |  |
| AST3708 |  |  |  |  |  |  |  |  |  |  |  |  |  |
| AST3709 | $\begin{aligned} & \pi \\ & \pi \\ & \pi \\ & \pi \\ & \pi \end{aligned}$ | NPN <br> NPN <br> NPN <br> NCH | $\begin{aligned} & \text { GP } \\ & \text { GP } \\ & \text { GP } \\ & \mathrm{FE} \end{aligned}$ |  | $\begin{array}{ccc} \hline 625 & 30 & 30 \\ 625 & 30 & 30 \\ 625 & 30 & 30 \end{array}$ |  |  | $\begin{aligned} & 45-165 \\ & 90.330 \\ & 180-660 \\ & \text { f L5т } \end{aligned}$ |  | $\begin{array}{ll} \hline 1 & 10 \\ 1 & 10 \\ 1 & 10 \end{array}$ |  | $\begin{array}{r} 45 \\ 90 \\ 180 \end{array}$ |  |
| AST3710 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| AST3711 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| AST3821 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| AST3822 | $\left\lvert\, \begin{aligned} & \pi \\ & \pi \\ & \pi \\ & \pi \\ & \pi \end{aligned}\right.$ | NCH <br> NCH <br> NCH <br> NPN | $\begin{aligned} & \text { FE } \\ & \text { FE } \\ & \text { FE } \\ & \text { FW } \\ & \mathbf{S W} \end{aligned}$ | AST3822 AST3823 A.573824 A5T3903 | SEE FET INTERCHANGEABILTY UST SEE FET INTERCHANGEABLITY LIST SEE FET INTERCHANGEABHITY LST |  |  |  |  |  |  | 50 | 250 |
| AST3823 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| A5T3824 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| AST3903 |  |  |  |  | 625 | 60 | 40 | 50-150 | 10 | . 2 | 10 |  |  |
| A573904 | $\begin{aligned} & \mathbf{\pi} \\ & \pi \\ & \pi \\ & \pi \\ & \pi \end{aligned}$ | $\begin{aligned} & \text { NPN } \\ & \text { PNP } \\ & \text { PNP } \\ & \text { PNP } \end{aligned}$ | $\begin{aligned} & \mathbf{s w} \\ & \mathbf{s w} \\ & \mathbf{s w} \\ & \mathbf{G P} \end{aligned}$ | A.5T3904 A5T3905 A.573906 A.5T4026 | $\begin{aligned} & 625 \\ & 625 \\ & 625 \\ & 625 \end{aligned}$ | $\begin{aligned} & 60 \\ & 40 \\ & 40 \\ & 60 \end{aligned}$ | $\begin{aligned} & 40 \\ & 40 \\ & 40 \\ & 60 \end{aligned}$ | $\begin{array}{r} 100-300 \\ 50.150 \\ 100-300 \\ 40.120 \end{array}$ | $\begin{array}{r} 10 \\ 10 \\ 10 \\ 100 \end{array}$ | $\begin{array}{r} .2 \\ .25 \\ .25 \\ .5 \end{array}$ | 10 | $\begin{array}{r} 100 \\ 50 \\ 100 \end{array}$ | 300200250100 |
| A5T3903 |  |  |  |  |  |  |  |  |  |  | 10 |  |  |
| AsT3906 |  |  |  |  |  |  |  |  |  |  | 10 |  |  |
| AST4026 |  |  |  |  |  |  |  |  |  |  | 500 |  |  |
| A574027 | $\begin{aligned} & \pi \\ & \pi \\ & \pi \\ & \pi \\ & \pi \end{aligned}$ | $\begin{aligned} & \text { PNP } \\ & \text { PNP } \\ & \text { PNP } \\ & \text { PNP } \end{aligned}$ | GP <br> OP <br> ${ }^{O P}$ <br> GP | A5T4027 A5T4028 A5T4029 AST4058 | 625 | 80 | 80 | 40.120 | 100 | . 5 | 500 |  | 100150150 |
| AST4028 |  |  |  |  | 625 | 60 | 60 | 100-300 | 100 | . 5 | 500 |  |  |
| AST4029 |  |  |  |  | 625 | 80 | 80 | 100-300 | 100 | . 3 | 500 |  |  |
|  |  |  |  |  | 625 | 30 | 30 | 100-400 | . 1 | . 7 | 10 | 100 |  |
| AST4059 | $\begin{aligned} & \pi \\ & \pi \\ & \pi \\ & \pi \\ & \pi i \end{aligned}$ | $\begin{aligned} & \text { PNP } \\ & \text { PNP } \\ & \text { PNP } \\ & \text { PNP } \end{aligned}$ | $\begin{aligned} & G P \\ & G P \\ & G P \\ & G P \end{aligned}$ | A.ST4059 AST4060 A.5T4061 A.5T4062 | 625 | 30 | 30 | 45-660 |  |  |  | 454590180 |  |
| A574060 |  |  |  |  | 625 | 30 | 30 | 45.165 | 1 | . 7 | 10 |  |  |
| A574061 |  |  |  |  | 625 | 30 | 30 | 90-330 | 1 | . 7 | 10 |  |  |
| A5T4062 |  |  |  |  | 625 | 30 | 30 | 180.600 | 1 | . 7 |  |  |  |
| ${ }^{\text {A STA123 }}$ | $\begin{aligned} & \pi \\ & \pi \\ & \pi \\ & \pi \\ & \pi \end{aligned}$ | NPN <br> NPN <br> PNP <br> PNP | $\begin{aligned} & \text { sw } \\ & \text { SW } \\ & \text { SW } \\ & \text { SW } \end{aligned}$ | A5T4123 <br> A5T4124 <br> A5T4125 <br> A5T4126 | $\begin{aligned} & 625 \\ & 625 \\ & 625 \\ & 625 \end{aligned}$ | $\begin{aligned} & 40 \\ & 30 \\ & 30 \\ & 25 \end{aligned}$ | $\begin{aligned} & 30 \\ & 25 \\ & 30 \\ & 25 \end{aligned}$ | $\begin{array}{r} 50.150 \\ 120-360 \\ 50-150 \\ 120-360 \end{array}$ |  |  | 50 |  |  |
| AST4124 |  |  |  |  |  |  |  |  | 2 | . 3 | 50 | 120 | 300 |
| A 5 T4125 |  |  |  |  |  |  |  |  | 2 | . 4 | 50 | 50 | 200 |
| A514126 |  |  |  |  |  |  |  |  | 2 | . 4 | 50 | 120 | 250 |
| A514248 | $\begin{aligned} & \pi \\ & \pi \\ & \pi \\ & \pi \\ & \pi \end{aligned}$ | $\begin{aligned} & \text { PNP } \\ & \text { PNP } \\ & \text { PNP } \\ & \text { PNP } \end{aligned}$ | $\begin{aligned} & G P \\ & G P \\ & G P \\ & \text { GF } \end{aligned}$ | A5T4248 A5T4249 A5T4250 A.ST4260 | 625 | 40 | 40 | 50. | .1 | . 25 | 10 |  | 4040501600 |
| AST4249 |  |  |  |  | 625 | 60 | ¢0 | 100.300 | . 1 | . 25 | 10 | 100 |  |
| A544250 |  |  |  |  | 625 | 40 | 40 | 250.700 | . 1 | . 25 | 10 | 250 |  |
| A 514260 |  |  |  |  | 200 | 20 | 15 | 30. | 10 | . 35 | 10 |  |  |


| TYPE NLMERA | $\qquad$ | $\frac{2}{8}$ | $\begin{aligned} & 3 \\ & \frac{8}{8} \\ & \frac{3}{8} \\ & 8 \end{aligned}$ | $\begin{aligned} & \text { II } \\ & \text { REPLACEMENT } \\ & \text { OR NFAREST } \\ & \text { ECUIVALENT } \end{aligned}$ | MNXIMUM RATINES |  |  | ELCTRICAL CHARACTEXESTICS |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  | $\left\{\begin{array}{ccc} \mathrm{T}_{\mathrm{A}}=25^{\circ} \mathrm{C} & \mathrm{VCSO} & \mathrm{VCSO} \\ { }^{{ }^{\top} \mathrm{T}=25^{\circ} \mathrm{C}} & & \\ \text { (mW) } & \text { (V) } & \text { (V) } \end{array}\right.$ |  |  | MFE  <br>   <br> MIN  |  |  |  | $\begin{gathered} \text { ho } \\ 1 \text { kdta } \\ \text { Min } \end{gathered}$ |  |
| A5T4261 A5T4402 A5T4403 A5T4409 | $\begin{aligned} & \mathrm{TI} \\ & \mathrm{r} \\ & \mathrm{TI} \\ & \mathrm{TI} \end{aligned}$ | PNP <br> PNP <br> PNP <br> NPN | RF <br> SW <br> SW <br> GP | A5T4261 <br> A5T4402 <br> A5T4403 <br> A574409 | $\begin{aligned} & 200 \\ & 625 \\ & 625 \\ & 625 \end{aligned}$ | $\begin{aligned} & 20 \\ & 40 \\ & 40 \\ & 80 \end{aligned}$ | $\begin{aligned} & 15 \\ & 40 \\ & 40 \\ & 50 \end{aligned}$ | $\begin{aligned} & 30- \\ & 50-150 \\ & 100-300 \\ & 60-400 \end{aligned}$ | $\begin{array}{r} 10 \\ 150 \\ 150 \\ 1 \end{array}$ | $\begin{array}{r} .35 \\ .4 \\ .4 \\ .2 \end{array}$ | $\begin{array}{r} 10 \\ 150 \\ 150 \\ 1 \end{array}$ | $\begin{aligned} & 30 \\ & 60 \end{aligned}$ | $\begin{array}{r} 20 \\ 150 \\ 200 \\ 60 \end{array}$ |
| $\begin{array}{\|l\|l\|l\|l\|l\|} \hline \text { AST4 } 40 \\ \text { AST5058 } \\ \text { AST5059 } \\ \text { AST5086 } \end{array}$ | $\left\lvert\, \begin{aligned} & \mathrm{T} \\ & \mathrm{TI} \\ & \mathrm{~T} 1 \\ & \mathrm{Ti} \end{aligned}\right.$ | NPN <br> NPN <br> NPN <br> PNP | $\begin{aligned} & G P \\ & G P \\ & G P \\ & G P \end{aligned}$ | A5T4410 <br> A5T5058 <br> A.5T5059 <br> A5T5086 | $\begin{aligned} & 625 \\ & 800 \\ & 800 \\ & 625 \end{aligned}$ | $\begin{array}{r} 120 \\ 300 \\ 250 \\ 50 \end{array}$ | $\begin{array}{r} 80 \\ 300 \\ 250 \\ 50 \end{array}$ | $\begin{array}{r} 60-400 \\ 35-150 \\ 30-150 \\ 150-500 \end{array}$ | 1 30 30 .1 | .2 1 1 .3 | $\begin{gathered} 1 \\ 30 \\ 30 \\ 10 \end{gathered}$ | 150 | 60 30 30 40 |
| $\begin{aligned} & \text { AST5087 } \\ & \text { AST5172 } \\ & \text { AST5209 } \\ & \text { AST5210 } \end{aligned}$ | $\left\lvert\, \begin{aligned} & \pi \\ & \pi \\ & \pi \\ & \pi \\ & \pi \end{aligned}\right.$ | $\begin{aligned} & \text { PNP } \\ & \text { NPN } \\ & \text { NPN } \\ & \text { NPN } \end{aligned}$ | $\begin{aligned} & G P \\ & G P \\ & G P \\ & G P \end{aligned}$ | A5T5087 <br> A5T5172 <br> A575209 <br> A5T5210 | $\begin{aligned} & 625 \\ & 625 \\ & 625 \\ & 625 \end{aligned}$ | $\begin{aligned} & 50 \\ & 25 \\ & 50 \\ & 50 \end{aligned}$ | $\begin{aligned} & 50 \\ & 25 \\ & 50 \\ & 50 \end{aligned}$ | $\begin{aligned} & 250-800 \\ & 100-500 \\ & 100-300 \\ & 200-600 \end{aligned}$ | .1 10 .1 .1 | .3 .25 .7 .7 | 10 10 10 10 | 250 100 150 250 | 40 30 30 |
| $\begin{aligned} & \text { AST5219 } \\ & \text { AST5220 } \\ & \text { AST5221 } \\ & \text { AST5223 } \end{aligned}$ | $\left\lvert\, \begin{aligned} & \pi 1 \\ & \pi \\ & \pi \\ & \pi 1 \\ & \pi \end{aligned}\right.$ | $\begin{aligned} & \text { NPN } \\ & \text { NPN } \\ & \text { PNP } \\ & \text { NPN } \end{aligned}$ | GP GP GP GP | A5T5219 <br> A.5T5220 <br> AST5221 <br> AST5223 | $\begin{aligned} & 625 \\ & 625 \\ & 625 \\ & 625 \end{aligned}$ | 20 15 15 25 | 15 15 15 20 | $\begin{aligned} & 35-500 \\ & 30-600 \\ & 30-600 \\ & 50-800 \end{aligned}$ | $\begin{array}{r} 2 \\ 50 \\ 50 \\ 2 \end{array}$ | .4 .5 .5 .7 | $\begin{array}{r} 10 \\ 150 \\ 150 \\ 10 \end{array}$ | 35 30 30 50 | 150 100 100 150 |
| A5T5225 <br> A5T5226 <br> AST5227 <br> A5T5400 | $\left\lvert\, \begin{aligned} & \mathrm{m} \\ & \mathrm{n} \\ & \mathrm{n} \\ & \mathrm{n} \\ & \mathrm{n} \end{aligned}\right.$ | NPN PNP PNP PNP | GP GP GP GP | AST5225 <br> AST5226 <br> A5T5227 <br> A5T5400 | $\begin{aligned} & 625 \\ & 625 \\ & 625 \\ & 625 \end{aligned}$ | $\begin{array}{r} 25 \\ 25 \\ 30 \\ 130 \end{array}$ | $\begin{array}{r} 25 \\ 25 \\ 30 \\ 120 \end{array}$ | $\begin{aligned} & 30-600 \\ & 30-600 \\ & 50-700 \\ & 40-180 \end{aligned}$ | $\begin{array}{r} 50 \\ 50 \\ 2 \\ 10 \end{array}$ | .8 .8 .4 .2 | 100 100 10 10 | 30 30 50 30 | 50 50 100 100 |
| A5T5401 <br> A5T5460 <br> A5T5461 <br> A575462 | $\begin{aligned} & 11 \\ & n \\ & n \\ & 11 \\ & 1 \end{aligned}$ | $\left\lvert\, \begin{aligned} & \text { PNP } \\ & \hline P C H \\ & P C H \end{aligned}\right.$ | $\begin{aligned} & \text { GP } \\ & \text { FE } \\ & \text { FE } \\ & \text { FE } \end{aligned}$ | A.5T5401 <br> A575460 <br> A.5T5461 <br> AST5462 | 625 <br> SEE FET <br> SEE FET <br> SEE FET | 160 INTERCH INTERCH INTERCH | 150 ANGEABLL ANGEABIL | 60-240 <br> ITY LIST <br> ITY LIST ITY LIST | $10$ | . 2 | 10 | 40 | 100 |
| A5T5550 <br> A5T5551 <br> AST6116 <br> A576117 | $\begin{aligned} & \pi \\ & \pi \\ & \pi \\ & \pi \\ & \pi \end{aligned}$ | NPN NPN | $\begin{aligned} & \text { GP } \\ & \text { GP } \\ & \text { UJ } \\ & \text { UJ } \end{aligned}$ | AST5550 <br> A575551 <br> AST61 16 <br> AST6117 | $\begin{gathered} 625 \\ 625 \\ \text { SEE DA } \\ \text { SEE DA } \end{gathered}$ | $\begin{gathered} 160 \\ 180 \\ \text { A SHEET } \\ \text { A SHEET } \end{gathered}$ | $\begin{array}{r} 140 \\ 160 \\ \text { ON A.5T61 } \\ \text { ON A.5T61 } \end{array}$ | $\begin{aligned} & 60-250 \\ & 16^{80-250} \\ & 17 \end{aligned}$ | $\begin{aligned} & 10 \\ & 10 \end{aligned}$ | $\begin{aligned} & .15 \\ & .15 \end{aligned}$ | $\begin{aligned} & 10 \\ & 10 \end{aligned}$ | 50 50 | $\begin{aligned} & 100 \\ & 100 \end{aligned}$ |
| A.5T6118 <br> A5T6449 <br> A576450 <br> A6T5222 | $t I$ | NCH <br> NCH <br> NPN | UJ <br> FE <br> FE <br> RF | A.576118 <br> A5T6449 <br> A5T6450 <br> A6T5222 | SEE DA <br> SEE FET <br> SEE FET <br> 625 | A SHEET INTERCH INTERCH 20 | ON ASTO ANGEABH ANGEABIL 15 | 118 <br> TV LIST ITY LIST 20-1500 | 4 | 1 | 4 | 20 | 450 |
| A7T3391 <br> ATT3391A <br> ATT3392 <br> AT5172 | $\begin{aligned} & \mathrm{Ti} \\ & \mathrm{Ti} \\ & \mathrm{TH} \\ & \mathrm{TI} \end{aligned}$ | NPN <br> NPN <br> NPN <br> NPN | GP GP GP GP | AT3391 <br> ATt3391A <br> A7T3392 <br> ATTS172 | $\begin{aligned} & 625 \\ & 625 \\ & 625 \\ & 625 \end{aligned}$ | 25 25 25 25 | 25 25 25 25 | $\begin{aligned} & 250-500 \\ & 250-500 \\ & 150-300 \\ & 100-500 \end{aligned}$ | 2 2 2 10 | . 25 | 10 | $\begin{array}{r} 20 \\ 100 \end{array}$ | 600 |
| A576116 A5T6117 <br> AST6118 <br> ATT6027 | $\begin{aligned} & \mathrm{TI} \\ & \mathrm{TI} \\ & \mathrm{~T} \\ & \mathrm{TI} \end{aligned}$ | $\begin{aligned} & \text { PUT } \\ & \text { PUT } \\ & \text { PUT } \\ & \text { PUT } \end{aligned}$ | $\begin{aligned} & \mathrm{UJ} \\ & \mathrm{UJ} \\ & \mathrm{UJ} \\ & \mathrm{UJ} \end{aligned}$ | A576116 <br> AST61 17 <br> A5761 18 <br> ATT6027 | SEE UNIJUNCTION INTERCHANGEABLITY LIST SEE UNUUNCTION INTERCHANGEABLITY LIST SEE UNIJUNCTION INTERCHANGEABLITY UST SEE UNIJUNCTION INTERCHANGEABLITTY LIST |  |  |  |  |  |  |  |  |

## TRANSISTOR INTERCHANGEABILITY MASTER LIST OF NONREGISTERED TYPES



## TRANSISTOR INTERCHANGEABILITY

MASTER LIST OF NONREGISTERED TYPES


## TRANSISTOR INTERCHANGEABILITY MASTER LIST OF NONREGISTERED TYPES



## TRANSISTOR INTERCHANGEABILITY <br> MASTER LIST OF NONREGISTERED TYPES

| TYPE NUMBER |  | $\begin{aligned} & k \\ & \frac{k}{6} \\ & \frac{2}{6} \\ & 6 \end{aligned}$ | $z$$\frac{2}{1}$$\frac{4}{4}$$\frac{1}{4}$$\frac{1}{4}$3 |  | MAXIMUM RATINGS |  |  | ELECTRICAL CHARACTERISTICS |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  | $\begin{gathered} P_{T} \\ T_{A}=25^{\circ} \mathrm{C} \\ { }^{\circ} \mathrm{T}_{\mathrm{C}}=25^{\circ} \mathrm{C} \\ (\mathrm{~mW}) \\ \hline \end{gathered}$ | $V_{C B O}$ <br> (V) | $\mathbf{V}_{\text {ceo }}$ <br> (V) | hfe | $\begin{gathered} \mathrm{lc} \\ (\mathrm{~mA}) \end{gathered}$ | $V_{C E}$ <br> MAX <br> (V) | sat) <br> (mA <br> mA |  | $\begin{array}{c\|} \hline \boldsymbol{T} \\ \\ \text { MIN } \\ \text { (MHz) } \\ \hline \end{array}$ |
| EN2369A <br> EN2484 <br> EN2894A <br> EN2905 | F | NPN NPN PNP PNP | $\begin{aligned} & S W \\ & G P \\ & S W \\ & G P \end{aligned}$ | A5T3707 <br> 2N4423 <br> A.5T2907 | 200 200 200 300 | 40 60 12 60 | 15 60 12 40 | $40-$ $100-500$ $40-120$ $100-300$ | 10 .01 30 150 | .2 .35 .19 .4 | 10 1 30 150 | 150 | 500 60 800 200 |
| EN2907 <br> EN3009 <br> EN3011 <br> EN3013 | F | PNP <br> NPN <br> NPN <br> NPN | $\begin{aligned} & \text { GP } \\ & \text { SW } \\ & \mathbf{S W} \\ & \mathbf{S W} \end{aligned}$ | $\begin{aligned} & \text { A5T2907 } \\ & \text { 2N3903 } \\ & \text { 2N3903 } \\ & \text { 2N3903 } \end{aligned}$ | 200 200 200 200 | 60 40 30 40 | 40 15 12 15 | $100-300$ $30-120$ $30-120$ $30-120$ | 150 30 10 30 | .4 .18 .2 .18 | 150 30 10 30 |  | 150 350 400 350 |
| EN3014 <br> EN3250 <br> EN3502 <br> EN3504 | $\left\lvert\, \begin{aligned} & \mathbf{F} \\ & \mathbf{F} \\ & \mathbf{F} \end{aligned}\right.$ | NPN PNP PNP PNP | $\left\lvert\, \begin{aligned} & \text { SW } \\ & \text { SW } \\ & \text { GP } \\ & \text { GP } \end{aligned}\right.$ | 2N3903 <br> A5T3504 A5T3504 | 200 200 300 200 | 40 40 45 45 | 20 40 45 45 | $30-120$ $50-150$ $100-300$ $100-300$ | 30 10 150 150 | .18 .25 .4 .4 | 30 10 150 150 |  | 350 250 150 150 |
| $\begin{aligned} & \text { EN3962 } \\ & \text { FE0654A } \\ & \text { FE0654B } \\ & \text { FE3819 } \end{aligned}$ | $\left\lvert\, \begin{aligned} & F \\ & F \\ & F \\ & F \end{aligned}\right.$ | $\left\lvert\, \begin{aligned} & \mathrm{PNP} \\ & \mathrm{NCH} \\ & \mathrm{NCH} \\ & \mathrm{NCH} \end{aligned}\right.$ | GP <br> FE <br> FE <br> FE | $\begin{aligned} & \text { AST4061 } \\ & \text { 2N5950 } \\ & \text { 2N5951 } \\ & \text { 2N5953 } \end{aligned}$ | 200 60 60 ( 60 <br> SEE FET INTERCHANGEABILITY LIST <br> SEE FET INTERCHANGEABILITY LIST <br> SEE FET INTERCHANGEABILITY LIST |  |  |  |  | . 25 | 1 | 100 |  |
| $\begin{aligned} & \text { FE5245 } \\ & \text { FE5246 } \\ & \text { FE5247 } \\ & \text { FE5457 } \end{aligned}$ | $\left\lvert\, \begin{aligned} & F \\ & F \\ & F \\ & F \end{aligned}\right.$ | $\begin{aligned} & \mathrm{NCH} \\ & \mathrm{NCH} \\ & \mathrm{NCH} \\ & \mathrm{NCH} \end{aligned}$ | FE <br> FE <br> FE <br> FE | $\begin{aligned} & \text { 2N5245 } \\ & \text { 2N5246 } \\ & \text { 2N5247 } \\ & \text { 2N5953 } \end{aligned}$ | SEE FET INTERCHANGEABLLITY LIST SEE FET INTERCHANGEABILITY LIST SEE FET INTERCHANGEABILITY LIST SEE FET INTERCHANGEABILITY LIST |  |  |  |  |  |  |  |  |
| $\begin{aligned} & \text { FE5458 } \\ & \text { FE5459 } \\ & \text { FE5484 } \\ & \text { FE5485 } \end{aligned}$ | $\left\lvert\, \begin{aligned} & F \\ & F \\ & F \end{aligned}\right.$ | NCH <br> NCH <br> NCH <br> NCH | FE <br> FE <br> FE <br> FE | $\begin{aligned} & \text { 2N5952 } \\ & \text { 2N5950 } \\ & \text { 2N5953 } \\ & \text { 2N5952 } \end{aligned}$ | SEE FET INTERCHANGEABILITY LIST <br> SEE FET INTERCHANGEABILITY LIST <br> SEE FET INTERCHANGEABILTY LIST <br> SEE FET INTERCHANGEABLLTY LIST |  |  |  |  |  |  |  |  |
| FE5486 <br> FT0654A <br> FT0654B <br> FT0654C | F $F$ $F$ $F$ | NCH <br> NCH <br> NCH <br> NCH | FE <br> FE <br> FE <br> FE | 2N5949 | SEE FET INTERCHANGEABILITY LIST SEE FET INTERCHANGEABALITY LIST SEE FET INTERCHANGEABILITY LIST SEE FET INTERCHANGEABILITY LIST |  |  |  |  |  |  |  |  |
| FT0654D FT701 FT703 FT704 | $\begin{aligned} & F \\ & f \\ & F \\ & F \end{aligned}$ | NCH PCH PCH PCH | FE <br> FE <br> FE <br> FE | 3N207 <br> 3N160 <br> 3N163 | SEE FET INTERCHANGEABLLITY LIST SEE FET INTERCHANGEABLLITY LIST SEE FET INTERCHANGEABILITY LIST SEE FET INTERCHANGEABILITY LIST |  |  |  |  |  |  |  |  |
| $\begin{aligned} & \text { FT3567 } \\ & \text { FT3568 } \\ & \text { FT3569 } \\ & \text { FT3641 } \end{aligned}$ | $\begin{aligned} & F \\ & F \\ & F \\ & F \end{aligned}$ | NPN NPN NPN NPN | GP <br> GP <br> GP <br> RF | TIS 110 | $\begin{aligned} & 500 \\ & 500 \\ & 500 \\ & 450 \end{aligned}$ | $\begin{aligned} & 80 \\ & 80 \\ & 80 \\ & 60 \end{aligned}$ | $\begin{aligned} & 40 \\ & 60 \\ & 40 \\ & 30 \end{aligned}$ | $\begin{array}{r} 40-120 \\ 40-120 \\ 100-300 \\ 40-120 \end{array}$ | $\begin{aligned} & 150 \\ & 150 \\ & 150 \\ & 150 \end{aligned}$ | .25 .25 .25 .22 | $\begin{aligned} & 150 \\ & 150 \\ & 150 \\ & 150 \end{aligned}$ |  | 60 60 250 |
| $\begin{aligned} & \text { FT3642 } \\ & \text { FT3643 } \\ & \text { FT3644 } \\ & \text { FT3645 } \end{aligned}$ | F | NPN <br> NPN <br> PNP <br> PNP | RF RF GP GP | TIS 110 A5T2222 AST3644 A.5T3645 | $\begin{aligned} & 450 \\ & 450 \\ & 450 \\ & 450 \end{aligned}$ | 60 60 45 60 | 45 30 45 60 | $\begin{array}{r} 40-120 \\ 100-300 \\ 100-300 \\ 100-300 \end{array}$ | 150 150 150 150 | .22 .22 .4 .4 | 150 150 150 150 |  | 250 250 200 200 |

# TRANSISTOR INTERCHANGEABILITY MASTER LIST OF NONREGISTERED TYPES 



## TRANSISTOR INTERCHANGEABILITY

MASTER LIST OF NONREGISTERED TYPES

| TYPI NUMCES |  |  | $\begin{aligned} & 8 \\ & 8 \\ & 8 \\ & 8 \\ & 8 \end{aligned}$ | $\begin{aligned} & \text { II } \\ & \text { RBPLACBMENT } \\ & \text { OR NHAREBY } \\ & \text { EQUYALBNT } \end{aligned}$ |  | ELCTRLCAL CHARACTERISTICS |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  |  | MIN MAX 1 | VClent)  <br> MAX IC <br> (V) (mA) | $\begin{gathered} \mathrm{h}_{8} \\ \mathrm{e} \\ \mathrm{k} \mathrm{kHz} \\ \mathrm{MiN} \end{gathered}$ |  |
| unp3935A <br> MF3956 <br> MF3957 <br> MP3958 | $\left\{\begin{array}{l} \mathbb{N} \\ \mathbb{N} \\ \mathbb{N} \\ \mathbb{N} \end{array}\right.$ | NCH <br> NCH <br> NCH <br> NCH | F <br> FE <br> 限 <br> FE | 2NS546 <br> 2N5547 <br> 2N5547 <br> 2N5045 | SEE FET NTERCHANGEABHTIY LIST SEE PET INTERCHANGEABILITY LST SEE FET INTERCHANGEABLLTY LIST SEE FET INTERCHANGEABILTYY LST |  |  |  |  |
| T108 <br> IT109 <br> III700 <br> IT1701 | $\left\lvert\, \begin{aligned} & \mathbb{N} \\ & \mathbb{N} \\ & \mathbb{N} \\ & \mathbb{N} \\ & \mathbb{N} \end{aligned}\right.$ | NCH <br> NCH <br> PCH <br> PCH | $\begin{aligned} & \text { FE } \\ & \text { FE } \\ & \text { FE } \\ & \text { FE } \end{aligned}$ | $\begin{aligned} & \text { 2N5245 } \\ & \text { 3N163 } \\ & \text { 3N163 } \end{aligned}$ | SEE FET INTERCHANGEABLITY LIST SER FET INTERCHANGEABILITY LIST SEE FET INTERCHANGEABLLITY LST sEE FET INTERCHANGEABLITY LIST |  |  |  |  |
| 171702 <br> IT1750 <br> 172700 <br> T2701 | $\left\lvert\, \begin{aligned} & \mathbf{N} \\ & \mathbf{N} \\ & \mathbf{N} \\ & \mathbf{N} \\ & \mathbf{N} \end{aligned}\right.$ | $\left\lvert\, \begin{aligned} & \mathrm{PCH} \\ & \mathrm{NCH} \\ & \mathrm{PCH} \\ & \mathrm{PCH} \end{aligned}\right.$ | $\begin{aligned} & \text { FE } \\ & \text { FE } \\ & \text { FE } \\ & \text { FE } \end{aligned}$ | 3 Nl 63 | SEE FET NTERCHANGEABILTY LST SEE FET iNTERCHANGEABLLTY LIST SEE FET INTERCHANGEABILITY LIST SEE FET INTERCHANGEABLLITY LIST |  |  |  |  |
| $\begin{aligned} & \text { ITESO66 } \\ & \text { TESE067 } \\ & \text { TESO68 } \\ & \text { TESHII7 } \end{aligned}$ | $\begin{aligned} & \mathbb{N} \\ & \mathbb{N} \\ & \mathbb{N} \\ & \mathbb{N} \\ & \mathbb{N} \end{aligned}$ | $\begin{aligned} & \mathrm{NCH} \\ & \mathrm{NCH} \\ & \mathrm{NCH} \\ & \mathrm{NCH} \end{aligned}$ | $\begin{aligned} & \text { FE } \\ & \text { FE } \\ & \text { FE } \\ & \text { FE } \end{aligned}$ | $\begin{aligned} & \text { 2N5953 } \\ & \text { 2N3460 } \end{aligned}$ | see fet interchangeablity list SEE FET INTERCHANGEABLLITY LIST SEE FET INTERCHANGEABILITY LIST SEE FET INTERCHANGEABILITY LIST |  |  |  |  |
| TE4118 <br> TTE419 <br> TEA338 <br> TrE4339 | $\left\lvert\, \begin{aligned} & \mathbf{N} \\ & \mathbb{N} \\ & \mathbb{N} \\ & \mathbb{N} \\ & \mathbf{N} \end{aligned}\right.$ | $\begin{aligned} & \mathrm{NCH} \\ & \mathrm{NCH} \\ & \mathrm{NCH} \\ & \mathrm{NCH} \end{aligned}$ | FE FE FE FE | $\begin{aligned} & \text { 2N3460 } \\ & \text { 2N3460 } \end{aligned}$ | SEE FET INTERCHANGEABILTTY LIST SEE FET INTERCHANGEABILITY LIST SEE FET INTERCHANGEABILTY LIST see fet interchangeablety list |  |  |  |  |
| $\begin{aligned} & \text { ITEA340 } \\ & \text { TEA341 } \\ & \text { TEA391 } \\ & \text { TE\&392 } \end{aligned}$ | $\left\lvert\, \begin{aligned} & \mathbb{N} \\ & \mathbb{N} \\ & \mathbb{N} \\ & \mathbb{N} \\ & \mathbb{N} \end{aligned}\right.$ | NCH <br> NCH <br> NCH <br> NCH | FE <br> FE <br> FE <br> FE | 2N5953 <br> 2N5953 <br> TIS73 <br> TIS74 | SEE FET INTERCHANGEABLITY LIST SEE FET INTERCHANGEABLITTY LIST SEE FET INTERCHANGEABLITYY UST SEE FET INTERCHANGEABMTTY LIST |  |  |  |  |
| ITEA393 <br> TTE4416 <br> ITEA867 <br> ITEA868 | $\left\{\begin{array}{l} \mathbb{N} \\ \mathbb{N} \\ \mathbb{N} \\ \mathbb{N} \end{array}\right.$ | NCH <br> NCH <br> NCH <br> NCH | $\begin{aligned} & \text { FE } \\ & \text { FE } \\ & \text { FE } \\ & \text { FE } \end{aligned}$ | TIS75 <br> 2N5245 <br> 2N3460 <br> 2N3459 | see fet interchangeabllity list SEE FET INTERCHANGEABLITYY LIST SEE FET INTERCHANGEABILITY LIST SEE FET INTERCHANGEABLIITY LIST |  |  |  |  |
| ITEA869 KE3684 KE3685 KE3686 | $\left\lvert\, \begin{aligned} & \mathbf{N} \\ & \mathbf{N} \\ & \mathbf{N} \\ & \mathbf{N} \end{aligned}\right.$ | NCH <br> NCH <br> NCH <br> NCH | FE <br> FE <br> FE <br> FE | $\begin{aligned} & \text { 2N5953 } \\ & \text { 2N5953 } \\ & \text { A5T3821 } \end{aligned}$ | SEE FET INTERCHANGEABILITY LIST SEE FET INTERCHANGEABILITY LIST SEE FET INTERCHANGEABILITY LIST SEE FET INTERCHANGEABILITY LIST |  |  |  |  |
| $\begin{aligned} & \text { KE3687 } \\ & \text { KE3823 } \\ & \text { KE3970 } \\ & \text { KE3971 } \end{aligned}$ | $\begin{aligned} & \mathbb{N} \\ & \mathbb{N} \\ & \mathbb{N} \\ & \mathbb{N} \end{aligned}$ | NCH <br> NCH <br> NCH <br> NCH | $\begin{aligned} & \text { FE } \\ & \text { FE } \\ & \text { FE } \\ & \text { FE } \end{aligned}$ | A5T3823 <br> TIS73 <br> TIS74 | SEE FET INTERCHANGEABILITY LIST SEE FET INTERCHANGEABILITY LIST SEE FET INTERCHANGEABILITY LIST SEE FET INTERCHANGEABILTY LIST |  |  |  |  |
| $\begin{aligned} & \text { KE3972 } \\ & \text { KE4091 } \\ & \text { KE4092 } \\ & \text { KE4093 } \end{aligned}$ | $\left\lvert\, \begin{aligned} & \mathbb{N} \\ & \mathbb{N} \\ & \mathbb{N} \\ & \mathbf{N} \end{aligned}\right.$ | NCH <br> NCH <br> NCH <br> NCH | $\begin{aligned} & \text { FE } \\ & \text { FE } \\ & \text { FE } \\ & \text { FE } \end{aligned}$ | TIS75 <br> TIS73 <br> TIS74 <br> T1575 | SEE FET INTERCHANGEABLLLTY LIST SEE FET INTERCHANGEABLLITY LIST SEE FET INTERCHANGEABLLTY LIST SEE FET INTERCHANGEABILTTY LIST |  |  |  |  |

## TRANSISTOR INTERCHANGEABILITY MASTER LIST OF NONREGISTERED TYPES

| typlnumber |  | $\begin{gathered} \text { K } \\ \frac{5}{5} \end{gathered}$ | $\begin{aligned} & \frac{7}{6} \\ & \frac{5}{5} \\ & \frac{5}{5} \\ & \frac{6}{3} \end{aligned}$ | $\begin{aligned} & \text { II } \\ & \text { REPACEMENT } \\ & \text { OR NEAREST } \\ & \text { EGUIVALINT } \end{aligned}$ | maximum rativos |  |  | ELECTRICAL CHARACTERISTICS |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  | $\begin{array}{ccc} \mathrm{T}_{A}=25^{\circ} \mathrm{C} & \text { VCEO } & \text { VCEO }^{{ }^{\circ} \mathrm{P}_{\mathrm{C}}=23^{\circ} \mathrm{C}} \\ (\mathrm{~mW}) & \text { (V) } & \text { (V) } \\ \hline \end{array}$ |  |  | hre |  | $\mathrm{V}_{\text {ces }}^{\text {(sel }}$ ) |  | $\begin{gathered} h_{80} \\ \theta_{1} \mathrm{kdt} \\ \text { Mw } \end{gathered}$ |  |
|  |  |  |  |  |  |  |  | MIN M/ | $\begin{aligned} & \text { Ic } \\ & \text { (ma) } \end{aligned}$ |  | $\begin{array}{ll} \hline \mathrm{Ic} \\ (\mathrm{~mA}) \end{array}$ |  |  |
| KEA220 | $\mathfrak{N}$ | NCH | FE | A ${ }^{\text {ST3821 }}$ | SEE FET INTERCHANGEABLITY LST SEE FET INTERCHANGEABILTY LIST SEE FET INTERCHANGEABITY LIST SEE FET INTERCHANGEAGLLTY UST |  |  |  |  |  |  |  |  |
| KL4221 | IN | NCH | FE | A 453822 |  |  |  |  |  |  |  |  |  |
| KEA222 | N | NCH | FE | A5T3822 |  |  |  |  |  |  |  |  |  |
| KEA223 | IN | NCH | FE | 2NS950 |  |  |  |  |  |  |  |  |  |
| KEA224 | IN | NCH | PR | 2N5949 | SEE FET INTERCHANGEABHLTY LIST SEE FET INTERCHANGEABLITY LIST SEE FET INTERCHANGEABLITY LIST SEE FET INTERCHANGEABLLTY LIST |  |  |  |  |  |  |  |  |
| KE4391 | N | NCH | FE | T1573 |  |  |  |  |  |  |  |  |  |
| KE4392 | IN | NCH | FE | T1574 |  |  |  |  |  |  |  |  |  |
| KE4393 | IN | NCH | FE | T1875 |  |  |  |  |  |  |  |  |  |
| KE4416 | IN | NCH | PE | 2N5245 | See fet interchangeability ust SEE FET INTERCHANGEADIUTY LST SEE FET INTERCHANGEADILTYY LST SEE FET INTERCHANGEABLITY LST |  |  |  |  |  |  |  |  |
| KE4856 | IN | NCH | FE | 7573 |  |  |  |  |  |  |  |  |  |
| KE4857 | IN | NCH | PE | Tis74 |  |  |  |  |  |  |  |  |  |
| KE4858 | IN | NCH | FE | T1575 |  |  |  |  |  |  |  |  |  |
| KE4859 | IN | NCH | FE | 71573 | SEE FET INTERCHANGEABLITY LIST SEE FET INTERCHANGEABLLTYY LST SEE FET NTERCHANGEABMITY LST SEE FET INTERCHANGEABLLTY LIST |  |  |  |  |  |  |  |  |
| KEA860 | IN | NCH | FE | T1574 |  |  |  |  |  |  |  |  |  |
| KE4861 | IN | NCH | FE | Tis75 |  |  |  |  |  |  |  |  |  |
| KE5103 | 1 N | NCH | FE | 2N5952 |  |  |  |  |  |  |  |  |  |
| KES104 | $\mathfrak{N}$ | NCH | PE | 2N5953 | SEE FET INTERCHANGEABLITY LIST SEE FET INTERCHANGEABLITY LIST SEE FET INTERCHANGEABLUTY LST see fet interchangeablity list |  |  |  |  |  |  |  |  |
| KE5105 | IN | NCH | FE | 2NS245 |  |  |  |  |  |  |  |  |  |
| M100 | SI | NCH | FE |  |  |  |  |  |  |  |  |  |  |
| M101 |  | NCH | FE |  |  |  |  |  |  |  |  |  |  |
| M103 |  | PCH | FE | 3N161 | SEE fET INTERCHANGEABLITY LIST SEE FET INTERCHANGEABLITY LST SEe fet interchangeablity list SEE FET INTERCHANGEABLITY LIST |  |  |  |  |  |  |  |  |
| M104 | S1 | PCH | FE | 3N161 |  |  |  |  |  |  |  |  |  |
| M106 | 51 | PCH | FE | 3N208 |  |  |  |  |  |  |  |  |  |
| M107 | 51 | PCH | FE | 3N208 |  |  |  |  |  |  |  |  |  |
| M108 | st | PCH | FE | 3N207 | SEE FET INTERCHANGEABILTY LIST SEE FET INTERCHANGEAELITY LIST SEE FET INTERCHANGEABMTYY LIST SEE fet interchangeablity list |  |  |  |  |  |  |  |  |
| M113 | SI | PCH | FE | 3N158 |  |  |  |  |  |  |  |  |  |
| M114 | SI | PCH | FE | 3N160 |  |  |  |  |  |  |  |  |  |
| M116 |  | NCH | FE | 3N161 |  |  |  |  |  |  |  |  |  |
| M117 |  | NCH | FE | 3N160 | SEE fET INTERCHANGEABLITY LIST SEE FET INTERCHANGEABILITY LIST SEE FET INTERCHANGEABLITYY LIST SEE FET INTERCHANGEABHITY LIST |  |  |  |  |  |  |  |  |
| M119 | SI | PCH | FE | 3N161 |  |  |  |  |  |  |  |  |  |
| M511 | SI | PCH | FE | 3N161 |  |  |  |  |  |  |  |  |  |
| MSIIA | SI | PCH | FE | 3N161 |  |  |  |  |  |  |  |  |  |
| M517 MD708 MD708A MD708B | $\begin{aligned} & s i \\ & M \\ & M \\ & M \end{aligned}$ | PCH |  | 3N161 | SEE fet interchanceability list |  |  |  |  |  |  |  |  |
|  |  | NPN | DU |  | 400 | 40 | 15 | 10-200 | 10 |  |  |  |  |
|  |  | NPN | DU |  | 400 | 40 | 15 | 40-200 | 10 | . 2 | 10 |  | 300 300 |
|  |  | NPN | DU |  | 400 |  | 15 | 40-200 | 10 |  | 10 |  | 300 |
| MD918 | M | NPN | DU | D2T918 | 400 | 30 | 15 | 50. | 1 |  | 10 |  |  |
| MD918A | M | NPN | DU | D2T918 | 400 | 30 | 15 | 50. | 1 | . 2 | 10 |  | 600 |
| M09188 | M | NPN | DU | D2T918 | 400 | 30 | 15 | so. | 1 | . 2 | 10 |  | 400 |
| MD984 | M | PNP | DU | D2T2905 | 600 | 40 | 20 | 25. | 10 |  | 10 |  |  |

## TRANSISTOR INTERCHANGEABILITY MASTER LIST OF NONREGISTERED TYPES

| TYPE NUMEES |  |  | $\begin{aligned} & 5 \\ & \frac{8}{8} \\ & 8 \\ & 8 \\ & 8 \end{aligned}$ |  | MAXIMUM RATINOS |  |  | EECTRICAL CHARACTIRISTICS |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  | $\begin{gathered} P_{T} \\ T_{A}=25^{\circ} \mathrm{C} \\ { }^{T_{C}-25^{\circ} \mathrm{C}} \\ (\mathrm{~mW}) \\ \hline \end{gathered}$ | Vcso <br> (V) | Vceo <br> (V) | $\begin{aligned} & \text { hFE } \\ & \text { MIN MAX } \end{aligned}$ | $\begin{gathered} 1 c \\ (\mathrm{~mA}) \end{gathered}$ | $$ | seil) (ma) |  |  |
| MD986 <br> MD1 120 <br> MD1 121 <br> MD1 122 | $\begin{aligned} & M \\ & M \\ & M \\ & M \end{aligned}$ | N/P <br> NPN <br> NPN <br> NPN | DU <br> DU <br> DU <br> DU | 2N4854 <br> D2T2219 <br> D2T2219 <br> D2T2219 | $\begin{aligned} & 600 \\ & 600 \\ & 600 \\ & 600 \end{aligned}$ | $\begin{aligned} & 40 \\ & 60 \\ & 60 \\ & 60 \end{aligned}$ | $\begin{aligned} & 15 \\ & 30 \\ & 30 \\ & 30 \end{aligned}$ | $\begin{aligned} & 25- \\ & 50-200 \\ & 50-200 \\ & 50-200 \end{aligned}$ | 10 10 10 10 | .3 .1 .1 .1 | $\begin{aligned} & 10 \\ & 10 \\ & 10 \\ & 10 \end{aligned}$ |  | $\begin{aligned} & 200 \\ & 250 \\ & 250 \\ & 250 \end{aligned}$ |
| MD1 126 <br> MD1 127 <br> MDII28 <br> MD1 129 | $\begin{aligned} & M \\ & M \\ & M \\ & M \end{aligned}$ | NPN <br> NPN <br> NPN <br> NPN | $\text { DU } \begin{aligned} & D U \\ & D U \\ & D U \end{aligned}$ | D2T2219 | $\begin{array}{r} 400 \\ 400 \\ 400 \\ 600 \end{array}$ | $\begin{array}{r} 40 \\ 40 \\ 40 \\ 60 \end{array}$ | $\begin{aligned} & 15 \\ & 15 \\ & 15 \\ & 30 \end{aligned}$ | $\begin{gathered} 30 . \\ 30- \\ 25 . \\ 100-300 \end{gathered}$ | 10 10 10 .1 | .4 .25 .3 .1 | 10 10 10 10 |  | 300 300 350 200 |
| MDII30 <br> MDI131 <br> MDI 132 <br> MDI 134 | $\begin{aligned} & M \\ & M \\ & M \\ & M \end{aligned}$ | $\begin{aligned} & \text { PNP } \\ & \text { NPN } \\ & \text { NPN } \\ & \text { NPN } \end{aligned}$ | DU | $\begin{aligned} & \text { D2T2905 } \\ & \text { D2T918 } \\ & \text { D2T918 } \\ & \text { D2T918 } \end{aligned}$ | $\begin{aligned} & 600 \\ & 400 \\ & 400 \\ & 600 \end{aligned}$ | $\begin{aligned} & 60 \\ & 30 \\ & 30 \\ & 40 \end{aligned}$ | $\begin{aligned} & 40 \\ & 15 \\ & 15 \\ & 15 \end{aligned}$ | $\begin{aligned} & 100-300 \\ & 50- \\ & 50- \\ & 30- \end{aligned}$ | 1 1 1 10 | .25 .4 .4 .25 | $\begin{aligned} & 10 \\ & 10 \\ & 10 \\ & 10 \end{aligned}$ |  | $\begin{aligned} & 200 \\ & 600 \\ & 600 \\ & 500 \end{aligned}$ |
| $\begin{aligned} & \mathrm{MD} 2218 \\ & \mathrm{MD} 2218 \mathrm{~A} \\ & \mathrm{MD} 2119 \\ & \mathrm{MD2219A} \end{aligned}$ | $\left(\begin{array}{l} M \\ M \\ M \\ M \end{array}\right.$ | NPN NPN NPN NPN | $\begin{aligned} & D U \\ & D U \\ & D U \\ & D U \end{aligned}$ | D2T2219 <br> D2T2219 <br> D272219 <br> D2T2219 | $\begin{aligned} & 600 \\ & 600 \\ & 600 \\ & 600 \end{aligned}$ | $\begin{aligned} & 60 \\ & 75 \\ & 60 \\ & 75 \end{aligned}$ | $\begin{aligned} & 30 \\ & 40 \\ & 30 \\ & 40 \end{aligned}$ | $\begin{aligned} & 40-120 \\ & 40.120 \\ & 40-120 \\ & 40-120 \end{aligned}$ | $\begin{aligned} & 150 \\ & 150 \\ & 150 \\ & 150 \end{aligned}$ | .4 .3 .4 .3 | $\begin{aligned} & 150 \\ & 150 \\ & 150 \\ & 150 \end{aligned}$ |  | 200 200 200 200 |
| $\begin{aligned} & \text { MD2369 } \\ & \text { MD2369A } \\ & \text { MD23698 } \\ & \text { MD2904 } \end{aligned}$ | $\begin{aligned} & M \\ & M \\ & M \\ & M \end{aligned}$ | $\begin{aligned} & \text { NPN } \\ & \text { NPN } \\ & \text { NPN } \\ & \text { PNP } \end{aligned}$ | DU <br> DU <br> DU <br> DU | D2T2905 | $\begin{aligned} & 600 \\ & 600 \\ & 600 \\ & 600 \end{aligned}$ | $\begin{aligned} & 40 \\ & 40 \\ & 40 \\ & 60 \end{aligned}$ | $\begin{aligned} & 15 \\ & 15 \\ & 15 \\ & 40 \end{aligned}$ | $\begin{aligned} & 40-140 \\ & 40-140 \\ & 40-140 \\ & 40-120 \end{aligned}$ | $\begin{array}{r} 10 \\ 10 \\ 10 \\ 150 \end{array}$ | .25 .25 .25 .4 | $\begin{array}{r} 10 \\ 10 \\ 10 \\ 150 \end{array}$ |  | 500 500 500 200 |
| $\begin{aligned} & \text { MD2904A } \\ & \text { MD2905 } \\ & \text { MD2905A } \\ & \text { MD3250 } \end{aligned}$ | $\begin{aligned} & M \\ & M \\ & M \\ & M \end{aligned}$ | PNP PNP PNP PNP | DU DU DU DU | D2T2905 <br> 0272905 <br> D2T2905 <br> 2N3347 | $\begin{aligned} & 600 \\ & 600 \\ & 600 \\ & 600 \end{aligned}$ | $\begin{aligned} & 60 \\ & 60 \\ & 60 \\ & 50 \end{aligned}$ | $\begin{aligned} & 60 \\ & 40 \\ & 40 \\ & 40 \end{aligned}$ | $\begin{array}{r} 40-120 \\ 100-300 \\ 100-300 \\ 50-150 \end{array}$ | $\begin{array}{r} 150 \\ 150 \\ 150 \\ .1 \end{array}$ | .4 .4 .4 .25 | 150 150 150 10 | 50 | 200 200 200 200 |
| $\begin{aligned} & \text { MD3250A } \\ & \text { MD3251 } \\ & \text { MD3251A } \\ & \text { MD3467 } \end{aligned}$ | $\begin{aligned} & M \\ & M \\ & M \\ & M \end{aligned}$ | $\begin{array}{\|l\|l} \text { PNP } \\ \text { PNP } \\ \text { PNP } \\ \text { PNP } \end{array}$ | DU DU DU DU | $\begin{aligned} & \text { 2N3347 } \\ & \text { 2N3350 } \\ & \text { 2N3350 } \end{aligned}$ | $\begin{aligned} & 600 \\ & 600 \\ & 600 \\ & 600 \end{aligned}$ | $\begin{aligned} & 50 \\ & 50 \\ & 50 \\ & 40 \end{aligned}$ | $\begin{aligned} & 40 \\ & 40 \\ & 40 \\ & 40 \end{aligned}$ | $\begin{aligned} & 50-150 \\ & 100-300 \\ & 100-300 \\ & 20- \end{aligned}$ | $\begin{array}{r} .1 \\ .1 \\ .1 \\ 500 \end{array}$ | .25 .25 .25 .35 | $\begin{array}{r} 10 \\ 10 \\ 10 \\ 500 \end{array}$ | 50 100 100 | $\begin{aligned} & 200 \\ & 150 \end{aligned}$ |
| $\begin{aligned} & \text { MD3725 } \\ & \text { MD3762 } \\ & \text { MD4957 } \\ & \text { MD5000 } \end{aligned}$ | $\begin{aligned} & M \\ & M \\ & M \\ & M \end{aligned}$ | $\begin{aligned} & \text { NPN } \\ & \text { PNN } \\ & \text { PNNP } \\ & \text { PNP } \end{aligned}$ | DU <br> DU <br> DU <br> DU |  | $\begin{aligned} & 600 \\ & 600 \\ & 400 \\ & 400 \end{aligned}$ | 65 40 30 20 | 40 40 30 15 | $50-150$ 20 $20-150$ $20-$ | 100 14 2 3 | $\begin{array}{r} .26 \\ 1 \end{array}$ | $\begin{array}{r} 100 \\ 14 \\ 10 \end{array}$ |  | 250 150 16 600 |
| $\begin{aligned} & \text { MD5000A } \\ & \text { MD5000 } \\ & \text { MD6001 } \\ & \text { MD6002 } \end{aligned}$ | $\begin{aligned} & M \\ & M \\ & M \\ & M \end{aligned}$ | $\begin{aligned} & \text { PNP } \\ & \text { PNN } \\ & N / P \\ & N / P \end{aligned}$ | DU <br> DU <br> DU <br> DU | $\begin{aligned} & \text { 2N4855 } \\ & \text { 2N4854 } \end{aligned}$ | $\begin{aligned} & 400 \\ & 400 \\ & 600 \\ & 600 \end{aligned}$ | $\begin{aligned} & 20 \\ & 20 \\ & 60 \\ & 60 \end{aligned}$ | $\begin{aligned} & 15 \\ & 15 \\ & 30 \\ & 30 \end{aligned}$ | $\begin{aligned} & 20- \\ & 20- \\ & 40-120 \\ & 100-300 \end{aligned}$ | $\begin{array}{r} 3 \\ 3 \\ 150 \\ 150 \end{array}$ | .4 .4 .4 .4 | $\begin{array}{r} 10 \\ 10 \\ 150 \\ 150 \end{array}$ |  | 600 600 200 200 |
| MD6003 <br> MEMSII <br> MEMSIIC <br> MEM517 | $\left\lvert\, \begin{aligned} & M \\ & G 1 \\ & G 1 \\ & G 1 \end{aligned}\right.$ | $\left\lvert\, \begin{aligned} & \mathrm{N} / \mathrm{P} \\ & \mathrm{PCH} \\ & \mathrm{PCH} \\ & \mathrm{PCH} \end{aligned}\right.$ | $\begin{aligned} & \text { DU } \\ & \text { FE } \\ & \text { fE } \\ & \text { FE } \end{aligned}$ | $\begin{aligned} & \text { 2N4854 } \\ & \text { 3N174 } \\ & \text { 3N174 } \end{aligned}$ | 600 SEE FE SEE FE SEE FE | 50 <br> INTERCH <br> INTERC <br> INTERCI | 30 <br> ANGEABI ANGEABLI ANGEABI | 70. <br> ITY LIST ITY LIST ITY LIST | $150$ | . 4 | $150$ |  | 200 |

## TRANSISTOR INTERCHANGEABILITY MASTER LIST OF NONREGISTERED TYPES



## TRANSISTOR INTERCHANGEABILITY MASTER LIST OF NONREGISTERED TYPES

| TYPE NUMBER |  | 288 | $\begin{aligned} & \text { Z } \\ & \frac{5}{\mathbf{2}} \\ & \frac{\mathbf{2}}{\mathbf{3}} \\ & \mathbf{3} \end{aligned}$ | $\begin{gathered} \text { MI } \\ \text { REPLACEMENT } \\ \text { OR NEAREST } \\ \text { EOUVAUENT } \end{gathered}$ | MAXIMUM RATMNSS |  |  | EECTRICAL CMARACTERISTICS |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  | $\begin{gathered} P_{T} \\ { }^{T_{A}=25^{\circ} \mathrm{C}} \\ { }^{\circ}{ }^{\circ} \mathrm{C}=25^{\circ} \mathrm{C} \\ (\mathrm{~mW}) \\ \hline \end{gathered}$ | VC3O <br> (V) | $V_{c E O}$ <br> (V) | MIN MAX | $\begin{gathered} \mathbf{k} \\ (\mathrm{mA}) \\ \hline \end{gathered}$ |  | $\begin{aligned} & \text { sefi) } \\ & \hline(\mathrm{mA}) \\ & \hline \end{aligned}$ |  | $\qquad$ |
| MFE2133 <br> MFE3001 <br> MFE3002 <br> MFE3003 | $\begin{aligned} & M \\ & M \\ & M \\ & M \end{aligned}$ | NCH NCH NCH PCH | $\begin{array}{\|l\|l} \text { FE } \\ \text { FE } \\ \text { FE } \end{array}$ | 2N4860 <br> 3N128 <br> 3N169 <br> 3N156 | set fet interchangeabluit list SEE FET INTERCHANGEABHITY LST SEE FET INTERCHANGEABLLTY LIST SEE FET INTERCHANGEABLLTTY LIST |  |  |  |  |  |  |  |  |
| $\begin{aligned} & \text { MFE } 3004 \\ & \text { MFE } 3005 \\ & \text { MFE3006 } \\ & \text { MFE } \end{aligned}$ | $\begin{aligned} & M \\ & M \\ & M \\ & M \end{aligned}$ | NCH <br> NCH <br> NCH <br> NCH | $\begin{aligned} & \mathrm{FE} \\ & \mathrm{FE} \\ & \mathrm{FE} \\ & \mathrm{FE} \end{aligned}$ | $\begin{aligned} & \text { 3N203 } \\ & \text { 3N201 } \end{aligned}$ | SEE FET INTERCHANGEABMLTY LIST SEE FET INTERCHANGEABLLITY LIST SEE FET INTERCHANGEABHITY LIST SEE FET INTERCHANGEABILITY LIST |  |  |  |  |  |  |  |  |
| $\begin{aligned} & \text { MFE3008 } \\ & \text { MFE3020 } \\ & \text { MFE3021 } \\ & \text { MFE4007 } \end{aligned}$ | $\begin{aligned} & M \\ & M \\ & M \\ & M \end{aligned}$ | $\begin{aligned} & \mathrm{NCH} \\ & \mathrm{PCH} \\ & \mathrm{PCH} \\ & \mathrm{PCH} \end{aligned}$ | $\begin{aligned} & \mathrm{FE} \\ & \mathrm{FE} \\ & \mathrm{FE} \\ & \mathrm{FE} \end{aligned}$ | $\begin{aligned} & \text { 3N203 } \\ & \text { 3N207 } \end{aligned}$ | SEE FET INTERCHANGEABILITY LIST SEE PET INTERCHANGEABILITY LIST SEE FET INTERCHANGEABHLITY LIST SEE FET INTERCHANGEABILTTY LIST |  |  |  |  |  |  |  |  |
| $\begin{aligned} & \text { MFE } 4008 \\ & \text { MFE4009 } \\ & \text { MFE } 4010 \\ & \text { MFE4011 } \end{aligned}$ | $\begin{aligned} & M \\ & M \\ & M \\ & M \end{aligned}$ | $\left\lvert\, \begin{aligned} & \mathrm{PCH} \\ & \mathrm{PCH} \\ & \mathrm{PCH} \\ & \mathrm{PCH} \end{aligned}\right.$ | FE <br> FE <br> FE <br> FE |  | SEE FET INTERCHANGEABILTYY LIST SEE FET INTERCHANGEABLLITY LIST SEE FET INTERCHANGEABMTYY UST SEE FET INTERCHANGEABLITY UST |  |  |  |  |  |  |  |  |
| MFE4012 <br> M420 <br> MJ421 <br> M 18100 | $\begin{aligned} & M \\ & M \\ & M \\ & M \end{aligned}$ | $\begin{aligned} & \text { PCH } \\ & \text { NPN } \\ & \text { NPN } \\ & \text { PNP } \end{aligned}$ | FE <br> GP <br> GP <br> GP | $\begin{aligned} & \text { 2N5059 } \\ & \text { 2N5058 } \end{aligned}$ | SEE FET <br> 800 <br> 800 <br> 10W | $\begin{gathered} \text { NTERCH } \\ 275 \\ 350 \\ 60 \end{gathered}$ | $\begin{aligned} & \text { ANGEABML } \\ & 250 \\ & 325 \\ & 60 \end{aligned}$ | $\begin{array}{\|l\|l} \text { TY } \\ \text { LIST } \\ 25-250 \\ 25-250 \\ 25-180 \end{array}$ | $\begin{aligned} & 30 \\ & 30 \\ & 2 \mathrm{AA} \end{aligned}$ | 5 5 .7 | 30 30 24 |  | 15 15 30 |
| M 8101 <br> mM709 <br> MM1803 <br> MM1812 | $\begin{aligned} & M \\ & M \\ & M \\ & M \end{aligned}$ | PNP NPN NPN NPN | GP SW RF GP | 2N5059 | $\begin{array}{r} 10 \mathrm{w} \\ 400 \\ 800 \\ 1 \mathrm{w} \end{array}$ | 80 15 50 175 | 80 8 25 175 | $25-180$ $15-120$ $40-160$ $40-300$ | $2 A$ 10 50 100 | .7 .35 .3 .6 | $\begin{array}{r} 2 A \\ 3 \\ 50 \\ 100 \end{array}$ | 50 | 30 300 |
| MM1941 <br> MM2258 <br> MM2259 <br> MM2260 | $\begin{aligned} & M \\ & M \\ & M \\ & M \end{aligned}$ | NPN <br> NPN <br> NPN <br> NPN | RF <br> GP <br> GP <br> GP | $\begin{aligned} & \text { 2N5059 } \\ & \text { 2N5059 } \\ & \text { 2N5059 } \end{aligned}$ | $\begin{aligned} & 300 \\ & 16 \\ & 16 \\ & 1 W \end{aligned}$ | $\begin{array}{r} 30 \\ 120 \\ 175 \\ 175 \end{array}$ | 20 120 175 175 | $25-$ $35-$ $50-$ 50 | 10 50 50 50 | . 4 | $\begin{aligned} & 25 \\ & 25 \\ & 25 \end{aligned}$ |  | 600 150 150 150 |
| $\begin{aligned} & \text { MM2483 } \\ & \text { MW2484 } \\ & \text { MM2894 } \\ & \text { MM3000 } \end{aligned}$ | $\begin{aligned} & M \\ & M \\ & M \\ & M \end{aligned}$ | NPN <br> NPN <br> PNP <br> NPN | GP GP SW GP | 2N2483 <br> 2N2484 <br> 2N2894 <br> 2N5059 | 360 360 360 $1 W$ | 60 60 15 | 60 60 12 100 | $40-120$ $100-500$ $40-150$ $20-$ | .01 .01 30 10 | .35 .35 .2 | $\begin{array}{r} 1 \\ 1 \\ 30 \end{array}$ | 80 150 | 60 60 400 150 |
| $\begin{aligned} & \text { MM3001 } \\ & \text { MM3002 } \\ & \text { MM3003 } \\ & \text { MM3008 } \end{aligned}$ | $\begin{aligned} & M \\ & M \\ & M \\ & M \end{aligned}$ | NPN <br> NPN <br> NPN <br> NPN | GP GP GP GP | 2N5059 <br> 2N5059 <br> 2N5059 <br> 2N3114 | iw iw iw iw |  | $\begin{aligned} & 150 \\ & 200 \\ & 250 \\ & 120 \end{aligned}$ | $20-$ 20 $20-$ $30-$ | 10 10 10 30 |  |  |  | 150 150 150 50 |
| $\begin{aligned} & \text { MM3009 } \\ & \text { MM3724 } \\ & \text { MM3725 } \\ & \text { MM3726 } \end{aligned}$ | $\begin{aligned} & M \\ & M \\ & M \\ & M \end{aligned}$ | NPN <br> NPN <br> NPN <br> PNP | GP SW <br> SW <br> SW | $\begin{aligned} & \text { 2N5059 } \\ & \text { 2N3724 } \\ & \text { 2N3725 } \end{aligned}$ | $\begin{aligned} & \text { 1w } \\ & \text { 1W } \\ & \text { iw } \\ & \text { iw } \end{aligned}$ |  | $\begin{array}{r} 180 \\ 30 \\ 50 \\ 50 \end{array}$ | $\begin{aligned} & 30- \\ & 25-150 \\ & 25-150 \\ & 30-120 \end{aligned}$ | $\begin{array}{r} 30 \\ 500 \\ 500 \\ 500 \end{array}$ | .6 .6 .6 | 500 500 500 |  | 50 200 200 200 |

## TRANSISTOR INTERCHANGEABILITY MASTER LIST OF NONREGISTERED TYPES

| tryme |  | $\begin{aligned} & \frac{\xi}{2} \\ & \frac{6}{2} \end{aligned}$ | $\begin{aligned} & \text { K } \\ & \frac{8}{5} \\ & \frac{5}{4} \\ & \frac{5}{3} \end{aligned}$ | $\begin{aligned} & \text { TI } \\ & \text { REMACEMONT } \\ & \text { OR NEAREST } \\ & \text { ECUHVAIENT } \end{aligned}$ | maximum ratmes |  |  | Eectircal chatacteristics |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  | $\begin{array}{ccc} P_{T} & & \\ { }^{\mathrm{T}_{A}-25^{\circ} \mathrm{C}} & \mathrm{VCBO} & \mathrm{~V}_{\mathrm{CE}} \\ { }^{\circ} \mathrm{T}_{\mathrm{C}}=25^{\circ} \mathrm{C} & & \\ (\mathrm{~mW}) & \text { (V) } & \text { (V) } \\ \hline \end{array}$ |  |  | hre |  | $\mathbf{V C E}_{\text {(mat) }}$ |  | $\begin{gathered} \mathrm{m}_{\mathrm{f}_{6}} \\ 1 \mathrm{kNtz} \\ \text { mwn } \end{gathered}$ |  |
| м 43903 Mu3904 M43905 M43906 | ${\underset{M}{M}}_{M}^{M}$ | $\begin{array}{\|l} \text { NPN } \\ \text { NPN } \\ \text { PNP } \\ \text { PNP } \end{array}$ | $\begin{aligned} & s w \\ & \text { sw } \\ & \text { sw } \\ & s w \end{aligned}$ |  | $\begin{aligned} & 360 \\ & 360 \\ & 360 \\ & 360 \end{aligned}$ | $\begin{aligned} & 60 \\ & 80 \\ & 40 \\ & 40 \end{aligned}$ | $\begin{aligned} & 40 \\ & 40 \\ & 40 \\ & 40 \end{aligned}$ | 50-150 100-300 50.150 100.300 | $\begin{aligned} & 10 \\ & 10 \\ & 10 \\ & 10 \end{aligned}$ | $\begin{array}{\|r} .2 \\ .2 \\ .25 \\ .25 \end{array}$ | $\begin{aligned} & 10 \\ & 10 \\ & 10 \\ & 10 \end{aligned}$ | $\begin{array}{r} 50 \\ 100 \\ 50 \\ 100 \end{array}$ | 250 300 200 250 |
| M44000 <br> MM4001 <br> MM4002 <br> MM4003 | $\begin{aligned} & M \\ & M \\ & M \\ & M \end{aligned}$ | $\begin{array}{\|l} \text { PNP } \\ \text { PNP } \\ \text { PNP } \\ \text { PNP } \end{array}$ | $\begin{aligned} & \text { GP } \\ & \text { GP } \\ & \text { GP } \\ & \text { GP } \end{aligned}$ | $\begin{aligned} & \text { 2N3634 } \\ & \text { 2N3635 } \end{aligned}$ | $\begin{aligned} & 1 w \\ & 1 w \\ & 1 w \\ & 1 w \end{aligned}$ | $\begin{aligned} & 100 \\ & 150 \\ & 200 \\ & 250 \end{aligned}$ | $\begin{aligned} & 100 \\ & 150 \\ & 200 \\ & 250 \end{aligned}$ | $\begin{aligned} & 20 \\ & 20 \\ & 20 \\ & 20 . \end{aligned}$ | $\begin{aligned} & 10 \\ & 10 \\ & 10 \\ & 10 \end{aligned}$ | .6 .6 .6 .6 | $\begin{aligned} & 10 \\ & 10 \\ & 10 \\ & 10 \end{aligned}$ |  |  |
| M M 4018 MW4019 M44048 MM4049 | $\begin{aligned} & M \\ & M \\ & M \\ & M \end{aligned}$ | $\begin{aligned} & \text { PNP } \\ & \text { PNP } \\ & \text { PNP } \\ & \text { PNP } \end{aligned}$ | $\begin{aligned} & \mathrm{RF} \\ & \mathrm{RF} \\ & \mathrm{RF} \\ & \mathrm{GP} \\ & \mathrm{RF} \end{aligned}$ | 2N3798 | $\begin{aligned} & 800 \\ & 800 \\ & 360 \\ & 200 \end{aligned}$ | 40 60 45 15 | $\begin{aligned} & 20 \\ & 40 \\ & 45 \\ & 10 \end{aligned}$ | $\begin{aligned} & 10- \\ & 10- \\ & 150-450 \\ & 20-80 \end{aligned}$ | $\begin{array}{r} 50 \\ 250 \\ .5 \\ 25 \end{array}$ | . 1 | 250 .5 |  | 900 750 100 20 |
| MM4052 <br> MM4645 <br> MM4646 <br> MM4647 | $\begin{gathered} M \\ M \\ M \\ M \\ M \end{gathered}$ | $\left\lvert\, \begin{aligned} & \mathbf{P N P} \\ & \mathbf{P N P} \\ & \mathbf{P N P} \\ & \mathbf{P N P} \end{aligned}\right.$ | $\begin{aligned} & s w \\ & G P \\ & G P \\ & G P \end{aligned}$ |  | $\begin{array}{r} 500 \\ \cdot 5 w \\ \cdot 5 w \\ \cdot 5 w \end{array}$ | 200 300 400 | $\begin{array}{r} 30 \\ 200 \\ 300 \\ 400 \end{array}$ | 15 20 20 20 | $\begin{aligned} & 150 \\ & 500 \\ & 500 \\ & 500 \end{aligned}$ | 1 1.2 1.5 | $\begin{aligned} & 500 \\ & 500 \\ & 500 \end{aligned}$ | 20 | 12 40 40 30 |
|  | $\begin{aligned} & M \\ & M \\ & M \\ & M \end{aligned}$ | $\begin{aligned} & \text { PNP } \\ & \text { PNP } \\ & \text { PNP } \\ & \text { NPN } \end{aligned}$ | $\begin{aligned} & \text { GP } \\ & \text { GP } \\ & \text { GP } \\ & \text { RF } \end{aligned}$ | 2N4030 | $\begin{aligned} & 1.5 \\ & 1.5 \\ & 1.5 \\ & 3.5 \end{aligned}$ | $\begin{array}{r} 80 \\ 100 \\ 120 \\ 40 \end{array}$ | $\begin{array}{r} 60 \\ 80 \\ 100 \\ 30 \end{array}$ | $\begin{aligned} & 50-250 \\ & 50-250 \\ & 50-250 \\ & 30 \end{aligned}$ | $\begin{array}{r} 150 \\ 200 \\ 250 \\ 50 \end{array}$ | .5 .5 .5 | $\begin{aligned} & 150 \\ & 150 \\ & 150 \end{aligned}$ |  | 30 30 30 700 |
| MM8001 m43002 mue006 MM8007 | $\begin{array}{\|c} \hline M \\ M \\ M \\ M \\ M \end{array}$ | NPN <br> NPN <br> NPN <br> NPN | $\begin{array}{\|l\|} \hline \mathbf{R F} \\ \mathbf{R F} \\ \hline \mathbf{R F} \\ \mathbf{R F} \end{array}$ | $\begin{array}{\|l\|l\|} \text { 2N3571 } \\ \text { 2N3571 } \end{array}$ | 3.5 3.5 200 200 | 40 40 15 15 | 30 30 10 10 | 30. 30. 25. 25. | 50 50 1 1 |  |  |  | 900 1200 16 16 |
| M48009 <br> MMT3823 <br> MPF 102 <br> MPF103 | $\left\lvert\, \begin{aligned} & M \\ & M \\ & M \\ & M \end{aligned}\right.$ | NPN <br> NCH <br> NCH <br> NCH | $\begin{aligned} & \mathrm{RF} \\ & \mathrm{FE} \\ & \mathrm{FE} \\ & \mathrm{FE} \\ & \mathrm{FE} \end{aligned}$ | 2N3823 <br> 2N3819 <br> 2N5953 | $3.5$ <br> SEE FET <br> SEE FET <br> SEE FET | 55 <br> TERCHAN <br> TERCHA <br> tercha |  | $\begin{aligned} & \mathbf{Y} \text { ust } \\ & \mathbf{Y} \text { ust } \\ & \mathbf{Y} \text { uST } \end{aligned}$ |  | . 5 | 100 |  | 100 |
| MPF104 MPF105 MPF106 MPF107 | $\begin{aligned} & M \\ & M \\ & M \\ & M \end{aligned}$ | NCH <br> NCH <br> NCH <br> NCH | $\begin{array}{\|l\|l} \mathrm{FE} \\ \mathrm{FE} \\ \mathrm{FE} \\ \mathrm{FE} \\ \mathrm{FE} \end{array}$ | 2N5952 <br> 2N5951 <br> 2N5952 <br> 2N5950 | SEE FET IN <br> SEE FET IN <br> SEE FET IN <br> SEE FET IN |  |  | $\begin{aligned} & \text { Y UST } \\ & \text { Y UST } \\ & \text { Y UST } \\ & \text { Y UST } \end{aligned}$ |  |  |  |  |  |
| MPF108 MPF109 MPF111 MPFI12 | $\begin{aligned} & M \\ & M \\ & M \\ & M \end{aligned}$ | NCH NCH NCH NCH | FE <br> fE <br> FE <br> FE | 2N3819 <br> 2N3819 <br> 2N3819 <br> 2N3819 | SEE FET <br> SEE FET IN <br> SEE FET IN <br> SEE FET IN |  | NGEABHIT TGEASLIT NGEABLIT HGEABLC | $\begin{aligned} & \text { Y ust } \\ & \text { Y ust } \\ & \text { Y uss } \\ & \text { Y ust } \end{aligned}$ |  |  |  |  |  |
| MPF120 MPF121 MPF122 MPF161 | $\begin{aligned} & M \\ & M \\ & M \\ & M \end{aligned}$ | NCH NCH NCH PCH | FE <br> FE <br> FE <br> FE | 2N5462 | SEE FET IN SEE FET IN SEE FET SEE FET IN | TERCHA TERCHAN TERCHAN TERCHAN |  | $\begin{aligned} & \text { Y UST } \\ & \text { Y UST } \\ & \text { Y UST } \\ & \text { Y UST } \end{aligned}$ |  |  |  |  |  |

## TRANSISTOR INTERCHANGEABILITY MASTER LIST OF NONREGISTERED TYPES

| TYPE NUMBER |  | $\begin{aligned} & \frac{k}{k} \\ & \frac{1}{x} \\ & \frac{1}{6} \end{aligned}$ | 3$\frac{6}{6}$$\frac{3}{2}$$\frac{1}{2}$$\frac{5}{4}$ | 7 REPLACEMENT OR NEAREST EOUIVALENT | MAXIMUM RATINGS |  |  | ELECTRICAL CHARACTERISTICS |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  | $\begin{gathered} \mathrm{T}_{\mathrm{A}}=25^{\circ} \mathrm{C} \\ { }^{{ }^{\mathrm{T}} \mathrm{C}=25^{\circ} \mathrm{C}} \\ (\mathrm{~mW}) \end{gathered}$ | $\mathbf{V C B O}$ <br> (V) | Vceo <br> (V) | hFE | $\left.\begin{array}{c} \mathrm{l} C \\ (\mathrm{~mA}) \end{array}\right]$ |  | (sot) <br> (mA) |  | $\begin{gathered} \mathbf{f}_{\boldsymbol{T}} \\ \mathbf{M I N} \\ (\mathbf{M H z}) \\ \hline \end{gathered}$ |
| MPQ3303 MPQ3725 MPS404 MP5404A | $\begin{aligned} & M \\ & M \\ & M \\ & M \end{aligned}$ | NPN <br> NPN <br> PNP <br> PNP | $\begin{aligned} & \text { sw } \\ & \text { sw } \\ & \text { sw } \\ & \text { sw } \end{aligned}$ | Q273725 <br> A8T404 <br> A8T404A | 600 600 310 310 | $\begin{aligned} & 25 \\ & 25 \\ & 40 \end{aligned}$ | 12 40 24 35 | $40-200$ $35-200$ $30-400$ $30-400$ | 300 100 12 12 | .33 .45 .15 .15 | 300 500 12 12 |  | 400 250 |
| MPS706 <br> MPS706A <br> MPS834 <br> MPS918 | $\begin{aligned} & M \\ & M \\ & M \\ & M \end{aligned}$ | NPN NPN NPN NPN | $\begin{array}{\|l} \text { SW } \\ \text { SW } \\ \text { SW } \\ \text { RF } \end{array}$ | $\begin{aligned} & \text { 2N3903 } \\ & \text { TIS62 } \end{aligned}$ | $\begin{aligned} & 310 \\ & 310 \\ & 310 \\ & 310 \end{aligned}$ | $\begin{aligned} & 25 \\ & 25 \\ & 40 \\ & 30 \end{aligned}$ | $\begin{aligned} & 15 \\ & 15 \\ & 15 \end{aligned}$ | $20-$ $20-60$ $25-$ $20-$ | 10 10 10 3 | .6 .6 .25 .4 | $\begin{aligned} & 10 \\ & 10 \\ & 10 \\ & 10 \end{aligned}$ |  | $\begin{aligned} & 200 \\ & 200 \\ & 350 \\ & 600 \end{aligned}$ |
| $\begin{aligned} & \text { MPS2369 } \\ & \text { MPS2711 } \\ & \text { MPS2712 } \\ & \text { MPS2713 } \end{aligned}$ | $\begin{aligned} & M \\ & M \\ & M \\ & M \end{aligned}$ | NPN NPN NPN NPN | $\begin{aligned} & \text { SW } \\ & \text { GP } \\ & \text { GP } \\ & \text { SW } \end{aligned}$ | A8T3709 <br> A873710 <br> 2N3903 | $\begin{aligned} & 310 \\ & 310 \\ & 310 \\ & 310 \end{aligned}$ | 40 18 18 18 | 15 18 18 18 | $40-120$ $30-90$ $75-225$ $30-90$ | 10 2 2 2 | . 25 | 10 | 30 80 30 | 500 |
| $\begin{aligned} & \text { MPS2714 } \\ & \text { MPS2923 } \\ & \text { MPS2924 } \\ & \text { MPS2925 } \end{aligned}$ | $\left(\begin{array}{l} M \\ M \\ M \\ M \end{array}\right.$ | NPN NPN NPN NPN | $\begin{aligned} & \text { SW } \\ & G P \\ & G P \\ & G P \end{aligned}$ | $\begin{aligned} & \text { 2N3904 } \\ & \text { A8T3710 } \\ & \text { A8T3710 } \\ & \text { A8T3711 } \end{aligned}$ | 310 200 200 200 | 18 25 25 25 | $\begin{aligned} & 18 \\ & 25 \\ & 25 \\ & 25 \end{aligned}$ | 75-225 | 2 |  |  | 80 90 150 235 |  |
| $\begin{aligned} & \text { MPS2926 } \\ & \text { MPS3392 } \\ & \text { MPS3393 } \\ & \text { MPS3394 } \end{aligned}$ | $\begin{aligned} & M \\ & M \\ & M \\ & M \end{aligned}$ | NPN NPN NPN NPN | GP GP GP GP | A8T3709 <br> AT3392 <br> TIS95 <br> TIS96 | $\begin{aligned} & 310 \\ & 310- \\ & 310 \\ & 310 \end{aligned}$ | $\begin{aligned} & 18 \\ & 25 \\ & 25 \\ & 25 \end{aligned}$ | $\begin{aligned} & 18 \\ & 25 \\ & 25 \\ & 25 \end{aligned}$ | $150-300$ $90-180$ $55-110$ | 2 $\mathbf{2}$ $\mathbf{2}$ |  |  | 35 150 90 55 |  |
| $\begin{aligned} & \text { MPS3395 } \\ & \text { MPS3563 } \\ & \text { MPS3638 } \\ & \text { MPS3638A } \end{aligned}$ | $\left\lvert\, \begin{aligned} & M \\ & M \\ & M \\ & M \end{aligned}\right.$ | NPN <br> NPN <br> PNP <br> PNP | GP <br> RF <br> GP <br> GP | TIS94 <br> TIS63 <br> A5T3638 <br> AST3638A | $\begin{aligned} & 310 \\ & 310 \\ & 310 \\ & 310 \end{aligned}$ | $\begin{aligned} & \mathbf{2 5} \\ & 30 \\ & \mathbf{2 5} \\ & \mathbf{2 5} \end{aligned}$ | $\begin{aligned} & 25 \\ & 12 \\ & 25 \\ & 25 \end{aligned}$ | $\begin{aligned} & 150-500 \\ & 20-200 \\ & 30- \\ & 100- \end{aligned}$ | $\begin{array}{r} 2 \\ 8 \\ 50 \\ 50 \end{array}$ | $\begin{aligned} & .25 \\ & .25 \end{aligned}$ | $\begin{aligned} & 50 \\ & 50 \end{aligned}$ | $\begin{array}{r} 150 \\ 25 \\ 100 \end{array}$ | 600 100 150 |
| $\begin{aligned} & \text { MP53639 } \\ & \text { MPS3640 } \\ & \text { MPS3646 } \\ & \text { MPS3693 } \end{aligned}$ | $\begin{aligned} & M \\ & M \\ & M \\ & M \end{aligned}$ | PNP <br> PNP <br> NPN <br> NPN | SW <br> SW <br> SW <br> RF | 2N4423 <br> 2N4423 <br> 2N3903 <br> 2N4994 | $\begin{aligned} & 200 \\ & 310 \\ & 200 \\ & 310 \end{aligned}$ | $\begin{array}{r} 6 \\ 12 \\ 40 \\ 45 \end{array}$ | $\begin{array}{r} 6 \\ 12 \\ 15 \\ 45 \end{array}$ | $\begin{aligned} & 30-120 \\ & 30-120 \\ & 30-120 \\ & 40-160 \end{aligned}$ | 10 10 30 10 | .16 .2 .2 | 10 10 30 |  | 500 500 350 200 |
| $\begin{aligned} & \text { MPS3694 } \\ & \text { MPS3702 } \\ & \text { MPS3703 } \\ & \text { MPS3704 } \end{aligned}$ | $\begin{aligned} & M \\ & M \\ & M \\ & M \end{aligned}$ | NPN PNP PNP NPN | RF <br> GP <br> GP <br> GP | 2N4995 <br> A8T3702 <br> A8T3703 <br> A873704 | $\begin{aligned} & 310 \\ & 310 \\ & 310 \\ & 310 \end{aligned}$ | $\begin{aligned} & 45 \\ & 40 \\ & 50 \\ & 50 \end{aligned}$ | $\begin{aligned} & \mathbf{4 5} \\ & \mathbf{2 5} \\ & 30 \\ & \mathbf{3 0} \end{aligned}$ | $\begin{array}{r} 100-400 \\ 60-300 \\ 30-150 \\ 100-300 \end{array}$ | 10 50 50 50 | .25 .25 .6 | 50 50 100 |  | 200 100 100 100 |
| $\begin{aligned} & \text { MPS3705 } \\ & \text { MPS3706 } \\ & \text { MPS3707 } \\ & \text { MPS } 3708 \end{aligned}$ | $\begin{aligned} & M \\ & M \\ & M \\ & M \end{aligned}$ | NPN <br> NPN <br> NPN <br> NPN | GP <br> GP <br> GP <br> GP | A8T3705 <br> A873706 <br> A873707 <br> A8T3708 | $\begin{array}{r} 310 \\ 310 \\ 310 \\ 310 \end{array}$ | $\begin{aligned} & 50 \\ & 40 \\ & 30 \\ & 30 \end{aligned}$ | $\begin{aligned} & 30 \\ & 20 \\ & 30 \\ & 30 \end{aligned}$ | $\begin{array}{r} 50-150 \\ 30-600 \\ 100-400 \\ 45-660 \end{array}$ | 50 50 .1 1 | .8 1 1 1 | 100 100 10 10 | 100 45 | 100 100 |
| MPS3709 <br> MPS3710 <br> MPS3711 <br> MPS3721 | $\begin{aligned} & M \\ & M \\ & M \\ & M \end{aligned}$ | NPN <br> NPN <br> NPN <br> NPN | GP GP GP GP | A873709 <br> A8T3710 <br> A873711 <br> TIS96 | $\begin{aligned} & 310 \\ & 310 \\ & 310 \\ & 310 \end{aligned}$ | $\begin{aligned} & 30 \\ & 30 \\ & 30 \\ & 18 \end{aligned}$ | $\begin{aligned} & 30 \\ & 30 \\ & 30 \\ & 18 \end{aligned}$ | $45-165$ $90-330$ $180-660$ | 1 1 1 | 1 1 1 | 10 10 10 | 45 90 180 60 |  |

## TRANSISTOR INTERCHANGEABILITY MASTER LIST OF NONREGISTERED TYPES



## TRANSISTOR INTERCHANGEABILITY

MASTER LIST OF NONREGISTERED TYPES

|  |  | $\begin{aligned} & \frac{6}{6} \\ & \frac{1}{6} \end{aligned}$ | $\begin{aligned} & 8 \\ & \frac{8}{3} \\ & 8 \\ & 8 \end{aligned}$ | $\begin{aligned} & \text { TI } \\ & \text { REPLACTMINT } \\ & \text { OR NBAREST } \\ & \text { COUNALENT } \end{aligned}$ | MAXIMUM RATINOS |  |  | EACMmCAL CHARAGTEISTICS |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| TYFE MUMBER |  |  |  |  | $\begin{array}{ccc} P_{T} & & \\ T_{A}=23^{\circ} \mathrm{C} & \mathbf{V}_{\text {ceo }} & \mathrm{V}_{\mathrm{CHO}} \\ { }^{\circ} \mathrm{T}_{\mathrm{C}}=25^{\circ} \mathrm{C} & & \\ (\mathrm{~mW}) & (\mathrm{V}) & (\mathrm{V}) \\ \hline \end{array}$ |  |  | hn/ |  | VCl(sat) |  |  | $\begin{gathered} \text { T } \\ \text { MuN } \\ \text { (MHz) } \\ \hline \end{gathered}$ |
| MPS-A05 <br> MPS-A06 <br> MPS-A09 <br> MPS-A10 | $\begin{aligned} & M \\ & M \\ & M \\ & M \end{aligned}$ | NPN NPN NPN NPN | GP <br> GP <br> GP <br> GP | TIS96 <br> TIS96 <br> A873707 <br> TIS96 | $\begin{aligned} & 500 \\ & 500 \\ & 310 \\ & 300 \end{aligned}$ | $\begin{aligned} & 60 \\ & 80 \\ & 50 \end{aligned}$ | 60 80 50 40 | $\begin{aligned} & 50- \\ & 50- \\ & 100-600 \\ & 40-400 \end{aligned}$ | $\begin{array}{r} 10 \\ 10 \\ .1 \\ 5 \end{array}$ | .25 .25 .9 | $\begin{array}{r} 100 \\ 100 \\ 10 \end{array}$ |  | 50 50 30 50 |
| $\begin{aligned} & \text { MPS-A12 } \\ & \text { MPS-A13 } \\ & \text { MPS-A14 } \\ & \text { MPS-A20 } \end{aligned}$ | $\begin{aligned} & M \\ & M \\ & M \\ & M \end{aligned}$ | NPN <br> NPN <br> NPN <br> NPN | DA <br> DA <br> DA <br> GP | $\begin{aligned} & \text { 2N5525 } \\ & \text { 2N5525 } \\ & \text { 2N5525 } \\ & \text { TIS94 } \end{aligned}$ | $\begin{aligned} & 500 \\ & 500 \\ & 500 \\ & 300 \end{aligned}$ | $\begin{aligned} & 20 \\ & 30 \\ & 30 \end{aligned}$ | 40 | $\begin{aligned} & 20 \mathrm{~K}- \\ & 5 \mathrm{~K}- \\ & 10 \mathrm{~K}- \\ & 40-400 \end{aligned}$ | 10 10 10 5 | 1 1.5 1.5 .25 | $\begin{array}{r} 10 \\ 100 \\ 100 \\ 10 \end{array}$ |  | 125 125 125 |
| $\begin{aligned} & \text { MPS-A55 } \\ & \text { MPS-A56 } \\ & \text { MPS-A65 } \\ & \text { MPS-A66 } \end{aligned}$ | $\begin{aligned} & M \\ & M \\ & M \\ & M \end{aligned}$ | \|PNP | $\begin{aligned} & \text { GP } \\ & \text { GP } \\ & D A \\ & D A \end{aligned}$ | $\begin{aligned} & \text { A.5T2907 } \\ & \text { A5T2907 } \end{aligned}$ | $\begin{aligned} & 500 \\ & 500 \\ & 500 \\ & 500 \end{aligned}$ | $\begin{aligned} & 30 \\ & 30 \end{aligned}$ | $\begin{aligned} & 60 \\ & 80 \\ & 30 \\ & 30 \end{aligned}$ | $\begin{array}{r} 50- \\ 50- \\ 50 \mathrm{~K}- \\ 75 \mathrm{~K}- \end{array}$ | $\begin{array}{r} 100 \\ 100 \\ 10 \\ 10 \end{array}$ | $\begin{aligned} & .25 \\ & .25 \end{aligned}$ | $\begin{aligned} & 100 \\ & 100 \end{aligned}$ |  | 50 50 100 100 |
| $\begin{aligned} & \text { MPS-A70 } \\ & \text { MPS-H02 } \\ & \text { MPS-H04 } \\ & \text { MPS-H05 } \end{aligned}$ | $\begin{aligned} & M \\ & M \\ & M \\ & M \end{aligned}$ | PNP <br> NPN <br> NPN <br> NPN | $\begin{aligned} & \text { GP } \\ & \text { RF } \\ & \text { RF } \\ & \text { RF } \end{aligned}$ | $\begin{aligned} & \text { A8T3702 } \\ & \text { TIS84 } \\ & \text { TIS94 } \\ & \text { TIS94 } \end{aligned}$ | $\begin{aligned} & 300 \\ & 500 \\ & 300 \\ & 300 \end{aligned}$ | $\begin{aligned} & 20 \\ & 80 \\ & 80 \end{aligned}$ | $\begin{aligned} & 40 \\ & 20 \\ & 80 \\ & 80 \end{aligned}$ | $\begin{aligned} & 40-400 \\ & 20-200 \\ & 30-120 \\ & 30-150 \end{aligned}$ | $\begin{array}{r} 5 \\ 4 \\ 1.5 \\ 1.5 \end{array}$ | $\begin{aligned} & .25 \\ & .25 \\ & .25 \end{aligned}$ | $\begin{aligned} & 10 \\ & 10 \\ & 10 \end{aligned}$ |  | 125 375 80 80 |
| $\begin{aligned} & \text { MPS-H07 } \\ & \text { MPS-H08 } \\ & \text { MPS-H10 } \\ & \text { MPS-H11 } \end{aligned}$ | $\begin{aligned} & M \\ & M \\ & M \\ & M \end{aligned}$ | $\begin{aligned} & \text { NPN } \\ & \text { NPN } \\ & \text { NPN } \\ & \text { NPN } \end{aligned}$ | $\begin{aligned} & R F \\ & R F \\ & R F \\ & R F \end{aligned}$ | $\begin{aligned} & \text { TIS125 } \\ & \text { TIS125 } \end{aligned}$ | 500 500 310 310 | 30 30 30 30 | 30 30 25 25 | 20 20 $60-$ 60 | 3 3 4 4 | . 5 | 4 |  | 400 500 650 650 |
| $\begin{aligned} & \text { MPS-H20 } \\ & \text { MPS-H24 } \\ & \text { MPS-H30 } \\ & \text { MPS-H31 } \end{aligned}$ | $\left\lvert\, \begin{aligned} & M \\ & M \\ & M \end{aligned}\right.$ | NPN PNP NPN NPN | $\begin{aligned} & \text { RF } \\ & \text { RF } \\ & \text { RF } \\ & \text { RF } \end{aligned}$ | TIS86 <br> TIS 126 <br> TIS 108 <br> TIS 108 | $\begin{aligned} & 310 \\ & 500 \\ & 310 \\ & 310 \end{aligned}$ | $\begin{aligned} & 40 \\ & 40 \\ & 20 \\ & 20 \end{aligned}$ | $\begin{aligned} & 30 \\ & 30 \\ & 20 \\ & 20 \end{aligned}$ | $\begin{aligned} & 25- \\ & 30- \\ & 20-200 \\ & 20-200 \end{aligned}$ | 4 4 4 4 | 3 3 | 10 10 |  | 400 400 300 300 |
| $\begin{aligned} & \text { MPS-H32 } \\ & \text { MPS-H34 } \\ & \text { MPS-H37 } \\ & \text { MPS-H54 } \end{aligned}$ | $\begin{aligned} & M \\ & M \\ & M \\ & M \end{aligned}$ | NPN NPN NPN PNP | $\begin{aligned} & \text { RF } \\ & \text { RF } \\ & \text { RF } \\ & \text { GP } \end{aligned}$ | T1584 <br> TIS126 <br> 2N4994 <br> TIS 104 | $\begin{aligned} & 500 \\ & 500 \\ & 310 \\ & 300 \end{aligned}$ | $\begin{aligned} & 40 \\ & 45 \\ & 80 \end{aligned}$ | 30 45 40 80 | $27-200$ $40-$ $25-$ $30-120$ | 4 7 5 1.5 | 3 .5 .5 .25 | 10 20 10 10 |  | 300 500 300 80 |
| MPS.H55 <br> MPS-H83 <br> MP5-LOI <br> MPS-L07 | $\begin{aligned} & M \\ & M \\ & M \\ & M \end{aligned}$ | $\begin{aligned} & \text { PNP } \\ & \text { PNP } \\ & \text { NPN } \\ & \text { PNP } \end{aligned}$ | RF <br> RF <br> GP <br> SW | TIS104 <br> 2N5550 <br> 2N4423 | $\begin{aligned} & 300 \\ & 625 \\ & 310 \\ & 310 \end{aligned}$ | $\begin{array}{r} 80 \\ 30 \\ 140 \\ 12 \end{array}$ | $\begin{array}{r} 80 \\ 30 \\ 120 \\ 6 \end{array}$ | $\begin{aligned} & 30-150 \\ & 20- \\ & 50-300 \\ & 30-120 \end{aligned}$ | $\begin{array}{r} 1.5 \\ 2.5 \\ 10 \\ 10 \end{array}$ | $\begin{array}{r} .25 \\ .2 \\ .15 \end{array}$ | $\begin{aligned} & 10 \\ & 10 \\ & 10 \end{aligned}$ | 30 | 80 600 60 500 |
| MPS-L08 <br> MPS-L5 1 <br> MU4891 <br> MU4892 | $\begin{aligned} & M \\ & M \\ & M \\ & M \end{aligned}$ | $\left\lvert\, \begin{aligned} & \text { PNP } \\ & \text { PNP } \\ & \text { P-N } \\ & \text { P-N } \end{aligned}\right.$ | SW <br> GP <br> UJ <br> UJ | 2N4423 <br> 2N5400 <br> 2N4891 <br> 2N4892 | $\begin{aligned} & 310 \\ & 310 \end{aligned}$ <br> SEE UN SEE UN |  | $\begin{array}{r}6 \\ 100 \\ \hline\end{array}$ <br> I INTERCH | $\begin{aligned} & 30-120 \\ & 40-250 \end{aligned}$ <br> HANGEABILIT HANGEABHLI | $\begin{array}{r} 10 \\ \text { IST } \\ \\ 50 \\ \text { IST } \end{array}$ | $\begin{array}{r} 15 \\ .3 \end{array}$ | $\begin{aligned} & 10 \\ & 50 \end{aligned}$ | 20 | 700 60 |
| MU4893 <br> MU4894 <br> NF500 <br> NF501 | $\left\|\begin{array}{c} M \\ M \\ \mathrm{NA} \end{array}\right\|$ $\|\mathrm{NA}\|$ | $\left\lvert\, \begin{aligned} & \text { P-N } \\ & \mathrm{P}-\mathrm{N} \\ & \mathrm{NCH} \\ & \mathrm{NCH} \end{aligned}\right.$ | $\begin{aligned} & \text { UJ } \\ & \text { UJ } \\ & \text { FE } \\ & \text { FE } \end{aligned}$ | 2N4893 2N4894 2N3823 2N3823 | SEE UNUUNCTION INTERCHANGEABMLTY LIST <br> SEE UNUUNCTION INTERCHANGEABILITY LIST <br> SEE FET INTERCHANGEABILITY LIST <br> SEE FET INTERCHANGEABILITY LIST |  |  |  |  |  |  |  |  |

## TRANSISTOR INTERCHANGEABILITY MASTER LIST OF NONREGISTERED TYPES

| TYP NUME |  |  | 88888 | TIRMACMANTOR NDARESTGEUNALENT | MaxII | UM RA | 108 | InCTRICAI CMARACTLISIICS |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  | $\left\lvert\, \begin{array}{ccc} \mathrm{T}_{A}-23^{\circ} \mathrm{C} & \text { VCNO } & \text { VCCO } \\ { }^{\circ} \mathrm{T}_{\mathrm{C}}=25^{\circ} \mathrm{C} & & \\ (\mathrm{~mW}) & \text { (V) } & \text { (V) } \\ \hline \end{array}\right.$ |  |  | $h_{\text {P }}$ |  | Vclent) |  | $\begin{gathered} h_{40} \\ 1 \mathrm{kdts} \\ \text { MiN } \end{gathered}$ | $\begin{gathered} \text { H } \\ \text { MN } \\ \text { (MHz) } \end{gathered}$ |
|  |  |  |  |  |  |  |  | MiN M | - lc (ma) | $\begin{aligned} & \max \\ & (\mathrm{V}) \\ & \hline \end{aligned}$ | $\begin{aligned} & C \\ & (\mathrm{ma}) \end{aligned}$ |  |  |
| NFSO6 | NA | NCH | FE | 2NA416 | SEE FET INTERCHANGEABILITY LIST SEE FET INTERCHANGEABLITY LST SEE FET INTERCHANGEABLITYY LIST SEE FET INTERCHANGEABHITY LIST |  |  |  |  |  |  |  |  |
| NF510 | NA | NCH | FE | 2N4861 |  |  |  |  |  |  |  |  |  |
| NF511 | NA | NCH | FE | 2N4861 |  |  |  |  |  |  |  |  |  |
| NF520 | NA | NCH | FE | 2N3822 |  |  |  |  |  |  |  |  |  |
| NF521 | NA | NCH | FE | 2N3821 | SEE FET INTERCHANGEABLITY LIST SEE FET INTERCHANGEABIUTY LIST SEE FET INTERCHANGEABLLTY UST SEE FET INTERCHANGEABILTY LIST |  |  |  |  |  |  |  |  |
| NF522 | NA | NCH | FE | 2N3822 |  |  |  |  |  |  |  |  |  |
| NF523 | NA | NCH | FE | 2N3821 |  |  |  |  |  |  |  |  |  |
| NF530 | MA | NCH | FE | 2N3459 |  |  |  |  |  |  |  |  |  |
| NF531 | NA | NCH | FE | 2N3460 | SEE FET INTERCHANGEABLLTTY UST <br> SEE FET INTERCHANGEABILTY LIST <br> SEE FET INTERCHANGEABLITY LIST <br> SEE FET INTERCHANGEABILTY LST |  |  |  |  |  |  |  |  |
| NF532 | NA | NCH | FE | 2N3459 |  |  |  |  |  |  |  |  |  |
| NF533 | MA | NCH | FE | 2N3460 |  |  |  |  |  |  |  |  |  |
| NF580 | NA | NCH | FE |  |  |  |  |  |  |  |  |  |  |
| NF581 | NA |  |  |  | SEE FET INTERCHANGEABLITY LIST <br> SEE FET INTERCHANGEABUTY LIST <br> SEE FET INTERCHANGEABLITY LIST <br> SEE FET INTERCHANGEABLLTY LST |  |  |  |  |  |  |  |  |
| NF582 | NA | $\mathrm{NCH}$ | FE |  |  |  |  |  |  |  |  |  |  |
| NF583 | NA | NCH | FE |  |  |  |  |  |  |  |  |  |  |
| NF584 | NA | NCH | FE |  |  |  |  |  |  |  |  |  |  |
| NF585 | NA | NCH | FE |  | SEE FET INTERCHANGEABILTYY LIST SEE FET INTERCHANGEABLITY LIST SEE FET INTERCHANGEABLITY LIST SEE FET INTERCHANGEABLITY LIST |  |  |  |  |  |  |  |  |
| NF4445 | NA | NCH | FE |  |  |  |  |  |  |  |  |  |  |
| NF4446 | NA | NCH | FE |  |  |  |  |  |  |  |  |  |  |
|  |  |  | FE |  |  |  |  |  |  |  |  |  |  |
| NF4448 | NA | NCH | FE |  | SEE FET INTERCHANGEABILITY LIST SEE FET INTERCHANGEABILITY LIST SEE FET INTERCHANGEABILITY LIST SEE FET INTERCHANGEABILITY LIST |  |  |  |  |  |  |  |  |
| NF5457 | NA | NCH | FE | 2N3459 |  |  |  |  |  |  |  |  |  |
| NF5458 | NA | NCH | FE | 2N3459 |  |  |  |  |  |  |  |  |  |
| NF5459 | NA | NCH | FE | 2N3458 |  |  |  |  |  |  |  |  |  |
| NP5485 | NA | NCH | FE | 2 N 4416 | SEE FET INTERCHANGEABILITY LIST SEE FET INTERCHANGEABILTY LIST SEE FET INTERCHANGEAMLITY LST SEE FET INTERCHANGEABLITY LIST |  |  |  |  |  |  |  |  |
| NP5486 | NA | NCH | FE | 2N4416 |  |  |  |  |  |  |  |  |  |
| NF5555 | Na | NCH | FE |  |  |  |  |  |  |  |  |  |  |
|  | NA | NCH | FE | 2N4391 |  |  |  |  |  |  |  |  |  |
| NF5639 | NA | NCH | FE | 2N4392 | SEE FET INTERCHANGEABILTYY LIST SEE FET INTERCHANGEABILTY LIST SEE FET INTERCHANGEABILTY LIST SEE FET INTERCHANGEABILTY UST |  |  |  |  |  |  |  |  |
| NF5640 | NA | NCH | FE | 2N4393 |  |  |  |  |  |  |  |  |  |
| NF5653 | NA | NCH | FE | 2N4856 |  |  |  |  |  |  |  |  |  |
| NF5654 | NA | NCH | FE | 2N4857 |  |  |  |  |  |  |  |  |  |
| Q272222 | 7 | NPN | GP | Q272222 | 1.5 | 60 | 30 | 100-300 | 150 | . 4 | 150 |  | 250 |
| Q272905 | T1 | PNP | GP | Q2T2905 | 1.5 | 60 | 40 | 100.300 | 150 | . 4 | 150 |  | 200 |
| Q273244 | TI | PNP | SW | Q273244 | 1.5 | 40 | 40 | 50-150 | 500 | . 5 | 500 |  | 175 |
| Q273725 | 7 | NPN | SW | Q2T3725 | 1.5 | 60 | 40 | 60-200 | 100 |  | 500 |  | 250 |
| SE1001 | F | NPN | RF | 2N4994 | 200 | 45 | 45 | 40-160 | 10 |  |  |  | 200 |
| SE1002 | F | NPN | RF | 2N4995 | 200 | 45 | 45 | 100-400 | 10 |  |  |  | 200 |
| SE1010 | $F$ | NPN | GP | T1595 | 200 | 30 | 15 | 20. | 2 |  |  |  | 200 |
| SE1132 | $F$ | PNP | GP | 2N5448 | 300 | 50 | 35 | 30-90 | 150 | 1.5 | 150 | 25 | 60 |

## TRANSISTOR INTERCHANGEABILITY MASTER LIST OF NONREGISTERED TYPES

| TYPE NUMERE |  | $\xi$3$\$$ | $z$$\frac{8}{8}$$\frac{8}{6}$38 | $\begin{aligned} & \text { II } \\ & \text { REPLACEMENT } \\ & \text { OR NEAREST } \\ & \text { ECUTVALENT } \end{aligned}$ | MAXIMUM RATENOS |  |  | ETCTRICAL CNARACTIEISILCS |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  | $\begin{gathered} P_{T} \\ T_{A}=25^{\circ} \mathrm{C} \\ { }^{-1} \mathrm{C}=25^{\circ} \mathrm{C} \\ (\mathrm{~mW}) \end{gathered}$ | Veso <br> (V) | Veeo <br> (V) |  | $\begin{gathered} C \\ (m A) \end{gathered}$ | MaX <br> (V) | $\begin{array}{\|l\|} \hline(0 n) \\ \hline \\ \hline \end{array}$ |  | $\mathrm{f}_{\mathrm{T}}$ MN $\mathrm{MOHz}_{\mathrm{M}}$ |
| $\begin{aligned} & \text { SE2001 } \\ & \text { SE2002 } \\ & \text { SE3001 } \\ & \text { SE3002 } \end{aligned}$ | F F F | NPN <br> NPN <br> NPN <br> NPN | $\begin{aligned} & \text { GP } \\ & \text { GP } \\ & \text { RF } \\ & \text { RF } \end{aligned}$ | 2N5450 <br> 2N5449 <br> TIS62 <br> TIS62 | $\begin{aligned} & 200 \\ & 200 \\ & 200 \\ & 200 \end{aligned}$ | 35 35 30 30 | 20 20 12 12 | $40-160$ $100-400$ 20. 20 | 10 10 8 8 | .7 .7 .6 .6 | 10 10 10 10 |  | $\begin{aligned} & 200 \\ & 200 \\ & 600 \\ & 600 \end{aligned}$ |
| $\begin{aligned} & \text { sE3005 } \\ & \text { sE4001 } \\ & \text { sE4002 } \\ & \text { sE4010 } \end{aligned}$ | F $\mathbf{F}$ $\mathbf{F}$ $\mathbf{F}$ | NPN NPN NPN NPN | RF <br> GP <br> GP <br> GP | A5T3571 <br> A5T3710 <br> A5T3711 <br> A5T3711 | $\begin{aligned} & 200 \\ & 200 \\ & 200 \\ & 200 \end{aligned}$ | $\begin{aligned} & 30 \\ & 30 \\ & 30 \\ & 30 \end{aligned}$ | $\begin{aligned} & 15 \\ & 25 \\ & \mathbf{2 5} \\ & \mathbf{2 5} \end{aligned}$ | $\begin{gathered} 45-300 \\ 200-1000 \\ 200-1000 \\ 200-1000 \end{gathered}$ | 5 1 1 1 | .35 .35 .35 | 1 1 1 |  | 800 40 60 60 |
| $\begin{aligned} & \text { SE4020 } \\ & \text { SE4021 } \\ & \text { SE4022 } \\ & \text { SE5001 } \end{aligned}$ | $\begin{aligned} & F \\ & F \\ & F \\ & F \end{aligned}$ | NPN <br> NPN <br> NPN <br> NPN | GP <br> GP <br> GP <br> RF | $\begin{aligned} & \text { TIS97 } \\ & \text { TIS97 } \\ & \text { TIS108 } \end{aligned}$ | $\begin{aligned} & 200 \\ & 200 \\ & 200 \\ & 200 \end{aligned}$ | $\begin{aligned} & 60 \\ & 45 \\ & 30 \\ & 40 \end{aligned}$ | $\begin{aligned} & 60 \\ & 45 \\ & 30 \\ & 40 \end{aligned}$ | $\begin{gathered} 150-950 \\ 600-1550 \\ 1200-2200 \\ 30 \end{gathered}$ | 10 10 10 4 | . 2 | $\begin{aligned} & 10 \\ & 10 \\ & 10 \end{aligned}$ |  | $\begin{aligned} & 100 \\ & 150 \\ & 200 \\ & 400 \end{aligned}$ |
| $\begin{array}{\|l} \text { SES002 } \\ \text { SES003 } \\ \text { SES006 } \\ \text { SES025 } \end{array}$ | $\left\lvert\, \begin{aligned} & F \\ & F \\ & F \\ & F \end{aligned}\right.$ | $\begin{aligned} & \text { NPN } \\ & \text { NPN } \\ & \text { NPN } \\ & \text { NPN } \end{aligned}$ | $\begin{aligned} & \text { RF } \\ & \text { RF } \\ & \text { RF } \\ & \text { RF } \end{aligned}$ | T15108 <br> TIS84 <br> TIS84 <br> TIS86 | 200 200 200 250 | 40 40 40 30 | 40 40 40 30 | $30-$ $30-$ $30-$ $20-$ | 4 4 4 10 | . 6 | 10 20 |  | 400 400 400 300 |
| $\begin{array}{\|l\|l} \text { SE6001 } \\ \text { SE6002 } \\ \text { SE6020 } \\ \text { SE6020A } \end{array}$ | F | $\begin{aligned} & \text { NPN } \\ & \text { NPN } \\ & \text { NPN } \\ & \text { NPN } \end{aligned}$ | $\begin{aligned} & \text { GP } \\ & G P \\ & G P \\ & G P \end{aligned}$ | $\begin{aligned} & \text { TIS99 } \\ & \text { TIS97 } \\ & \text { TS111 } \\ & \text { TS111 } \end{aligned}$ | $\begin{aligned} & 300 \\ & 300 \\ & 300 \\ & 500 \end{aligned}$ | $\begin{aligned} & 40 \\ & 40 \\ & 60 \\ & 60 \end{aligned}$ | 30 30 60 60 | $\begin{array}{r} 50-200 \\ 150-600 \\ 100-300 \\ 100-300 \end{array}$ | $\begin{array}{r} 10 \\ 10 \\ 150 \\ 150 \end{array}$ | 1 1 .18 .18 | $\begin{aligned} & 100 \\ & 100 \\ & 150 \\ & 150 \end{aligned}$ |  | 40 40 250 250 |
| $\begin{array}{\|l} \text { SE6021 } \\ \text { SE6021A } \\ \text { SE6022 } \\ \text { SE6023 } \end{array}$ | F | NPN NPN NPN NPN | GP <br> GP <br> GP <br> GP | TSIII | $\begin{aligned} & 300 \\ & 500 \\ & 220 \\ & 220 \end{aligned}$ | $\begin{aligned} & 80 \\ & 80 \\ & 60 \\ & 80 \end{aligned}$ | $\begin{aligned} & 80 \\ & 80 \\ & 60 \\ & 80 \end{aligned}$ | $\begin{aligned} & 100-300 \\ & 100-300 \\ & 100-300 \\ & 100-300 \end{aligned}$ | $\begin{aligned} & 150 \\ & 150 \\ & 150 \\ & 150 \end{aligned}$ | $\begin{aligned} & .18 \\ & .18 \\ & .18 \\ & .18 \end{aligned}$ | $\begin{aligned} & 150 \\ & 150 \\ & 150 \\ & 150 \end{aligned}$ |  | 250 250 250 250 |
| $\begin{aligned} & \text { SE7015 } \\ & \text { SE7016 } \\ & \text { SE7017 } \\ & \text { SE8012 } \end{aligned}$ | $\left\lvert\, \begin{aligned} & F \\ & F \\ & F \end{aligned}\right.$ | NPN NPN NPN NPN | GP <br> GP <br> GP <br> RF |  | $\begin{array}{r} 450 \\ 450 \\ 450 \\ 500 \end{array}$ | $\begin{aligned} & 100 \\ & 140 \\ & 180 \\ & 100 \end{aligned}$ | $\begin{array}{r} 100 \\ 140 \\ 180 \\ 60 \end{array}$ | $\begin{aligned} & 50-275 \\ & 50-275 \\ & 20-275 \\ & 40- \end{aligned}$ | $\begin{array}{r} 50 \\ 50 \\ 50 \\ 100 \end{array}$ | $\begin{array}{r} 2 \\ 2 \\ 2 \\ .75 \end{array}$ | $\begin{array}{r} 25 \\ 25 \\ 25 \\ 500 \end{array}$ | $\begin{array}{r} 40 \\ 40 \\ 40 \end{array}$ | 50 50 50 300 |
| $\begin{aligned} & \text { SE8040 } \\ & \text { SE8540 } \\ & \text { SU2028 } \\ & \text { SU2029 } \end{aligned}$ | $\begin{array}{\|l} \mathbf{F} \\ \mathbf{F} \\ \mathbb{N} \\ \mathbb{N} \\ \mathbb{N} \end{array}$ | $\begin{aligned} & \mathrm{NPN} \\ & \mathrm{PNP} \\ & \mathrm{NCH} \\ & \mathrm{NCH} \end{aligned}$ | $\begin{aligned} & \text { GP } \\ & \text { GP } \\ & \text { FE } \\ & \text { FE } \end{aligned}$ | $\begin{aligned} & \text { AST2222 } \\ & \text { AST2907 } \end{aligned}$ | $\begin{aligned} & 500 \\ & 500 \\ & \text { SEE FET } \\ & \text { SEE FET } \end{aligned}$ | $\begin{gathered} 30 \\ 30 \\ \text { INTERCH } \\ \text { INTERCHA } \end{gathered}$ |  | $\begin{aligned} & 40-540 \\ & 40-540 \\ & \text { TY LIST } \\ & \text { TY LST } \end{aligned}$ | $\begin{aligned} & 150 \\ & 150 \end{aligned}$ | $\begin{aligned} & .12 \\ & .25 \end{aligned}$ | $\begin{aligned} & 150 \\ & 150 \end{aligned}$ |  | $\begin{aligned} & 130 \\ & 100 \end{aligned}$ |
| $\begin{aligned} & \text { SU2031 } \\ & \text { SU2032 } \\ & \text { SU2033 } \\ & \text { SU2034 } \end{aligned}$ | $\begin{aligned} & \mathbb{N} \\ & \mathbb{N} \\ & \mathbb{N} \\ & \mathbb{N} \\ & \mathfrak{N} \end{aligned}$ | $\begin{aligned} & \mathrm{NCH} \\ & \mathrm{NCH} \\ & \mathrm{NCH} \\ & \mathrm{NCH} \end{aligned}$ | $\begin{aligned} & \text { FE } \\ & \text { FE } \\ & \text { FE } \\ & \text { FE } \end{aligned}$ | $\begin{aligned} & \text { 2N5545 } \\ & \text { 2N5545 } \\ & \text { 2N5547 } \end{aligned}$ | SEE FET <br> SEE FET <br> SEE FET <br> SEE FET | NTERCH <br> NTERCH <br> NTERCH <br> NTERCH | NGEABI NGEAEI NGEABI NGEABI | TY LST <br> TY LUST <br> TY UST <br> TY UST |  |  |  |  |  |
| $\begin{aligned} & \text { SU2035 } \\ & \text { SU2098 } \\ & \text { SU2098A } \\ & \text { SU2098B } \end{aligned}$ | $\begin{aligned} & \mathbb{N} \\ & \mathbb{N} \\ & \mathbb{N} \\ & \mathbb{N} \\ & \mathbb{N} \end{aligned}$ | $\begin{aligned} & \mathrm{NCH} \\ & \mathrm{NCH} \\ & \mathrm{NCH} \\ & \mathrm{NCH} \end{aligned}$ | $\begin{aligned} & \text { FE } \\ & \text { FE } \\ & \text { FE } \\ & \text { FE } \end{aligned}$ | $\begin{aligned} & \text { 2N5547 } \\ & \text { 2N5545 } \\ & \text { 2N5545 } \end{aligned}$ | SEE FET <br> SEE FET <br> SEE FET <br> SEE FET | NTERCH <br> NTERCH <br> NTERCH <br> NTERCH | NGEABIL <br> NGEAB <br> ANGEAB <br> ANGEABI | TY UST <br> TY LIST <br> TY LIST <br> TY LIST |  |  |  |  |  |

## TRANSISTOR INTERCHANGEABILITY MASTER LIST OF NONREGISTERED TYPES

| TYPE NUMBER |  | $E$888 |  |  | MAXIMUM RATINGS |  |  | EECTRICAL CHARACTERISTICS |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  | $\begin{gathered} \mathrm{PT} \\ \mathrm{~T}_{\mathrm{A}}=25^{\circ} \mathrm{C} \\ \\ { }^{{ }^{\circ} \mathrm{T}_{\mathrm{C}}=25^{\circ} \mathrm{C}} \\ (\mathrm{~mW}) \end{gathered}$ | $\mathbf{V}_{\text {CBO }}$ <br> (V) | VCEO <br> (V) | hre |  | VCE(sat) |  |  | $\begin{array}{c\|} \hline \boldsymbol{T} \\ \text { MWN } \\ \left(M H_{z}\right) \\ \hline \end{array}$ |
|  |  |  |  |  |  |  |  | MIN MA | $\begin{gathered} I_{C} \\ (\mathrm{ma}) \end{gathered}$ |  | $\begin{aligned} & \mathrm{IC} \\ & \text { (mA) } \end{aligned}$ |  |  |
| SU2099 | IN | NCH | FE | 2N5547 | SEE FET INTERCHANGEABILITY LIST SEE FET INTERCHANGEABILITY LIST |  |  |  |  |  |  |  |  |
| SU2099A | IN | NCH | FE | 2N5547 |  |  |  |  |  |  |  |  |  |
| SX37 | TI | PNP | RF | TIS137 | 360 | 35 | 32 | 45- | 1 |  |  |  | 80 |
| 5×38 | $\pi$ | PNP | RF | TIS138 | 360 | 35 | 32 | 25. | 1 |  |  |  | 50 |
| 5X3391 | $\pi$ | NPN | GP | A5T3391 | 625 | 25 | 25 | 250-500 | 2 |  |  |  |  |
| SX3702 | T1 | PNP | GP | 2N5447 | 360 | 40 | 25 | 60-300 | 50 |  | 50 |  | 100 |
| SX3703 | T1 | PNP | GP | 2N5448 | 360 | 50 | 30 | 30-150 | 50 | . 25 | 50 |  | 100 |
| SX3704 | TI | NPN | GP | 2N5449 | 360 | 50 | 30 | 100-300 | 50 | . 6 | 100 |  | 100 |
| S×3705 | 71 | NPN | GP | 2N5450 | 360 | 50 | 30 | 50-150 | 50 | . 8 | 100 |  | 100 |
| 5x3706 | 71 | NPN | GP | 2N5451 | 360 | 40 | 20 | 30-600 | 50 | 1 | 100 |  | 100 |
| SX3707 | II | NPN | GP | A5T3707 | 360 | 30 | 30 | 100.400 | . 1 | 1 | 10 | 100 |  |
| $5 \times 3708$ | 71 | NPN | GP | A5T3708 | 360 | 30 | 30 | 45-660 | 1 | 1 | 10 | 45 |  |
| 5x3709 | $\pi$ | NPN | GP | A5T3709 | 360 | 30 | 30 | 45-165 | 1 | 1 | 10 | 45 |  |
| 5×3710 | TI | NPN | GP | A573710 | 360 | 30 | 30 | 90-330 | 1 | 1 | 10 | 90 |  |
| 5x3711 | T1 | NPN | GP | A573711 | 360 | 30 | 30 | 180-660 | 1 | 1 | 10 | 180 |  |
| 5X3819 | 17 | NCH | FE | 2N5949/53 | SEE FET INTERCHANGEABMII |  |  | Y LIST |  |  |  |  |  |
| Sx3820 | It | PCH | FE | A.5T5460/62 | SEE FET INTERCHANGEABILITY LIST |  |  |  |  |  |  |  |  |
| SX4058 | 71 | PNP | GP | A.574058 | 360 | 30 | 30 | 100.400 | . 1 | . 7 | 10 | 100 |  |
| SX4059 | $\pi$ | PNP | GP | A5T4059 | 360 | 30 | 30 | 45-660 | 1 | . 7 | 10 | 45 |  |
| SX4060 | 71 | PNP | GP | A.5T4060 | 360 | 30 | 30 | 45.165 | 1 | . 7 | 10 | 45 |  |
| SX4061 | TI | PNP | GP | A574061 | 360 | 30 | 30 | 90.330 | 1 | . 7 | 10 | 90 |  |
| 5X4062 | T | PNP | GP | A5T4062 | 360 | 30 | 30 | 180-660 | 1 | . 7 | 10 | 180 |  |
| SX4254 | II | NPN | RF | 2N4996 | 250 | 30 | 18 | 50. | 2 |  |  |  | 600 |
| 71407 | 71 | NPN | RF | T1562 | 200 | 30 | 12 | 30. | 4 |  |  |  | 500 |
| 7408 | T | NPN | RF | T1563 | 200 | 30 | 12 | 20. | 4 |  |  |  | 400 |
| T409 | TI | NPN | RF | TIS64 | 200 | 30 | 12 | 20. |  |  |  |  | 300 |
| 71412 | 1 | NPN | GP | 2N3704 | 360 | 50 | 30 | 100-300 | 50 | . 6 | 100 |  | 100 |
| T1413 | 11 | NPN | GP | 2N3705 | 360 | 50 | 30 | 50.150 | 50 | . 8 | 100 |  | 100 |
| T1414 | 1 | NPN | GP | 2N3706 | 360 | 40 | 20 | 30-600 | 50 |  | 100 |  | 100 |
| T1415 | 71 | NPN | GP | 2N3707 | 360 | 30 | 30 | 100-400 | . 1 | 1 | 10 | 100 |  |
| 7416 | 71 | NPN | GP | 2N3708 | 360 | 30 | 30 | 45-660 | 1 | 1 | 10 | 45 |  |
| 11417 | TI | NPN | GP | 2N3710 | 360 | 30 | 30 | 90.330 | 1 | 1 | 10 | 90 |  |
| T1418 | II | NPN | GP | 2N3711 | 360 | 30 | 30 | 180-660 | 1 | 1 | 10 | 180 |  |
| T1480 | 71 | NPN | GP | 2N339 | 600 | 50 | 40 |  |  |  |  | 9 |  |
| T1481 | 71 | NPN | GP | 2N340 | 600 | 80 | 70 |  |  |  |  | 9 |  |
| T482 | TI | NPN | GP | 2N2217 | 600 | 20 | 20 | 20. | 150 | 1.5 | 150 |  | 40 |
| T483 | TI | NPN | GP | 2N2217 | 600 | 40 | 20 | 20-60 | 150 | 1.5 | 150 |  | 40 |
| T1484 | 71 | NPN | GP | 2N2218 | 600 | 40 | 20 | 40-120 | 150 |  | 150 |  | 40 |
| T1492 | T1 | NPN | GP | 2N332A | 150 | 40 | 20 |  |  |  |  | 15 |  |
| T1493 | 11 | NPN | GP | 2N332A | 125 | 40 | 20 | 15-45 | 10 |  |  |  |  |

## TRANSISTOR INTERCHANGEABILITY MASTER LIST OF NONREGISTERED TYPES

| TYPE NUMEER |  | $\begin{aligned} & \frac{k}{N} \\ & \frac{5}{3} \\ & \frac{1}{2} \end{aligned}$ | $\begin{aligned} & Z \\ & \frac{0}{6} \\ & \frac{3}{2} \\ & \frac{1}{2} \\ & 3 \end{aligned}$ | 7 REPLACEMENT Or nearest ECUVALENT | MAXIMMM RATINES |  |  | EECTRICAL CHARACTERISTICS |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  | $\begin{gathered} \mathrm{PT}_{\mathrm{T}} \\ \mathrm{r}_{\mathrm{A}}=25^{\circ} \mathrm{C} \\ { }^{{ }^{2} \mathrm{~T} \mathrm{C}=25^{\circ} \mathrm{C}} \\ (\mathrm{~mW}) \end{gathered}$ | $V_{\text {CBO }}$ <br> (V) | $V_{\text {CEO }}$ <br> (V) | hfe | $\begin{gathered} l_{C} \\ (\mathrm{~mA}) \\ \hline \end{gathered}$ | max <br> (V) | sed) <br> - Ic <br> (mA) | $\mathrm{h}_{\mathrm{fe}}$ $\boldsymbol{1} \mathrm{kHz}$ MIN | TT MNN $(M \mathrm{~Hz})$ |
| TL494 <br> T1495 <br> TM96 <br> TISO3 | $\left\lvert\, \begin{aligned} & \pi \\ & \pi 1 \\ & \pi \\ & \pi \end{aligned}\right.$ | NPN <br> NPN <br> NPN <br> PNP | GP <br> GP <br> GP <br> GP | $\begin{aligned} & \text { 2N335A } \\ & \text { 2N2219A } \\ & \text { 2N340 } \\ & \text { 2N3702 } \end{aligned}$ | 125 125 600 300 | 40 40 70 40 | 20 20 25 | $\begin{aligned} & 40-125 \\ & 120-250 \\ & 10- \\ & 60-300 \end{aligned}$ | $\begin{array}{r} 10 \\ 10 \\ 3 \\ 50 \end{array}$ | $\begin{aligned} & 1.5 \\ & 2.5 \end{aligned}$ | $\begin{array}{r} 3 \\ 50 \end{array}$ |  | 100 |
| TISO4 <br> TIS14 <br> TIS 18 <br> TIS25 | $\left\lvert\, \begin{aligned} & \mathrm{TI} \\ & \mathrm{TI} \\ & \mathrm{TI} \\ & \mathrm{TI} \end{aligned}\right.$ | PNP <br> NCH <br> NPN <br> NCH | $\begin{aligned} & \mathrm{GP} \\ & \mathrm{FE} \\ & \mathrm{RF} \\ & \mathrm{FE} \end{aligned}$ | 2N3703 <br> TIS14 <br> TIS62 <br> TIS25 | 300 SEE FET 200 SEE FET | $\begin{gathered} 50 \\ \text { NTERCHA } \\ 25 \\ \text { NTERCHA } \end{gathered}$ | 30 13 NGEABHII |  | 50 <br> 10 | 2.5 | 50 |  | $\begin{aligned} & 100 \\ & 600 \end{aligned}$ |
| $\begin{array}{\|l} \text { TIS26 } \\ \text { TIS27 } \\ \text { TIS28 } \\ \text { TIS29 } \end{array}$ | $\begin{aligned} & \mathrm{T} \\ & \mathrm{TI} \\ & \mathrm{TI} \\ & \mathrm{TI} \end{aligned}$ | NCH <br> NCH <br> NPN <br> NPN | $\begin{aligned} & \mathrm{FE} \\ & \mathrm{FE} \\ & \mathrm{RF} \\ & \mathrm{RF} \end{aligned}$ | $\begin{aligned} & \text { TIS26 } \\ & \text { TIS27 } \\ & \text { TIS84 } \\ & \text { TIS84 } \end{aligned}$ | SEE FET SEE FET 200 200 | $\begin{aligned} & \text { INTERCH } \\ & \text { INTERCHA } \\ & 40 \\ & 40 \end{aligned}$ | NGEABILIT NGEABILIT 40 40 | $\begin{array}{r} \text { TY LIST } \\ \text { TY LIST } \\ 30- \\ 30- \end{array}$ | 4 |  |  |  | 630 500 |
| $\begin{array}{\|l} \text { TIS30 } \\ \text { TIS31 } \\ \text { TIS34 } \\ \text { TIS37 } \end{array}$ | $\begin{aligned} & \mathrm{TI} \\ & \mathrm{TI} \\ & \mathrm{TI} \\ & \mathrm{TI} \end{aligned}$ | NPN NPN NCH PNP | $\begin{aligned} & \text { RF } \\ & \text { RF } \\ & \text { FE } \\ & \text { RF } \end{aligned}$ | TIS 108 <br> TIS108 <br> 2N5248 <br> TIS37 | $\begin{aligned} & 200 \\ & 200 \\ & \text { SEE FET } \\ & 625 \end{aligned}$ | 40 40 NTERCH 35 | 40 40 <br> angeabil $32$ | $\begin{array}{r} 30- \\ 30- \\ T Y \text { LIST } \\ 45- \end{array}$ | $\begin{aligned} & 4 \\ & 4 \\ & 1 \end{aligned}$ |  |  |  | 500 500 80 |
| $\begin{aligned} & \text { TIS38 } \\ & \text { TIS42 } \\ & \text { TIS43 } \\ & \text { TIS44 } \end{aligned}$ | $\left[\begin{array}{l} \mathrm{TI} \\ \mathrm{TI} \\ \mathrm{TI} \\ \mathrm{TI} \end{array}\right.$ | PNP <br> NCH <br> P-N <br> NPN | RF <br> FE <br> UJ <br> SW | $\begin{aligned} & \text { TIS38 } \\ & \text { TIS75 } \\ & \text { TIS43 } \end{aligned}$ | 625 SEE FET SEE UNI 250 | 35 NTERCH UNCTIO 25 | 32 <br> ANGEABILI <br> N INTERCH <br> 20 | $\begin{aligned} & 25- \\ & \text { TY LIST } \\ & \text { IANGEABILITY } \\ & 20 \text {. } \end{aligned}$ | 1 <br> 10 | . 6 | 10 |  | $\begin{array}{r} 50 \\ 200 \end{array}$ |
| TIS45 <br> TIS46 <br> TIS47 <br> TIS48 | $\begin{aligned} & \mathbf{n} \\ & \mathrm{n} \\ & \mathrm{n} \\ & \mathrm{n} \end{aligned}$ | NPN <br> NPN <br> NPN <br> NPN | SW <br> SW <br> SW <br> SW |  | $\begin{aligned} & 250 \\ & 250 \\ & 250 \\ & 250 \end{aligned}$ | 40 40 40 40 | $\begin{aligned} & 15 \\ & 15 \\ & 15 \\ & 15 \end{aligned}$ | $\begin{aligned} & 30-120 \\ & 30-120 \\ & 20-60 \\ & 40-120 \end{aligned}$ | 10 10 10 10 | .4 .25 .25 .25 | $\begin{aligned} & 10 \\ & 20 \\ & 10 \\ & 10 \end{aligned}$ |  | 300 300 400 500 |
| $\begin{aligned} & \text { TIS49 } \\ & \text { TIS50 } \\ & \text { TIS51 } \\ & \text { TIS52 } \end{aligned}$ | $\begin{aligned} & \mathrm{TI} \\ & \mathrm{TI} \\ & \mathrm{TI} \\ & \mathrm{TI} \end{aligned}$ | NPN <br> PNP <br> NPN <br> NPN | $\begin{aligned} & s w \\ & s w \\ & s w \\ & s w \end{aligned}$ | 2N4423 | $\begin{aligned} & 250 \\ & 250 \\ & 250 \\ & 250 \end{aligned}$ | 40 12 30 40 | 15 12 12 20 | $\begin{array}{r} 40-120 \\ 40-150 \\ 30-120 \\ 30-120 \end{array}$ | 10 30 10 30 | . 25 .2 .2 .2 | $\begin{aligned} & 30 \\ & 30 \\ & 10 \\ & 30 \end{aligned}$ |  | 500 400 400 350 |
| $\begin{aligned} & \text { TIS53 } \\ & \text { TIS54 } \\ & \text { TIS55 } \\ & \text { TIS58 } \end{aligned}$ | $\left\lvert\, \begin{array}{ll} \mathrm{TI} \\ \mathrm{TI} \\ \mathrm{TI} \\ \mathrm{TI} \end{array}\right.$ | PNP <br> PNP <br> NPN <br> NCH | $\begin{aligned} & \text { SW } \\ & \text { SW } \\ & \text { SW } \\ & \text { FE } \end{aligned}$ | 2N5952/53 | $\begin{gathered} 250 \\ 250 \\ 250 \\ \text { SEE FET } \end{gathered}$ | $\begin{array}{r} 6 \\ 12 \\ 40 \\ \text { INTERCR } \end{array}$ | $\begin{array}{r} 6 \\ 12 \\ 15 \\ \text { ANGEABILI } \end{array}$ | $\begin{aligned} & 30-120 \\ & 30-120 \\ & 30-120 \end{aligned}$ <br> TY LIST | $\begin{aligned} & 10 \\ & 10 \\ & 30 \end{aligned}$ | r .16 .2 .2 | 10 10 30 |  | 500 500 350 |
| TIS59 <br> TIS60 <br> TIS61 <br> TIS62 | 71 <br> 71 <br> 71 <br> 1 | NCH <br> NPN <br> PNP <br> NPN | FE <br> GP <br> GP <br> RF | 2N5949/51 TIS60 TIS61 TIS62A | $\begin{aligned} & \text { SEE FET } \\ & 625 \\ & 625 \\ & 625 \end{aligned}$ | $\begin{gathered} \text { INTERCH } \\ 40 \\ 40 \\ 30 \end{gathered}$ | ANGEABIL <br> 25 <br> 25 <br> 12 | $\begin{aligned} & \text { ITY LIST } \\ & 100-300 \\ & 100-300 \\ & 30- \end{aligned}$ | 50 50 4 | . 6 | 100 50 |  | 500 |
| TIS63 TIS64 TIS67 11568 | $\left\lvert\, \begin{aligned} & \pi \\ & \pi \\ & \pi \\ & \pi \\ & I \\ & \hline \end{aligned}\right.$ | NPN <br> NPN <br> PCH <br> NCH | $\begin{aligned} & \mathrm{RF} \\ & \mathrm{RF} \\ & \mathrm{FE} \\ & \mathrm{FE} \end{aligned}$ | TIS63A TIS6.A <br> T1569 | $\begin{aligned} & 625 \\ & 625 \\ & \text { SEE FET } \\ & \text { SEE FET } \end{aligned}$ | $\begin{gathered} 30 \\ 30 \\ \text { INTERCH } \\ \text { INTERCH } \\ \hline \end{gathered}$ | $\begin{array}{r} 12 \\ 12 \\ \text { IANGEABIL } \\ \text { IANGEABIL } \\ \hline \end{array}$ | $\begin{array}{r} 20- \\ 20 \\ \text { ITY LIST } \\ \text { ITY LST } \end{array}$ | $\begin{aligned} & 4 \\ & 4 \end{aligned}$ |  |  |  | 400 300 |

## TRANSISTOR INTERCHANGEABILITY MASTER LIST OF NONREGISTERED TYPES

| TYFE Number |  | $\begin{aligned} & k \\ & \frac{k}{k} \\ & \frac{8}{6} \end{aligned}$ | $\begin{aligned} & z \\ & \frac{2}{2} \\ & \mathbf{y} \\ & \frac{12}{K} \\ & \frac{3}{3} \end{aligned}$ | $\begin{aligned} & \text { II } \\ & \text { REPLACEMENT } \\ & \text { OR NEAREST } \\ & \text { EQUNALENT } \end{aligned}$ | MAXIMUM RATMNOS |  |  | ELECTRICAL CHARACTEISISICS |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  | $\begin{gathered} \mathbf{P}_{\mathbf{T}} \\ \mathrm{T}_{\mathrm{A}}=25^{\circ} \mathrm{C} \\ { }^{*} \mathbf{T}_{\mathrm{C}}=25^{\circ} \mathrm{C} \\ (\mathrm{~mW}) \\ \hline \end{gathered}$ | $\forall_{C B O}$ <br> (V) | Vceo <br> (V) | $\operatorname{MNN} M$ |  | $\begin{array}{\|l} \|c\| \\ \hline \begin{array}{l} \text { Max } \\ \text { (V) } \end{array} \\ \hline \end{array}$ | $\begin{aligned} & \text { (sat) } \\ & \hline k c \\ & \text { (mA) } \end{aligned}$ |  | $\begin{gathered} \text { TT } \\ \text { MN } \\ \text { MNX } \end{gathered}$ |
| $\begin{aligned} & \text { TIS69 } \\ & \text { T1570 } \\ & \text { TIS73 } \\ & \text { TIS74 } \end{aligned}$ | $\begin{aligned} & \pi \\ & \pi \\ & \pi \\ & \pi \\ & \pi \end{aligned}$ | NCH <br> NCH <br> NCH <br> NCH | $\begin{aligned} & \text { FE } \\ & \text { FE } \\ & \text { FE } \\ & \text { FE } \end{aligned}$ | TIS69 <br> TIS70 <br> TIS73 <br> TIS74 | SEE FET INTERCHANGEABIUTY LIST SEE FET INTERCHANGEABIUTY LIST SEE FET INTERCHANGEABUTY LIST SEE FET INTERCHANGEABILTY LIST |  |  |  |  |  |  |  |  |
| $\begin{aligned} & \text { TIS75 } \\ & \text { TIS78 } \\ & \text { TIS79 } \\ & \text { TIS83 } \end{aligned}$ | $\begin{aligned} & \pi \\ & \pi \\ & \pi \\ & \pi \end{aligned}$ | NCH <br> NCH <br> NCH <br> NPN | $\begin{aligned} & \text { FE } \\ & \text { FE } \\ & \text { FE } \\ & \text { RF } \end{aligned}$ | TIS75 AST6449 A.576450 | SEE FET INTERCHANGEABHLTY LIST SEE FET INTERCHANGEABLITY LIST SEE FET INTERCHANGEABLLTY LIST |  |  |  |  |  |  |  | 600 |
| TIS84 <br> TIS85 <br> T1586 <br> TIS87 | $\begin{aligned} & \pi \\ & \pi \\ & \pi \\ & \pi \\ & \pi \end{aligned}$ | NPN <br> NPN <br> NPN <br> NPN | $\begin{aligned} & \text { RF } \\ & \text { RF } \\ & \text { RF } \\ & \text { RF } \end{aligned}$ | TIS84 <br> TIS 108 <br> T1586 <br> TS88 | $\begin{aligned} & 625 \\ & 250 \\ & 625 \\ & 625 \end{aligned}$ | 40 40 30 45 | $\begin{aligned} & 30 \\ & 30 \\ & 30 \\ & 45 \end{aligned}$ | $\begin{aligned} & 30- \\ & 25- \\ & 40-200 \\ & 30-150 \end{aligned}$ | $\begin{array}{r} 4 \\ 4 \\ 4 \\ 12 \end{array}$ | . 5 | 15 15 |  | $\begin{aligned} & 350 \\ & 350 \\ & 500 \\ & 500 \end{aligned}$ |
| TIS88 <br> T1589 <br> TIS90 <br> TIS91 | $\left\lvert\, \begin{aligned} & \pi \\ & \pi \\ & \pi \\ & \pi \\ & \pi \end{aligned}\right.$ | NCH <br> NPN <br> NPN <br> PNP | $\begin{aligned} & \text { FE } \\ & \text { RF } \\ & \text { GP } \\ & \text { GP } \end{aligned}$ | $\begin{aligned} & \text { 2N5245 } \\ & \text { TIS86 } \\ & \text { TS90 } \\ & \text { TIS91 } \end{aligned}$ | $\begin{aligned} & \text { SEE FET } \\ & 400 \\ & 625 \\ & 625 \end{aligned}$ | NTERCHA 35 40 40 | $\begin{gathered} \text { NGEABIL } \\ 35 \\ 40 \\ 40 \end{gathered}$ | $\begin{aligned} & \text { F LIST } \\ & 30-200 \\ & 100-300 \\ & 100-300 \end{aligned}$ | $\begin{array}{r} 4 \\ 50 \\ 50 \end{array}$ | .5 .25 .25 | 15 50 50 |  | 500 |
| TIS92 <br> TIS93 <br> TIS94 <br> TIS95 | T1 | NPN <br> PNP <br> NPN <br> NPN | $\begin{aligned} & \text { GP } \\ & \text { GP } \\ & \text { GP } \\ & \text { GP } \end{aligned}$ | $\begin{aligned} & \text { TIS92 } \\ & \text { TIS93 } \\ & \text { TIS94 } \\ & \text { nS95 } \end{aligned}$ | 625 625 625 625 | 40 40 60 80 | 40 40 40 60 | $\begin{aligned} & 100-300 \\ & 100-300 \\ & 250-700 \\ & 100-300 \end{aligned}$ | 50 50 .1 1 | $\begin{array}{r} .25 \\ .25 \\ .5 \end{array}$ | $\begin{array}{r} 50 \\ 50 \\ 100 \end{array}$ | 250 100 | 200 200 |
| TS96 <br> T1S97 <br> T1598 <br> 71599 | $\begin{aligned} & \mathbf{T} \\ & \mathbf{N} \\ & \mathbf{T} \\ & \mathbf{T} \end{aligned}$ | NPN <br> NPN <br> NPN <br> NPN | $\begin{aligned} & \text { GP } \\ & \text { GP } \\ & \text { GP } \\ & \text { GP } \end{aligned}$ | TIS96 <br> 71597 <br> TIS98 <br> TIS99 | $\begin{aligned} & 625 \\ & 625 \\ & 625 \\ & 625 \end{aligned}$ | $\begin{aligned} & 80 \\ & 60 \\ & 80 \\ & 80 \end{aligned}$ | $\begin{aligned} & 65 \\ & 40 \\ & 60 \\ & 65 \end{aligned}$ | $\begin{array}{r} 55-300 \\ 250-700 \\ 100-300 \\ 55-300 \end{array}$ | $\begin{array}{r} 100 \\ .1 \\ 1 \\ 100 \end{array}$ | $\begin{aligned} & .5 \\ & .5 \\ & .5 \end{aligned}$ | $\begin{aligned} & 100 \\ & 100 \\ & 100 \end{aligned}$ | $\begin{array}{r} 60 \\ 250 \\ 100 \\ 60 \end{array}$ | 200 200 200 200 |
| TIS100 <br> 75101 <br> TIS 102 <br> TIS103 | T | NPN <br> NPN <br> NPN <br> NPN | $\begin{aligned} & G P \\ & G P \\ & G P \\ & G P \end{aligned}$ | TIS100 <br> TIS 101 <br> 2N5059 <br> 2N5059 | $\begin{aligned} & 625 \\ & 625 \\ & 800 \\ & 800 \end{aligned}$ | $\begin{aligned} & 180 \\ & 150 \\ & 180 \\ & 150 \end{aligned}$ | $\begin{aligned} & 180 \\ & 150 \\ & 180 \\ & 150 \end{aligned}$ | $30-$ 30 30 30 | 25 25 25 25 | 1 1 1 1 | 25 25 25 25 |  | 80 80 80 80 |
| TIS104 TIS 105 TIS 106 TIS107 | T1 | PNP <br> NPN <br> NPN <br> NPN | RF <br> RF <br> GP <br> GP | TIS104 <br> TIS105 <br> TIS98 <br> TIS97 | $\begin{aligned} & 625 \\ & 625 \\ & 360 \\ & 360 \end{aligned}$ | $\begin{aligned} & 60 \\ & 45 \\ & 80 \\ & 60 \end{aligned}$ | $\begin{aligned} & 60 \\ & 45 \\ & 65 \\ & 40 \end{aligned}$ | $\begin{array}{r} 100-500 \\ 30-150 \\ 65-300 \\ 35-300 \end{array}$ | $\begin{array}{r} 1 \\ 10 \\ 100 \\ 100 \end{array}$ | $\begin{aligned} & .6 \\ & .5 \\ & .5 \\ & .5 \end{aligned}$ | $\begin{array}{r} 20 \\ 20 \\ 100 \\ 100 \end{array}$ | 100 60 | 90 300 200 200 |
| TIS108 <br> 75109 <br> TIS 110 <br> TIS 111 | TI | NPN <br> NPN <br> NPN <br> NPN | $\begin{aligned} & R F \\ & G P \\ & G P \\ & G P \end{aligned}$ | TIS108 <br> TIS109 <br> 75110 <br> TISIII | $\begin{aligned} & 625 \\ & 625 \\ & 625 \\ & 625 \end{aligned}$ | $\begin{aligned} & 40 \\ & 60 \\ & 60 \\ & 60 \end{aligned}$ | 30 30 40 40 | $\begin{aligned} & 25- \\ & 100-400 \\ & 50-150 \\ & 100-300 \end{aligned}$ | $\begin{array}{r} 4 \\ 150 \\ 150 \\ 150 \end{array}$ | . 4 | $\begin{aligned} & 150 \\ & 150 \\ & 150 \end{aligned}$ |  | 350 250 200 250 |
| TIS 112 <br> TIS113 <br> TIS114 <br> TIS115 | T1 | PNP <br> NPN <br> NPN <br> NPN | $\begin{aligned} & \text { GP } \\ & \text { SW } \\ & \text { SW } \\ & \text { SW } \end{aligned}$ | $\begin{aligned} & \text { TIS112 } \\ & \text { TIS133 } \\ & \text { TIS134 } \\ & \text { TIS135 } \end{aligned}$ | $\begin{aligned} & 625 \\ & 700 \\ & 700 \\ & 700 \end{aligned}$ | $\begin{aligned} & 60 \\ & 50 \\ & 50 \\ & 80 \end{aligned}$ | 40 30 30 50 | $\begin{array}{r} 100-300 \\ 60.150 \\ 50-150 \\ 60-150 \end{array}$ | $\begin{aligned} & 150 \\ & 100 \\ & 100 \\ & 100 \end{aligned}$ | $\begin{aligned} & .4 \\ & .3 \\ & .4 \\ & .3 \end{aligned}$ | $\begin{aligned} & 150 \\ & 100 \\ & 100 \\ & 100 \end{aligned}$ |  | 200 300 300 300 |

## TRANSISTOR INTERCHANGEABILITY MASTER LIST OF NONREGISTERED TYPES

| TYPE NUMBER |  | $\begin{aligned} & \text { 立 } \\ & \frac{1}{8} \\ & 8 \end{aligned}$ | $\begin{aligned} & \frac{0}{2} \\ & \frac{2}{3} \\ & \frac{14}{5} \\ & \frac{3}{3} \end{aligned}$ |  | MAXIMUM RATEVES |  |  | EIECTRICAL CHARACTERISTICS |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  | $\begin{gathered} \mathrm{P}_{\mathrm{T}} \\ \mathrm{~T}_{\mathbf{A}}=25^{\circ} \mathrm{C} \\ { }^{*} \mathrm{~T}_{\mathrm{C}}=25^{\circ} \mathrm{C} \\ (\mathrm{~mW}) \end{gathered}$ | $V_{C B O}$ <br> (V) | VCEO <br> (V) | $h_{\text {FE }}$ |  | $V_{C E}$ (sat) |  | hfe $\qquad$ 1 kHz MIN |  |
| $\begin{aligned} & \text { TIS116 } \\ & \text { TIS125 } \\ & \text { TIS126 } \\ & \text { TIS } 128 \end{aligned}$ | $\begin{aligned} & \pi \\ & \pi \\ & \pi \\ & \pi \\ & \pi \end{aligned}$ | NPN <br> NPN <br> NPN <br> NPN | $\begin{aligned} & \text { SW } \\ & \text { RF } \\ & R F \\ & R F \end{aligned}$ | $\begin{aligned} & \text { TIS } 136 \\ & \text { TIS } 125 \\ & \text { TIS } 126 \\ & \text { TIS128 } \end{aligned}$ | 700 625 625 250 | 80 40 40 60 | 50 30 30 45 | $\begin{aligned} & 50-150 \\ & 30- \\ & 25- \\ & 30- \end{aligned}$ | $\begin{array}{r} 100 \\ 4 \\ 10 \\ 2 \end{array}$ |  | $\begin{array}{r} 100 \\ 30 \end{array}$ |  | $\begin{aligned} & 300 \\ & 450 \\ & 600 \\ & 650 \end{aligned}$ |
| $\left\lvert\, \begin{aligned} & \text { TIS129 } \\ & \text { TIS133 } \\ & \text { TIS134 } \\ & \text { TIS135 } \end{aligned}\right.$ | $\begin{aligned} & \pi \\ & \pi 1 \\ & \pi 1 \\ & \pi I \end{aligned}$ | NPN NPN <br> NPN <br> NPN | RF SW SW SW | $\begin{aligned} & \text { TIS129 } \\ & \text { TIS133 } \\ & \text { TIS134 } \\ & \text { TIS135 } \end{aligned}$ | $\begin{aligned} & 250 \\ & 700 \\ & 700 \\ & 700 \end{aligned}$ | $\begin{aligned} & 40 \\ & 50 \\ & 50 \\ & 80 \end{aligned}$ | 25 30 30 50 | $\begin{aligned} & 60- \\ & 60-150 \\ & 50-150 \\ & 60-150 \end{aligned}$ | 4 100 100 100 | .5 .3 .4 .3 | $\begin{array}{r} 4 \\ 100 \\ 100 \\ 100 \end{array}$ |  | $\begin{aligned} & 800 \\ & 250 \\ & 250 \\ & 250 \end{aligned}$ |
| $\begin{aligned} & \text { TIS136 } \\ & \text { TIS137 } \\ & \text { TIS138 } \\ & \text { UII } 10 \end{aligned}$ | $\left\lvert\, \begin{array}{ll} \mathrm{TI} \\ \mathrm{TI} \\ \mathrm{TI} \\ \mathrm{si} \end{array}\right.$ | $\begin{aligned} & \text { NPN } \\ & \text { PNP } \\ & \text { PNP } \\ & \text { PCH } \end{aligned}$ | $\begin{array}{\|l} \hline S W \\ R F \\ R F \\ \text { FE } \end{array}$ |  | $\begin{gathered} 700 \\ 625 \\ 625 \\ \text { SEE FET } \end{gathered}$ | $\begin{gathered} 80 \\ 35 \\ 35 \\ \text { NTERCHA } \end{gathered}$ | $\begin{array}{r} 50 \\ 32 \\ 32 \\ \text { NGEABIL } \end{array}$ | $\begin{array}{r} 50-150 \\ 45- \\ 25- \\ \hline \text { IY LIST } \\ \hline \end{array}$ | $\begin{array}{r} 100 \\ 1 \\ 1 \end{array}$ | . 4 | 100 |  | 250 80 50 |
| U112 <br> U146 <br> U147 <br> U148 | $\left\lvert\, \begin{aligned} & \mathbf{S I} \\ & \mathbf{S I} \\ & \mathbf{S I} \\ & \mathbf{S I} \end{aligned}\right.$ | $\left\lvert\, \begin{aligned} & \mathrm{PCH} \\ & \mathrm{PCH} \\ & \mathrm{PCH} \\ & \mathrm{PCH} \end{aligned}\right.$ | $\begin{aligned} & \text { FE } \\ & \mathrm{FE} \\ & \mathrm{FE} \\ & \mathrm{FE} \end{aligned}$ |  | SEE FET <br> SEE FET <br> SEE FET <br> SEE FET | NTERCH NTERCH NTERCH NTERCHA | NGEABIL NGEABL NGEABIL NGEABIL | ITY LIST <br> TY LIST <br> TY LIST <br> TY LIST |  |  |  |  |  |
| U149 <br> U133 <br> U168 <br> U182 | $\left\lvert\, \begin{aligned} & S I \\ & S I \\ & S I \\ & \mathbf{N} \end{aligned}\right.$ | $\begin{aligned} & \mathrm{PCH} \\ & \mathrm{PCH} \\ & \mathrm{PCH} \\ & \mathrm{NCH} \end{aligned}$ | $\begin{aligned} & \mathrm{FE} \\ & \mathrm{FE} \\ & \mathrm{FE} \\ & \mathrm{FE} \end{aligned}$ | $\begin{aligned} & \text { 2N2608 } \\ & \text { 2N4860 } \end{aligned}$ | SEE FET <br> SEE FET <br> SEE FET <br> SEE FET | NTERCH NTERCHA NTERCH NTERCHA | NGEABIL NGEABI NGEABI NGEABI | ITY LIST TY LIST TY LIST TY LIST |  |  |  |  |  |
| U183 U184 U197 U198 | $\left\lvert\, \begin{aligned} & \mathbf{s} 1 \\ & \mathbf{s i} \\ & \mathbf{s} \\ & \mathbf{s i} \end{aligned}\right.$ | $\begin{aligned} & \mathrm{NCH} \\ & \mathrm{NCH} \\ & \mathrm{NCH} \\ & \mathrm{NCH} \end{aligned}$ | FE <br> FE <br> FE <br> FE | $\begin{aligned} & \text { 2N3458 } \\ & \text { 2N4416 } \\ & \text { 2N3460 } \\ & \text { 2N3459 } \end{aligned}$ | SEE FET <br> SEE FET <br> SEE FET <br> SEE FET | NTERCH NTERCH NTERCH NTERCH | NGEABI NGEABIL NGEABI NGEABI | TY LIST ITY LIST ITY LIST ITY LST |  |  |  |  |  |
| $\begin{aligned} & \text { U199 } \\ & \text { U200 } \\ & \text { U201 } \\ & \text { U202 } \end{aligned}$ | $\left\lvert\, \begin{aligned} & \mathbf{5 I} \\ & 5! \\ & 51 \\ & \mathbf{s I} \end{aligned}\right.$ | $\begin{aligned} & \mathrm{NCH} \\ & \mathrm{NCH} \\ & \mathrm{NCH} \\ & \mathrm{NCH} \end{aligned}$ | FE <br> FE <br> FE <br> FE | 2N3458 <br> 2N5549 <br> 2N4861 <br> 2N4860 | $\begin{aligned} & \text { SEE FET } \\ & \text { SEE FET } \\ & \text { SEE FET } \\ & \text { SEE FET } \end{aligned}$ | NTERCH NTERCH NTERCH NTERCH | NGEABI NGEABI NGEABI NGEABI | ITY LIST <br> ITY LIST <br> ITY LIST <br> ITY LIST |  |  |  |  |  |
| U221 <br> U222 <br> U231 <br> U232 | $\begin{aligned} & 5! \\ & 5! \\ & \mathbf{I N} \\ & \mathbf{N} \end{aligned}$ | $\left\lvert\, \begin{aligned} & \mathrm{NCH} \\ & \mathrm{NCH} \\ & \mathrm{NCH} \\ & \mathrm{NCH} \end{aligned}\right.$ | FE FE FE FE | $\begin{aligned} & \text { 2N5545 } \\ & \text { 2N5546 } \end{aligned}$ | SEE FET <br> SEE FET <br> SEE FET <br> SEE FET | INTERCH NTERCH NTERCH NTERCH | NGEAB: NGEABI NGEABI NGEAB | ITY LIST ITY LIST ITY LIST ITY LIST |  |  |  |  |  |
| $\begin{array}{\|l} \mathbf{U} 233 \\ \text { U234 } \\ \text { U235 } \\ \text { U240 } \end{array}$ | $\left\lvert\, \begin{aligned} & \mathbf{N} \\ & \mathbf{N} \\ & \mathbf{N} \\ & \mathbf{N} \\ & \mathbf{S} \end{aligned}\right.$ | NCH <br> NCH <br> NCH <br> NCH | FE <br> FE <br> FE <br> FE | $\begin{aligned} & \text { 2N5547 } \\ & \text { 2N5547 } \\ & \text { 2N5045 } \end{aligned}$ | SEE FET <br> SEE FET <br> SEE FET <br> SEE FET | INTERCH INTERCH INTERCH INTERCH | ANGEAB <br> ANGEAB <br> NGEAB <br> ANGEAB | ITY LIST <br> ITY LIST <br> ITY LIST <br> ITY LIST |  |  |  |  |  |
| U241 <br> U242 <br> U243 <br> U248 | $\begin{aligned} & \mathbf{S I} \\ & \mathbf{s i} \\ & \mathbf{S I} \\ & \mathbb{N} \end{aligned}$ | NCH NCH NCH NCH | FE <br> FE <br> FE <br> FE |  | see fet <br> SEE FET <br> SEE FET <br> SEE FET | INTERCH INTERCH INTERCH INTERCH | ANGEAB <br> angeab <br> ANGEAB <br> ANGEAB | ITY LIST ITY LIST ITY LIST ITY LIST 1 |  |  |  |  |  |

## TRANSISTOR INTERCHANGEABILITY MASTER LIST OF NONREGISTERED TYPES

|  |  | E$\frac{2}{3}$8 | $\begin{aligned} & \frac{8}{8} \\ & \frac{8}{8} \\ & 8 \end{aligned}$ | TIREMLACEMENTOR NEANESTEQUNAIENT | MAXIMUM RATINOS | EECTRICAL CMARACTERISTICS |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  | $\begin{array}{ccc} P_{T} & \\ T_{A}=25^{\circ} \mathrm{C} & V_{\mathrm{CNO}} & V_{\mathrm{CEO}} \end{array}$ | hTE | $V_{C E}$ (cat) | $h_{6}$ - |  |
|  |  |  |  |  | $\left\lvert\, \begin{array}{cc} { }^{*} \mathrm{C} \mathrm{C}=25^{\circ} \mathrm{C} \\ (\mathrm{~mW}) & \text { (V) } \end{array}\right.$ | $\text { MN MAX } \quad \begin{gathered} \mathrm{V} \\ (\mathrm{~mA}) \\ \hline \end{gathered}$ | $\begin{array}{lr} M A X & \mathrm{C} \\ (\mathrm{~V}) & (\mathrm{mA}) \\ \hline \end{array}$ | MM | $\begin{aligned} & \text { MW } \\ & \text { (MHz) } \end{aligned}$ |
| $\begin{aligned} & \text { U248A } \\ & \text { U249 } \\ & \mathbf{U 2 4 9 A} \\ & \text { U250 } \end{aligned}$ | $\begin{aligned} & \mathbf{N} \\ & \mathbf{N} \\ & \mathbf{N} \\ & \mathbf{N} \\ & \mathbf{N} \end{aligned}$ | $\left\lvert\, \begin{aligned} & \mathrm{NCH} \\ & \mathrm{NCH} \\ & \mathrm{NCH} \\ & \mathrm{NCH} \end{aligned}\right.$ | PE <br> FE <br> FE <br> FE |  | SEE FET INTERCHANGEABHITY UST SEE FET INTERCHANGEADILTY LST SEE FET INTERCHANGEABLITY LST SEE FET INTERCHANGEABLITY LIST |  |  |  |  |
| $\begin{aligned} & \text { U250A } \\ & \text { U251 } \\ & \text { U251A } \\ & \text { U252 } \end{aligned}$ | $\left\lvert\, \begin{aligned} & \mathbb{N} \\ & \mathbb{N} \\ & \mathbb{N} \\ & \mathbb{N} \\ & \mathbb{N} \end{aligned}\right.$ | $\left\lvert\, \begin{aligned} & \mathrm{NCH} \\ & \mathbf{N C H} \\ & \mathbf{N C H} \\ & \mathbf{N C H} \end{aligned}\right.$ | $\begin{aligned} & \text { FE } \\ & \text { FE } \\ & \text { FE } \end{aligned}$ FE |  | SEE FET INTERCHANGEABLLTY LST SEE FET INTERCHANGEABLITY LST SEE FET INTERCHANGEABLLTY LST SEE FET INTERCHANGEABLITY UST |  |  |  |  |
| $\begin{aligned} & \text { U253 } \\ & \text { U254 } \\ & \text { U255 } \\ & \text { U256 } \end{aligned}$ | $\begin{aligned} & \mathbb{N} \\ & \mathbb{N} \\ & \mathbb{N} \\ & \mathbb{N} \\ & \mathbb{N} \end{aligned}$ | $\begin{aligned} & \mathrm{NCH} \\ & \mathrm{NCH} \\ & \mathrm{NCH} \\ & \mathrm{NCH} \end{aligned}$ | $\begin{aligned} & \text { FE } \\ & \text { FE } \\ & \text { FE } \\ & \text { FE } \end{aligned}$ |  | SEE FET NNTERCHANGEABLITY LIST SEE FET INTERCHANGEABLITY LIST SEE FET INTERCHANGEASILTY UST SEE FET INTERCHANGEABLLTY LIST |  |  |  |  |
| $\begin{array}{\|l} \text { U257 } \\ \text { U273 } \\ \text { U273A } \\ \text { U274 } \end{array}$ | $\left\lvert\, \begin{aligned} & \mathbb{N} \\ & \mathbf{N} \\ & \mathbf{S} \\ & \mathbf{S I} \\ & \mathbf{S I} \end{aligned}\right.$ | $\begin{aligned} & \mathrm{NCH} \\ & \mathrm{NCH} \\ & \mathrm{NCH} \\ & \mathrm{NCH} \end{aligned}$ | $\begin{aligned} & \text { FE } \\ & \text { FE } \\ & \text { FE } \\ & \text { FE } \end{aligned}$ | 2N5047 | SEE FET INTERCHANGEABHLTY LIST SEE FET INTERCHANGEABLLTY LIST SEE FET INTERCHANGEABIITY LIST SEE FET INTERCHANGEABLTTY LST |  |  |  |  |
| $\begin{aligned} & \text { U274A } \\ & \text { U275 } \\ & \text { U275A } \\ & \text { U280 } \end{aligned}$ | $\left\lvert\, \begin{aligned} & \mathbf{S i} \\ & \mathbf{S i} \\ & \mathbf{S i} \\ & \mathbf{S i} \end{aligned}\right.$ | $\begin{aligned} & \mathrm{NCH} \\ & \mathrm{NCH} \\ & \mathrm{NCH} \\ & \mathrm{NCH} \\ & \mathrm{NCH} \end{aligned}$ | FE <br> FE <br> FE <br> FE |  | SEE FET INTERCHANGEABLLTY LLST <br> SEE FET INTERCHANGEABILTY LIST <br> SEE FET INTERCHANGEABLITY LIST <br> SEE FET INTERCHANGEABULTY LIST |  |  |  |  |
| U281 <br> U282 <br> U2E3 <br> U2e4 | $\left\lvert\, \begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s N} \end{aligned}\right.$ | $\begin{aligned} & \mathrm{NCH} \\ & \mathrm{NCH} \\ & \mathrm{NCH} \\ & \mathrm{NCH} \end{aligned}$ | Ft <br> FE <br> FE <br> FE |  | SEE FET INTERCHANGEABLITY UST <br> SEE FET INTERCHANGEABLITY LST <br> SEE FET INTERCHANGEABLITY LST <br> SEE FET INTERCHANGEAEHLTY UST |  |  |  |  |
| U245 <br> U290 <br> U291 <br> U300 | $\left\lvert\, \begin{aligned} & \mathbf{S I} \\ & \mathbf{s i} \\ & \mathbf{S I} \\ & \mathbf{S I} \end{aligned}\right.$ | $\begin{aligned} & \mathrm{NCH} \\ & \mathrm{NCH} \\ & \mathrm{NCH} \\ & \mathrm{PCH} \end{aligned}$ | FE <br> FE <br> FE <br> FE |  | SEE FET INTERCHANGEABLITY LIST SEE FET INTERCHANGEABUTTY LIST SEE FET INTERCHANGEABLLTY LST SEE FET INTERCHANGEABLTTY LST |  |  |  |  |
| U301 <br> U304 <br> U305 <br> U306 | $\left\lvert\, \begin{aligned} & \$ 1 \\ & \mathbf{S} \\ & \mathbf{S i} \\ & \mathbf{S i} \end{aligned}\right.$ | $\left\lvert\, \begin{aligned} & \mathrm{PCH} \\ & \mathrm{PCH} \\ & \mathrm{PCH} \\ & \hline \mathrm{PCH} \end{aligned}\right.$ | FE FE FE FE |  | SEE FET INTERCHANGEAEILITY LIST SEE FET INTERCHANGEABLITY LST SEE FET INTERCHANGEABLITY LIST SEE FET INTERCHANGEABILTY LIST |  |  |  |  |
| U310 U312 U1277 U1278 | $\left\lvert\, \begin{aligned} & \mathbf{S I} \\ & \mathbf{S !} \\ & \mathbb{N} \\ & \mathbb{N} \\ & \mathbb{N} \end{aligned}\right.$ | NCH <br> NCH <br> NCH <br> NCH | $\begin{aligned} & \text { FE } \\ & \text { FE } \\ & \text { FE } \\ & \text { FE } \\ & \text { FE } \end{aligned}$ | $\begin{aligned} & \text { 2N55.19 } \\ & \text { 2N5397 } \\ & \text { 2N5361 } \\ & \text { 2N5359 } \end{aligned}$ | SEE FET INTERCHANGEABHLTY UST SEE FET INTERCHANGEABLITY LIST SEE FET INTERCHANGEABLITY LIST SEE FET NTERCHANGEAPLITY LST |  |  |  |  |
| V1279 <br> U1260 <br> U1281 <br> U1282 | $\left\lvert\, \begin{aligned} & \mathbf{N} \\ & \mathbf{N} \\ & \mathbf{N} \\ & \mathbf{N} \\ & \mathbf{N} \end{aligned}\right.$ | NCH <br> NCH <br> NCH <br> NCH | $\begin{aligned} & \text { FE } \\ & \text { FE } \\ & \text { FE } \\ & \text { FE } \end{aligned}$ | $\begin{aligned} & \text { 2N5362 } \\ & \text { 2N5359 } \\ & \text { 2N5549 } \\ & \text { 2N3458 } \end{aligned}$ | SEE FET INTERCHANGEABLITY UST <br> SEE FET INTERCHANGEABLITY LIST <br> SEE FET NTERCHANGEABLITY UST <br> SEE FET INTERCHANGEABHITY LIST |  |  |  |  |


| TYPE |  | K$\frac{k}{2}$88 |  | $\begin{aligned} & \text { TI } \\ & \text { REPLACEMENT } \\ & \text { OR NEAREST } \\ & \text { EGUVALENT } \end{aligned}$ |  | EECTRICAL CHARACTRISTICS |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  |  | hat  <br> $\operatorname{MIN} \operatorname{MaX}$ IC <br> (mA) |  | $\begin{gathered} \mathrm{h}_{\mathrm{f}} \\ \mathrm{I} \text { ktt } \\ \text { Min } \end{gathered}$ | $\begin{array}{c\|} \hline \mathbf{T} \\ \\ \mathbf{M N N} \\ (\mathbf{M H z}) \\ \hline \end{array}$ |
| U1283 U1284 U1285 U1286 | $\begin{aligned} & \mathbf{N} \\ & \mathbb{N} \\ & \mathbb{N} \\ & \mathbb{N} \\ & \mathbb{N} \end{aligned}$ | NCH <br> NCH <br> NCH <br> NCH | $\begin{aligned} & \mathrm{FE} \\ & \mathbf{F E} \\ & \mathbf{F E} \\ & \mathbf{F E} \\ & \mathbf{F E} \end{aligned}$ | $\begin{aligned} & \text { 2N3459 } \\ & \text { 2N3458 } \\ & \text { 2N3459 } \end{aligned}$ | SEE FET INTERCHANGEABI SEE FET INTERCHANGEABI SEE FET INTERCHANGEABI SEE FET INTERCHANGEABI | TY LIST <br> TY List <br> TY LIST <br> TY LIST |  |  |  |
| U1287 U1321 U1322 U1323 | $\left\lvert\, \begin{aligned} & \mathbb{N} \\ & \mathbb{N} \\ & \mathbb{N} \\ & \mathbb{N} \\ & \mathbb{N} \end{aligned}\right.$ | NCH <br> NCH <br> NCH <br> NCH | $\begin{aligned} & \text { FE } \\ & \text { FE } \\ & \text { FE } \\ & \text { FE } \end{aligned}$ | $\begin{aligned} & \text { 2N4860 } \\ & \text { 2N3966 } \\ & \text { 2N3459 } \\ & \text { 2N3459 } \end{aligned}$ | SEE FET INTERCHANGEAB SEE FET INTERCHANGEAB SEE FET INTERCHANGEAB see fet interchangeab | TY LIST TY LIST TY LIST TY LIST |  |  |  |
| U1324 U1325 U1714 U1837E | $\begin{aligned} & \mathbb{N} \\ & \mathbb{N} \\ & \mathbb{N} \\ & \mathbb{N} \end{aligned}$ | $\begin{aligned} & \mathrm{NCH} \\ & \mathrm{NCH} \\ & \mathrm{NCH} \\ & \mathrm{NCH} \end{aligned}$ | $\begin{aligned} & \text { FE } \\ & \text { FE } \\ & \text { FE } \\ & \text { FE } \end{aligned}$ | $\begin{aligned} & \text { 2N5362 } \\ & \text { 2N3459 } \\ & \text { 2N5245 } \end{aligned}$ | SEE FET INTERCHANGEAB <br> SEE FET INTERCHANGEAB <br> seE fet interchangeab <br> see fet interchangeab | TY LIST <br> TY LIST <br> TY LIST TY LIST |  |  |  |
| U1897E <br> U1898E <br> U1899E <br> U1994E | $\left\lvert\, \begin{aligned} & \mathbb{N} \\ & \mathbb{N} \\ & \mathbb{N} \\ & \mathbb{N} \\ & \mathbb{N} \end{aligned}\right.$ | $\begin{aligned} & \mathrm{NCH} \\ & \mathrm{NCH} \\ & \mathrm{NCH} \\ & \mathrm{NCH} \end{aligned}$ | $\begin{array}{l\|l\|} \hline \text { FE } \\ \text { FE } \\ \text { FE } \\ \text { FE } \end{array}$ | $\begin{array}{\|l} \text { TIS73 } \\ \text { TIS74 } \\ \text { TIS75 } \\ \text { 2NS245 } \end{array}$ | SEE FET INTERCHANGEAB <br> SEE FET INTERCHANGEAB <br> SEE FET INTERCHANGEAB <br> SEE FET INTERCHANGEAB | TY LIST ITY LST ITY LIST TY LIST |  |  |  |
| U3000 <br> U3001 <br> U3002 <br> U3010 | $\left\lvert\, \begin{aligned} & \mathbb{N} \\ & \mathbb{N} \\ & \mathbb{N} \\ & \mathbb{N} \\ & \mathbb{N} \end{aligned}\right.$ | $\begin{array}{\|l\|l} \mathrm{NCH} \\ \mathrm{NCH} \\ \mathrm{NCH} \\ \mathrm{NCH} \end{array}$ | $\begin{aligned} & \mathrm{FE} \\ & \mathrm{FE} \\ & \mathrm{FE} \\ & \mathrm{FE} \\ & \mathrm{FE} \end{aligned}$ | $\begin{aligned} & \text { 2N3459 } \\ & \text { 2N3459 } \\ & \text { 2N3458 } \end{aligned}$ | SEE FET INTERCHANGEAB See fet interchangeab see fet interchangeab see fet interchangeab | TY LIST TY LST TV LIST TTY LIST |  |  |  |
| $\begin{aligned} & \text { U3011 } \\ & \text { U3012 } \\ & \text { UC20 } \\ & \text { UC21 } \end{aligned}$ | $\left\lvert\, \begin{aligned} & \mathbb{N} \\ & \mathbb{N} \\ & \mathbb{N} \\ & \mathbb{N} \\ & \mathbb{N} \end{aligned}\right.$ | $\left\lvert\, \begin{aligned} & \mathrm{NCH} \\ & \mathrm{NCH} \\ & \mathrm{NCH} \\ & \mathrm{NCH} \end{aligned}\right.$ | FE FE FE FE FE | $\begin{aligned} & \text { 2N3459 } \\ & \text { 2N3460 } \\ & \text { 2N5358 } \end{aligned}$ | SEE FET INTERCHANGEAB <br> SEE FET INTERCHANGEAB <br> SEE FET INTERCHANGEA <br> See fet interchangeal | ITY LIST ITY LIST ITY LIST ITY LIST |  |  |  |
| UC100 UC1 10 UC115 UCl30 | $\left\lvert\, \begin{aligned} & \mathbb{N} \\ & \mathbb{N} \\ & \mathbb{N} \\ & \mathbb{N} \\ & \mathbb{N} \end{aligned}\right.$ | $\begin{aligned} & \mathrm{NCH} \\ & \mathrm{NCH} \\ & \mathrm{NCH} \\ & \mathrm{NCH} \end{aligned}$ | $\begin{array}{\|l\|} \mathbf{F E} \\ \mathbf{F E} \\ \mathbf{F E} \\ \mathbf{F E} \end{array}$ | $\begin{aligned} & \text { 2N5361 } \\ & \text { 2N5360 } \\ & \text { 2N3459 } \end{aligned}$ | SEE FET INTERCHANGEAB SEE FET INTERCHANGEAB SEE FET INTERCHANGEAB SEE FET INTERCHANGEAB | ITY ust ITY LIST ITY LIST ITY LIST |  |  |  |
| UC155 <br> UC200 <br> UC201 <br> UC210 | $\left\lvert\, \begin{aligned} & \mathbb{N} \\ & \mathbb{N} \\ & \mathbb{N} \\ & \mathbb{N} \\ & \mathbb{N} \end{aligned}\right.$ | $\begin{array}{\|l\|} \mathrm{NCH} \\ \mathrm{NCH} \\ \mathrm{NCH} \\ \mathrm{NCH} \\ \hline \end{array}$ | $\begin{aligned} & \mathbf{F E} \\ & \mathbf{F E} \\ & \mathbf{F E} \\ & \mathbf{F E} \end{aligned}$ | $\begin{aligned} & \text { 2N5364 } \\ & \text { 2N5364 } \\ & \text { 2N5362 } \end{aligned}$ | SEE FET INTERCHANGEAI SEE FET INTERCHANGEAD SEE FET INTERCHANGEAB SEE FET INTERCHANGEAB | ITY LIST ITY UST ITY LIST ITY LIST |  |  |  |
| $\begin{aligned} & \text { UC220 } \\ & \text { UC240 } \\ & \text { UC241 } \\ & \text { UC250 } \end{aligned}$ | $\left\lvert\, \begin{aligned} & \mathbb{N} \\ & \mathbb{N} \\ & \mathbb{N} \\ & \mathbb{N} \\ & \mathbb{N} \end{aligned}\right.$ | $\begin{array}{\|l\|} \mathrm{NCH} \\ \mathrm{NCH} \\ \mathrm{NCH} \\ \mathrm{NCH} \end{array}$ |  | $\begin{aligned} & \text { 2N5360 } \\ & \text { 2N3459 } \\ & \text { 2NS361 } \\ & \text { 2N4391 } \end{aligned}$ | SEE FET INTERCHANGEA SEE FET INTERCHANGEA SEE FET INTERCHANGEA SEE FET INTERCHANGEA | ITY LIST ITY LST ITY LIST ITY LIST |  |  |  |
| UC251 UC400 UC401 UC410 | $\left\lvert\, \begin{aligned} & \mathbf{N} \\ & \mathbf{N} \\ & \mathbf{N} \\ & \mathbf{N} \\ & \mathbf{N} \end{aligned}\right.$ | $\begin{array}{\|l\|} \mathrm{NCH} \\ \mathrm{PCH} \\ \mathrm{PCH} \\ \mathrm{PCCH} \\ \hline \end{array}$ | FE FE FE FE FE | $\begin{aligned} & \text { 2N4392 } \\ & \text { 2N3331 } \\ & \text { 2N3994 } \\ & \text { 2N3330 } \end{aligned}$ | SEE FET INTERCHANGEA SEE FET INTERCHANGEA SEE FET INTERCHANGEA SEE FET INTERCHANGEA | ITY LIST ITY LIST ITY LIST ITY LIST |  |  |  |

## TRANSISTOR INTERCHANGEABILITY <br> MASTER LIST OF NONREGISTERED TYPES



| TME NUMBER |  | $\begin{aligned} & \frac{5}{6} \\ & \frac{5}{3} \\ & \frac{8}{8} \end{aligned}$ | 7 <br> REPACEMENT OR NEAREST EOUVALENT | 2ATED DRANS GATE VOLTACE <br> (V) | Elccibical charactensincs |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  | loss | lyad | $\mathrm{C}_{68}$ | OTH | PARA |  |
|  |  |  |  |  | $\begin{array}{ll} \operatorname{MNN} & M A X \\ (m A) & (m A) \end{array}$ | Mind MaX <br> (mmhe) (mmaha) | max <br> (pl) | symeor | $\mathbf{M A X}$ | $\begin{aligned} & f \\ & (H x) \end{aligned}$ |
| $\begin{aligned} & \text { 2N2386 } \\ & \text { 2N2386A } \\ & \text { 2N2497 } \\ & \text { 2N2498 } \end{aligned}$ | $\begin{array}{ll}P & J \\ P & J \\ P & J \\ P & J\end{array}$ | $\begin{aligned} & \text { FE } \\ & \text { FE } \\ & \text { FE } \\ & \text { FE } \end{aligned}$ | $\begin{aligned} & \text { 2N2386 } \\ & \text { 2N2386A } \\ & \text { 2N2497 } \\ & \text { 2N2498 } \end{aligned}$ | $\begin{array}{r} 20 \\ 20 \\ \cdot 20 \\ \cdot 20 \end{array}$ | $\begin{aligned} & .9-9 \\ & 1-15 \\ & 1-3 \\ & 2-6 \end{aligned}$ | $\begin{gathered} 1- \\ 2.2-5 \\ 1-2 \\ 1.5-3 \end{gathered}$ | $\begin{aligned} & 50 \\ & 10 \\ & 32 \\ & 32 \end{aligned}$ | NF <br> NF <br> NF <br> NF | $\begin{aligned} & 2 \mathrm{DB} \\ & 2 \mathrm{DA} \\ & 3 \mathrm{DB} \\ & 3 \mathrm{DB} \end{aligned}$ |  |
| $\begin{aligned} & \text { 2N2499 } \\ & \text { 2N2500 } \\ & \text { 2N2606 } \\ & \text { 2N2607 } \end{aligned}$ | $\left\|\begin{array}{ll} P & J \\ P & J \\ P & J \\ P & J \end{array}\right\|$ | $\begin{aligned} & \text { FE } \\ & \text { FE } \\ & \text { FE } \\ & \text { FE } \end{aligned}$ | $\begin{aligned} & \text { 2N2499 } \\ & \text { 2N2500 } \end{aligned}$ | $\begin{array}{r} 20 \\ 20 \\ 30 \\ 30 \end{array}$ | $\begin{aligned} & 5-15 \\ & 1.6 \\ & .1-.5 \\ & .3-1.5 \end{aligned}$ | $\begin{aligned} & 24 \\ & 1-2.2 \\ & .11 \\ & .33 \end{aligned}$ | $\begin{array}{r} 32 \\ 32 \\ 6 \\ 10 \end{array}$ | NF <br> NF <br> NF <br> NF | $\begin{aligned} & 4 \mathrm{DB} \\ & 1 \mathrm{DE} \\ & 3 \mathrm{DB} \\ & 3 \mathrm{DS} \end{aligned}$ | 10 M 10 M |
| $\begin{aligned} & 2 \mathrm{~N} 2608 \\ & 2 \mathrm{~N} 2609 \\ & 2 \mathrm{~N} 2841 \\ & 2 \mathrm{~N} 2842 \end{aligned}$ | $\left\|\begin{array}{ll} P & J \\ P & J \\ P & J \\ P & J \end{array}\right\|$ | $\begin{aligned} & \text { FE } \\ & \text { FE } \\ & \text { FE } \\ & \text { FE } \end{aligned}$ | $\begin{aligned} & \text { 2N2608 } \\ & \text { 2N2609 } \end{aligned}$ | $\begin{aligned} & 30 \\ & 30 \\ & 30 \\ & 30 \end{aligned}$ | $\begin{gathered} .9-4.5 \\ 2-10 \\ .025-.125 \\ .065-.325 \end{gathered}$ | $\begin{array}{r} 1- \\ 2.5 \\ .06 \\ .18 \end{array}$ | $\begin{array}{r} 17 \\ 30 \\ 6 \\ 10 \end{array}$ | NF <br> NF <br> NF <br> NF | $\begin{aligned} & 3 \mathrm{DB} \\ & 3 \mathrm{DA} \\ & 3 \mathrm{DB} \\ & 3 \mathrm{DB} \end{aligned}$ | IM <br> 1M <br> IK <br> 1K |
| $\begin{aligned} & \text { 2N2843 } \\ & \text { 2N2844 } \\ & \text { 2N3066 } \\ & \text { 2N3067 } \end{aligned}$ | $\begin{array}{ll} P & J \\ P & J \\ N & J \\ N & J \end{array}$ | FE FE FE FE | $\begin{aligned} & \text { 2N3459 } \\ & \text { 2N3460 } \end{aligned}$ | $\begin{aligned} & 30 \\ & 30 \\ & 50 \\ & 50 \end{aligned}$ | $\begin{aligned} & .2-1 \\ & .44-2.2 \\ & .8-4 \\ & .2-1 \end{aligned}$ | $\begin{gathered} .54 \\ 1.8 \\ .4-1 \\ .3-1 \end{gathered}$ | $\begin{aligned} & 17 \\ & 30 \\ & 10 \\ & 10 \end{aligned}$ | NF <br> NF <br> NF <br> NF | $\begin{aligned} & 3 \mathrm{Ds} \\ & 3 \mathrm{Ds} \\ & 3 \mathrm{Ds} \\ & 3 \mathrm{Ds} \end{aligned}$ | $\begin{aligned} & \text { 1K } \\ & \mathbf{1 K} \\ & \mathbf{1 K} \\ & \mathbf{1 K} \end{aligned}$ |
| $\begin{aligned} & \text { 2N3068 } \\ & \text { 2N3069 } \\ & \text { 2N3070 } \\ & \text { 2N3071 } \end{aligned}$ | $\begin{array}{ll} \mathbf{N} & J \\ \mathbf{N} & J \\ \mathbf{N} & J \\ \mathbf{N} & J \end{array}$ | $\begin{aligned} & \text { FE } \\ & \text { FE } \\ & \text { FE } \\ & \text { FE } \end{aligned}$ | 2N3458 <br> 2N3459 <br> 2N3460 | $\begin{aligned} & 50 \\ & 50 \\ & 50 \\ & 50 \end{aligned}$ | $\begin{gathered} .05-.25 \\ 2-10 \\ .5-2.5 \\ .1-.6 \end{gathered}$ | $\begin{array}{r} .2-1 \\ 1-2.5 \\ .75-2.5 \\ .5-2.5 \end{array}$ | $\begin{aligned} & 10 \\ & 15 \\ & 15 \\ & 15 \end{aligned}$ | NF <br> NF <br> NF <br> NF | $\begin{aligned} & 3 \mathrm{Ds} \\ & 3 \mathrm{Ds} \\ & 3 \mathrm{Ds} \\ & 3 \mathrm{Ds} \end{aligned}$ | $\begin{aligned} & \mathbf{1 K} \\ & \mathbf{1 K} \\ & \mathbf{1 K} \\ & \mathbf{1 K} \end{aligned}$ |
| $\left\lvert\, \begin{aligned} & \text { 2N } 3084 \\ & \text { 2N3085 } \\ & \text { 2N3086 } \\ & \text { 2N3087 } \end{aligned}\right.$ | $\begin{array}{ll} \mathbf{N} & J \\ \mathbf{N} & J \\ \mathbf{N} & J \\ \mathbf{N} & J \end{array}$ | FE <br> FE <br> FE <br> FE | 2N3459 <br> 2N3459 <br> 2N3459 <br> 2N3459 | $\begin{aligned} & 30 \\ & 30 \\ & 40 \\ & 40 \end{aligned}$ | $\begin{aligned} & .8-3 \\ & .8-3 \\ & .8-3 \\ & .8-3 \end{aligned}$ | $\begin{aligned} & .4-1.2 \\ & .4-1.2 \\ & .4-1.2 \\ & .4-1.2 \end{aligned}$ |  |  |  |  |
| $\begin{aligned} & \text { 2N3088 } \\ & \text { 2N3088A } \\ & \text { 2N3089 } \\ & \text { 2N3089A } \end{aligned}$ | $\begin{array}{ll} \mathbf{N} & J \\ \mathbf{N} & J \\ \mathbf{N} & J \\ \mathbf{N} & J \end{array}$ | $\begin{aligned} & \text { FE } \\ & \text { FE } \\ & \text { FE } \\ & \text { FE } \end{aligned}$ | $\begin{aligned} & \text { 2N3460 } \\ & \text { 2N3460 } \\ & \text { 2N3460 } \\ & \text { 2N3460 } \end{aligned}$ | $\begin{aligned} & 15 \\ & 15 \\ & 30 \\ & 15 \end{aligned}$ | $\begin{array}{r} .5-2 \\ .5-2 \\ .5-2 \\ .5-2 \end{array}$ | $\begin{aligned} & .3- \\ & .9-2 \\ & .3-2 \\ & .9-2 \end{aligned}$ | $\begin{array}{r} 14 \\ 6 \\ 14 \end{array}$ | NF <br> NF <br> NF <br> NF | $\begin{gathered} 3 \mathrm{DB} \\ .5 \mathrm{DB} \\ 3 \mathrm{DB} \\ .5 \mathrm{DB} \end{gathered}$ | $\begin{aligned} & 1 M \\ & 10 \\ & 1 M \end{aligned}$ |
| 2N3112 <br> 2N3113 <br> 2N3277 <br> 2N3278 | $\begin{array}{ll}\text { P } & J \\ \mathbf{P} & J \\ \mathbf{P} & J \\ \mathbf{P} & \\ \end{array}$ | FE FE FE FE |  | $\begin{aligned} & 20 \\ & 20 \\ & 25 \\ & 25 \end{aligned}$ | $\begin{gathered} .035-.175 \\ .035-.175 \\ .15-.5 \\ .4 .9 \end{gathered}$ | $\begin{gathered} .05-.11 \\ .05 .11 \\ .1- \\ .15 \end{gathered}$ | $\begin{array}{r} 3.5 \\ 2 \\ 4.5 \\ 4.5 \end{array}$ |  |  |  |
| $\begin{aligned} & \text { 2N3328 } \\ & \text { 2N3329 } \\ & \text { 2N3330 } \\ & \text { 2N3331 } \end{aligned}$ | $\left\lvert\, \begin{array}{ll} P & J \\ \mathbf{P} & J \\ \mathbf{P} & J \\ \mathbf{P} & J \end{array}\right.$ | FE <br> FE <br> FE <br> FE | $\begin{aligned} & \text { 2N3328 } \\ & \text { 2N3329 } \\ & \text { 2N3330 } \\ & \text { 2N3331 } \end{aligned}$ | $\begin{aligned} & 20 \\ & 20 \\ & 20 \\ & 20 \end{aligned}$ | $\begin{aligned} & -1 \\ & 1-3 \\ & 2-6 \\ & 5-15 \end{aligned}$ | $\begin{array}{r} 1- \\ 1-2 \\ 1.5-3 \\ 2-4 \end{array}$ |  | NF <br> NF <br> NF <br> NF | $\begin{aligned} & 3 \mathrm{DA} \\ & 3 \mathrm{DB} \\ & 3 \mathrm{DB} \\ & 4 \mathrm{DB} \end{aligned}$ | $\begin{aligned} & \text { IK } \\ & \text { 1K } \\ & \text { IK } \\ & \text { 1K } \end{aligned}$ |
| $\begin{aligned} & \text { 2N3332 } \\ & \text { 2N3333 } \\ & \text { 2N3334 } \\ & \text { 2N3335 } \end{aligned}$ | $\left\lvert\, \begin{array}{ll} P & J \\ P & J \\ P & J \\ P & J \end{array}\right.$ | $\begin{aligned} & \text { FE } \\ & \text { FE } \\ & \text { FE } \\ & F E \end{aligned}$ | $\begin{aligned} & \text { 2N3332 } \\ & \text { 2N3333 } \\ & \text { 2N3334 } \\ & \text { 2N3335 } \end{aligned}$ | $\begin{aligned} & 20 \\ & 20 \\ & 20 \\ & 20 \end{aligned}$ | $\begin{aligned} & 1-6 \\ & .3-1 \\ & .3-1 \\ & .3-1 \\ & \hline \end{aligned}$ | $\begin{gathered} 1-2.2 \\ .6-1.8 \\ .6-1.8 \\ .6-1.8 \end{gathered}$ | $\begin{aligned} & 20 \\ & 30 \\ & 30 \\ & 30 \\ & \hline \end{aligned}$ | NF | 1 DB |  |

# TRANSISTOR INTERCHANGEABILITY REGISTERED FIELD-EFFECT TRANSISTORS 

| TYPE NUMBER | $\begin{array}{ll} \vdots & \frac{m}{2} \\ \frac{2}{3} & \frac{2}{2} \\ \frac{2}{2} & \frac{m}{2} \end{array}$ |  |  | rated DRARMGATE VOLTAGE (V) | EECTULCAL CHARACTERISTICS |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  | $\begin{gathered} \text { LDSs } \\ \text { *D(on) } \end{gathered}$ | brad | Cbes <br> max <br> ( pF F) | OTHER PARAMETER |  |  |
|  |  |  |  |  | $\begin{array}{ll} \operatorname{Mn} & \max \\ (\mathrm{mA}) & (\mathrm{ma}) \end{array}$ | $\begin{array}{\|cc} \text { Mand } & \text { MaX } \\ \text { (mmho) } & \text { (manho) } \\ \hline \end{array}$ |  | SYMEOL | MAX | $\begin{gathered} e^{f} \\ \left(\mathrm{H}_{\mathrm{z}}\right) \end{gathered}$ |
| $\begin{aligned} & \text { 2N3336 } \\ & \text { 2N3365 } \\ & \text { 2N3366 } \\ & \text { 2N3367 } \end{aligned}$ | $\begin{array}{ll}\mathbf{P} & J \\ \mathbf{N} & J \\ \mathbf{N} & J \\ \mathbf{N} & J\end{array}$ | $\begin{aligned} & \hline \mathrm{FE} \\ & \mathrm{FE} \\ & \mathrm{FE} \\ & \mathrm{FE} \\ & \mathrm{FE} \end{aligned}$ | $\begin{aligned} & \text { 2N3336 } \\ & \text { 2N3459 } \\ & \text { 2N3460 } \end{aligned}$ | $\begin{aligned} & 20 \\ & 40 \\ & 40 \\ & 40 \end{aligned}$ | $\begin{gathered} .3-1 \\ .8-4 \\ .2-1 \\ .05-.25 \end{gathered}$ | $\begin{gathered} .6-1.8 \\ .4-2 \\ .25-1 \\ .1-1 \end{gathered}$ | $\begin{aligned} & 30 \\ & 15 \\ & 15 \\ & 15 \end{aligned}$ |  |  |  |
| $\begin{aligned} & \text { 2N3368 } \\ & \text { 2N3369 } \\ & \text { 2N3370 } \\ & \text { 2N3376 } \end{aligned}$ | $\begin{array}{ll} \mathbf{N} & J \\ \mathbf{N} & J \\ \mathbf{N} & J \\ \mathbf{P} & J \end{array}$ | $\begin{aligned} & \text { FE } \\ & \text { FE } \\ & \text { FE } \\ & \text { FE } \\ & \hline F \end{aligned}$ | $\begin{aligned} & \text { 2N3458 } \\ & \text { 2N3460 } \\ & \text { 2N3460 } \\ & \text { 2N3329 } \end{aligned}$ | $\begin{array}{r} 40 \\ 40 \\ 40 \\ 30 \end{array}$ | $\begin{aligned} & 2-12 \\ & .5-2.5 \\ & .1-.6 \\ & .6-6 \end{aligned}$ | $\begin{aligned} & 1-4 \\ & .6-2.5 \\ & .3-2.5 \\ & .8-2.3 \end{aligned}$ | $\begin{aligned} & 20 \\ & 20 \\ & 20 \end{aligned}$ |  |  |  |
| $\begin{aligned} & \text { 2N3377 } \\ & \text { 2N3378 } \\ & \text { 2N3379 } \\ & \text { 2N3380 } \end{aligned}$ | $\begin{array}{ll}\mathbf{P} & J \\ \mathbf{P} & J \\ \mathbf{P} & J \\ \mathbf{P} & J\end{array}$ | $\left\{\begin{array}{l} \mathrm{FE} \\ \mathrm{FE} \\ \mathrm{FE} \\ \mathrm{FE} \end{array}\right.$ | 2N3331 | $\begin{aligned} & 30 \\ & 30 \\ & 30 \\ & 30 \end{aligned}$ | $\begin{aligned} & .6-6 \\ & 3-6 \\ & 3-6 \\ & 3-20 \end{aligned}$ | $\begin{array}{r} .8-2.3 \\ 1.5-2.3 \\ 1.5-2.3 \\ 1.5-3 \end{array}$ |  |  |  |  |
| $\begin{aligned} & \text { 2N3381 } \\ & \text { 2N3382 } \\ & \text { 2N3383 } \\ & \text { 2N3384 } \end{aligned}$ | $\left\lvert\, \begin{array}{ll} P & J \\ P & J \\ P & J \\ P & J \end{array}\right.$ | $\begin{aligned} & \text { FE } \\ & \mathrm{FE} \\ & \mathrm{FE} \\ & \mathrm{FE} \end{aligned}$ | $\begin{aligned} & \text { 2N3994 } \\ & \text { 2N3993 } \end{aligned}$ | $\begin{aligned} & 30 \\ & 30 \\ & 30 \\ & 30 \end{aligned}$ | $\begin{array}{r} 3-20 \\ 3-30 \\ 3-30 \\ 15-30 \end{array}$ | $\begin{aligned} & 1.5-3 \\ & 4.5-12 . \\ & 2.5-7 \\ & 7.5-12 \end{aligned}$ |  |  |  |  |
| 2N3385 <br> 2N3386 <br> 2N3387 <br> 2N3436 | $\begin{array}{ll} P & J \\ P & J \\ P & J \\ N & J \end{array}$ | $\begin{array}{\|l\|l} \hline \mathbf{F E} \\ \text { FE } \\ \text { FE } \\ \text { FE } \end{array}$ | 2N3993 <br> 2N3458 | $\begin{aligned} & 30 \\ & 30 \\ & 30 \\ & 50 \end{aligned}$ | $\begin{array}{r} 15-30 \\ 15-50 \\ 15-50 \\ 3-15 \end{array}$ | $\begin{array}{r} 5-7 \\ 7.5-15 \\ 5-10 \\ 2.5-10 \end{array}$ | 18 | NF | 2 DB | 1K |
| $\begin{aligned} & \text { 2N3437 } \\ & \text { 2N3438 } \\ & \text { 2N3452 } \\ & \text { 2N3453 } \end{aligned}$ | $\begin{array}{ll} \mathbf{N} & J \\ \mathbf{N} & J \\ \mathbf{N} & J \\ \mathbf{N} & J \end{array}$ | $\begin{aligned} & \mathrm{FE} \\ & \mathrm{FE} \\ & \mathrm{FE} \\ & \mathrm{FE} \\ & \mathrm{FE} \end{aligned}$ | $\begin{aligned} & \text { 2N3459 } \\ & \text { 2N3460 } \\ & \text { 2N3821 } \\ & \text { 2N3821 } \end{aligned}$ | $\begin{aligned} & 50 \\ & 50 \\ & 50 \\ & 50 \end{aligned}$ | $\begin{aligned} & .8-4 \\ & .2-1 \\ & .8-4 \\ & .2-1 \end{aligned}$ | $\begin{aligned} & 1.5-6 \\ & .8-4.5 \\ & .2-1.2 \\ & .15-.9 \end{aligned}$ | $\begin{array}{r} 18 \\ 18 \\ 6 \\ 6 \end{array}$ | $\begin{aligned} & \mathrm{NF} \\ & \mathrm{NF} \\ & \mathrm{NF} \\ & \mathrm{NF} \end{aligned}$ | $\begin{aligned} & 2 \mathrm{DB} \\ & 2 \mathrm{DB} \\ & 2 \mathrm{DB} \\ & 2 \mathrm{DB} \end{aligned}$ | $\begin{aligned} & \mathbf{1 K} \\ & \mathbf{1 K} \end{aligned}$ |
| $\begin{aligned} & \text { 2N3454 } \\ & \text { 2N3455 } \\ & \text { 2N3456 } \\ & \text { 2N3457 } \end{aligned}$ | $\begin{array}{ll} \mathbf{N} & J \\ \mathbf{N} & J \\ \mathbf{N} & J \\ \mathbf{N} & J \end{array}$ | FE <br> FE <br> FE <br> FE | $\begin{aligned} & \text { 2N3821 } \\ & \text { 2N3821 } \end{aligned}$ | $\begin{aligned} & 50 \\ & 50 \\ & 50 \\ & 50 \end{aligned}$ | $\begin{gathered} .05-.25 \\ .8-4 \\ .2-1 \\ .05-.25 \end{gathered}$ | $\begin{gathered} .1-.6 \\ .4-1.2 \\ .3-.9 \\ .15-.6 \end{gathered}$ | $\begin{aligned} & 6 \\ & 5 \\ & 5 \\ & 5 \end{aligned}$ | $\begin{aligned} & \mathrm{NF} \\ & \mathrm{NF} \\ & \mathrm{NF} \\ & \mathrm{NF} \end{aligned}$ | $\begin{aligned} & 2 \mathrm{OB} \\ & 4 \mathrm{DB} \\ & 4 \mathrm{DB} \\ & 4 \mathrm{DB} \end{aligned}$ |  |
| $\begin{aligned} & \text { 2N3458 } \\ & \text { 2N3459 } \\ & \text { 2N3460 } \\ & \text { 2N3465 } \end{aligned}$ | $\begin{array}{ll} \mathbf{N} & J \\ \mathbf{N} & J \\ \mathbf{N} & J \\ \mathbf{N} & J \end{array}$ | FE <br> FE <br> FE <br> FE |  | $\begin{aligned} & 50 \\ & 50 \\ & 50 \\ & 40 \end{aligned}$ | $\begin{aligned} & 3-15 \\ & .8-4 \\ & .2-1 \\ & 1-5 \end{aligned}$ | $\begin{aligned} & 2.5-10 \\ & 1.5-6 \\ & .8-4.5 \\ & .4-1.2 \end{aligned}$ | $\begin{aligned} & 18 \\ & 18 \\ & 18 \end{aligned}$ | $\begin{aligned} & \text { NF } \\ & \text { NF } \\ & \mathbf{N F} \\ & \mathbf{N F} \end{aligned}$ | $\begin{aligned} & 6 \mathrm{DB} \\ & 4 \mathrm{DB} \\ & 4 \mathrm{DB} \\ & 5 \mathrm{DB} \end{aligned}$ | 20 20 20 |
| $\begin{aligned} & \text { 2N3466 } \\ & \text { 2N3573 } \\ & \text { 2N3574 } \\ & \text { 2N3575 } \end{aligned}$ | $\begin{array}{ll} \mathbf{N} & J \\ \mathbf{P} & J \\ \mathbf{P} & J \\ \mathbf{P} & J \end{array}$ | FE <br> FE <br> FE <br> FE | 2N3821 <br> 2N3573 <br> 2N3574 <br> 2N3575 | $\begin{aligned} & 40 \\ & 25 \\ & 25 \\ & 25 \end{aligned}$ | $\begin{gathered} 1-5 \\ .02 .1 \\ .075-.37 \\ .2-1 \end{gathered}$ | $\begin{aligned} & .4-1.2 \\ & .1-.3 \\ & .2-.6 \\ & .3-.9 \end{aligned}$ | $\begin{aligned} & 6 \\ & 6 \\ & 6 \end{aligned}$ | NF NF CRSS CRSS | $\begin{aligned} & 5 \mathrm{DB} \\ & 3 \mathrm{DB} \\ & 2 \mathrm{PF} \\ & 2 \mathrm{PF} \end{aligned}$ |  |
| $\begin{aligned} & \text { 2N3578 } \\ & \text { 2N3608 } \\ & \text { 2N3609 } \\ & \text { 2N3610 } \\ & \hline \end{aligned}$ | $\mathbf{P}$ $\mathbf{J}$ <br> $\mathbf{P}$ IG <br> $\mathbf{P}$ IG <br> $\mathbf{P}$ $\mathbf{I G}$ | FE <br> FE <br> FE <br> FE | $\begin{aligned} & \text { 2N2608 } \\ & \text { 3N155 } \end{aligned}$ | $\begin{aligned} & 20 \\ & 30 \\ & 25 \\ & 20 \end{aligned}$ | $\begin{gathered} .9-4.5 \\ * 4-7 \\ 2.25-3.25 \\ .4-.6 \\ \hline \end{gathered}$ | $\begin{gathered} 1.2-3.5 \\ .8- \end{gathered}$ | 65 | CRSS CRSS CRSS | $\begin{aligned} & 3 \mathrm{PF} \\ & 2 \mathrm{PF} \\ & 6 \mathrm{PF} \end{aligned}$ | $\begin{aligned} & 1 \mathrm{M} \\ & \mathrm{IM} \end{aligned}$ |


| TYF NUMEER |  | CIASSIFICATION | TIRERLACEMENTOR NEARESTECUIYALENT | RATED DRANGATE Voltace <br> (V) | EECTRICAL CHARACTERISTICS |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  | $\begin{aligned} & \text { loss } \\ & \text { *LD(on) } \end{aligned}$ | \|rat | $C_{\text {iss }}$ <br> Max <br> (pF) | OTHER PARAMETER |  |  |
|  |  |  |  |  | $\begin{array}{ll} \operatorname{man} & \operatorname{MAX} \\ (\mathrm{mA}) & (\mathrm{mA}) \\ \hline \end{array}$ | MNN MAX <br> (mmho) (mmho) |  | SYMBOL | MAX | $\begin{gathered} f \\ (\mathrm{~Hz}) \end{gathered}$ |
| $\begin{aligned} & \text { 2N3631 } \\ & \text { 2N3684 } \\ & \text { 2N3684A } \\ & \text { 2N3685 } \end{aligned}$ | $\left\|\begin{array}{ll} \mathbf{N} & \mathbf{I} \\ \mathbf{N} & J \\ \mathbf{N} & J \\ \mathbf{N} & J \end{array}\right\|$ | FE <br> FE <br> FE <br> FE | $\begin{aligned} & \text { 2N3822 } \\ & \text { 2N3822 } \\ & \text { 2N3821 } \end{aligned}$ | $\begin{aligned} & 20 \\ & 50 \\ & 50 \\ & 50 \end{aligned}$ | $\begin{gathered} 2-10 \\ 2.5-7.5 \\ 2.5-7.5 \\ 1-3 \end{gathered}$ | $\begin{gathered} 1.4-2.8 \\ 2-3 \\ 2-3 \\ 1.5-2.5 \end{gathered}$ | $\begin{array}{r} 7.5 \\ 4 \\ 4 \\ 4 \end{array}$ | CRSS <br> NF <br> NF <br> NF | $\begin{gathered} 1.6 \mathrm{PF} \\ .5 \mathrm{DB} \\ .5 \mathrm{DB} \\ .5 \mathrm{DB} \end{gathered}$ | $\begin{array}{r} 1 K \\ 100 \\ 100 \\ 100 \end{array}$ |
| $\begin{aligned} & \text { 2N3685A } \\ & \text { 2N3686 } \\ & \text { 2N3686A } \\ & \text { 2N3687 } \end{aligned}$ | $\begin{array}{ll} \mathbf{N} & J \\ \mathbf{N} & J \\ \mathbf{N} & J \\ \mathbf{N} & J \end{array}$ | $\begin{aligned} & \text { FE } \\ & \text { FE } \\ & \text { FE } \\ & \text { FE } \end{aligned}$ | $\begin{aligned} & \text { 2N3821 } \\ & \text { 2N3821 } \\ & \text { 2N3821 } \end{aligned}$ | $\begin{aligned} & 50 \\ & 50 \\ & 50 \\ & 50 \end{aligned}$ | $1-3$ $.4-1.2$ $.4-1.2$ $.1-.5$ | $\begin{aligned} & 1.5-2.5 \\ & 1-2 \\ & 1-2 \\ & .5-1.5 \end{aligned}$ | $\begin{aligned} & 4 \\ & 4 \\ & 4 \end{aligned}$ | NF <br> NF <br> NF <br> NF | $\begin{aligned} & .5 \mathrm{DB} \\ & .5 \mathrm{DB} \\ & .5 \mathrm{DB} \\ & .5 \mathrm{DB} \end{aligned}$ | $\begin{aligned} & 100 \\ & 100 \\ & 100 \\ & 100 \end{aligned}$ |
| $\begin{aligned} & \text { 2N3687A } \\ & \text { 2N3695 } \\ & \text { 2N3696 } \\ & \text { 2N3697 } \end{aligned}$ | $\begin{array}{ll} \mathbf{N} & J \\ \mathbf{P} & J \\ \mathbf{P} & J \\ \mathbf{P} & J \end{array}$ | FE FE FE FE | $\begin{aligned} & \text { 2N3329 } \\ & \text { 2N3329 } \end{aligned}$ | $\begin{aligned} & 50 \\ & 30 \\ & 30 \\ & 30 \end{aligned}$ | $\begin{gathered} .1-.5 \\ 1.25-3.75 \\ . .5-1.5 \\ =.2-.6 \end{gathered}$ | $\begin{gathered} .5-1.5 \\ 1-1.75 \\ .75-1.25 \end{gathered}$ | 4 | NF <br> NF <br> NF | $\begin{aligned} & .5 \mathrm{DB} \\ & .5 \mathrm{DB} \\ & .5 \mathrm{DB} \end{aligned}$ | $\begin{aligned} & 100 \\ & 10 \mathrm{M} \\ & 10 \mathrm{~m} \end{aligned}$ |
| $\begin{aligned} & \text { 2N3698 } \\ & \text { 2N3798 } \\ & \text { 2N3797 } \\ & \text { 2N3819 } \end{aligned}$ | $P$ $J$ <br> $N$ $1 G$ <br> $N$ $1 G$ <br> $N$ $J$ | $\begin{aligned} & \text { FE } \\ & \text { FE } \\ & \text { FE } \\ & \text { AF } \end{aligned}$ | 2N3819 | $\begin{aligned} & 30 \\ & 25 \\ & 20 \\ & 25 \end{aligned}$ | $\begin{aligned} & .05-.25 \\ & .5-3 \\ & 2-6 \\ & 2-20 \end{aligned}$ | $\begin{gathered} .25-.75 \\ .9-1.8 \\ 1.5-3 \\ 2-6.5 \end{gathered}$ | $\begin{aligned} & 7 \\ & 8 \\ & 8 \end{aligned}$ | $\begin{array}{r} \text { NF } \\ \text { CRSS } \\ \text { CRSS } \\ \text { CRSS } \end{array}$ | $\begin{aligned} & .5 \mathrm{DB} \\ & .8 \mathrm{PF} \\ & .8 \mathrm{PF} \\ & 4 \mathrm{PF} \end{aligned}$ | $\begin{array}{r} 10 \mathrm{M} \\ 1 \mathrm{~K} \\ 1 \mathrm{M} \\ 1 \mathrm{M} \end{array}$ |
| $\begin{array}{\|l\|} \text { 2N3820 } \\ \text { 2N3821 } \\ \text { 2N3822 } \\ \text { 2N3823 } \end{array}$ | $\begin{array}{ll} \mathbf{P} & J \\ \mathbf{N} & J \\ \mathbf{N} & J \\ \mathbf{N} & J \end{array}$ | $\begin{aligned} & \mathrm{AF} \\ & \mathrm{FE} \\ & \mathrm{FE} \\ & \mathrm{FE} \end{aligned}$ | $\begin{aligned} & \text { 2N3820 } \\ & \text { 2N3821 } \\ & \text { 2N3822 } \\ & \text { 2N3823 } \end{aligned}$ | $\begin{aligned} & 20 \\ & 50 \\ & 50 \\ & 30 \end{aligned}$ | $\begin{gathered} .3-15 \\ .5-2.5 \\ 2-10 \\ 4-20 \end{gathered}$ | $\begin{array}{r} .8-5 \\ 1.5- \\ 3- \\ 3.2- \end{array}$ | $\begin{array}{r} 32 \\ 6 \\ 6 \\ 6 \end{array}$ | CRSS <br> NF <br> NF <br> NF | $\begin{array}{r} 16 \mathrm{PF} \\ 5 \mathrm{DB} \\ 5 \mathrm{DB} \\ 2.5 \mathrm{DB} \end{array}$ | $\begin{array}{r} 1 M \\ 10 \\ 10 \\ 100 \mathrm{M} \end{array}$ |
| $\begin{aligned} & \text { 2N3824 } \\ & \text { 2N3882 } \\ & \text { 2N3909 } \\ & \text { 2N3909A } \end{aligned}$ | $\begin{array}{cc} N & J \\ P & 1 G \\ P & J \\ P & J \end{array}$ | FE <br> FE <br> FE <br> FE | $\begin{aligned} & \text { 2N3824 } \\ & \text { 2N3909 } \\ & \text { 2N3909A } \end{aligned}$ | $\begin{aligned} & 50 \\ & 30 \\ & 20 \\ & 20 \end{aligned}$ | $\begin{gathered} *-1 \\ .3-15 \\ 1-15 \end{gathered}$ | $\begin{gathered} 1-2.5 \\ 1-5 \\ 2.2-5 \end{gathered}$ | 6 <br> 32 | $\begin{gathered} \text { CRSS } \\ \text { NF } \end{gathered}$ | $\begin{aligned} & 3 \mathrm{PF} \\ & 3 \mathrm{DB} \end{aligned}$ | $\begin{array}{r} 1 \mathrm{M} \\ 10 \mathrm{~K} \end{array}$ |
| 2N3921 <br> 2N3922 <br> 2N3934 <br> 2N3935 | $\begin{array}{ll} \mathbf{N} & J \\ \mathbf{N} & J \\ \mathbf{N} & J \\ \mathbf{N} & J \end{array}$ | $\begin{array}{\|l\|} \hline F E \\ \text { FE } \\ \text { FE } \\ \text { FE } \end{array}$ | 2N5545 <br> 2N5545 <br> 2N5546 | $\begin{aligned} & 50 \\ & 50 \\ & 50 \\ & 50 \end{aligned}$ | $\begin{gathered} 1-10 \\ 1-10 \\ .25-1.3 \\ .25-1.3 \end{gathered}$ | $\begin{gathered} 1.5-7.5 \\ 1.5-7.5 \\ .3- \\ .3- \end{gathered}$ | $\begin{aligned} & 18 \\ & 18 \end{aligned}$ | NF <br> NF <br> NF <br> NF | $\begin{aligned} & 2 \mathrm{DB} \\ & 2 \mathrm{DB} \\ & 2 \mathrm{DB} \\ & 2 \mathrm{DB} \end{aligned}$ | $\begin{aligned} & \text { IK } \\ & \text { IK } \end{aligned}$ |
| $\begin{aligned} & \text { 2N3954 } \\ & \text { 2N3954A } \\ & \text { 2N3955 } \\ & \text { 2N3955A } \end{aligned}$ | $\begin{array}{ll} N & J \\ N & J \\ N & J \\ N & J \end{array}$ | FE <br> 限 <br> FE <br> FE |  | $\begin{aligned} & 50 \\ & 50 \\ & 50 \\ & 50 \end{aligned}$ | $.5-5$ $.5-5$ $.5-5$ $.5-5$ | $\begin{aligned} & 1- \\ & 1-3 \\ & 1- \\ & 1-3 \end{aligned}$ | 4 | NF <br> NF <br> NF <br> NF | $\begin{aligned} & .5 \mathrm{DB} \\ & .5 \mathrm{DB} \\ & .5 \mathrm{DB} \\ & .5 \mathrm{DB} \end{aligned}$ | $\begin{aligned} & 100 \\ & 100 \end{aligned}$ |
| $\begin{array}{\|l\|} \hline \text { 2N3956 } \\ \text { 2N3957 } \\ \text { 2N3958 } \\ \text { 2N3966 } \end{array}$ | $\begin{array}{ll} \mathbf{N} & J \\ \mathbf{N} & J \\ \mathbf{N} & J \\ \mathbf{N} & J \end{array}$ | FE FE FE FE | 2N5547 <br> 2N5547 <br> 2N5547 <br> 2N3966 | 50 50 50 40 | $.5-5$ $.5-5$ $.5-5$ 2. | 1. | 6 | $\begin{array}{r} \mathrm{NF} \\ \mathrm{NF} \\ \mathbf{N F} \\ \text { CRSS } \end{array}$ | $\begin{array}{r} .5 \mathrm{DB} \\ .5 \mathrm{DB} \\ .5 \mathrm{DB} \\ 1.5 \mathrm{PF} \end{array}$ |  |
| $\begin{aligned} & \text { 2N3967 } \\ & \text { 2N3967A } \\ & \text { 2N3968 } \\ & \text { 2N3968A } \end{aligned}$ | $\begin{array}{ll} \mathbf{N} & J \\ \mathbf{N} & J \\ \mathbf{N} & J \\ \mathbf{N} & J \end{array}$ | $\begin{array}{\|l\|l\|} \hline F E \\ \text { FE } \\ \text { FE } \\ \text { FE } \\ \hline \end{array}$ | $\begin{aligned} & \text { 2N3822 } \\ & \text { 2N3822 } \\ & \text { 2N3822 } \\ & \text { 2N3821 } \end{aligned}$ | $\begin{aligned} & 30 \\ & 30 \\ & 30 \\ & 30 \end{aligned}$ | $\begin{gathered} 2.5-10 \\ 2.5-10 \\ 1-5 \\ 1.5 \\ \hline \end{gathered}$ | $\begin{aligned} & 1.6-2.4 \\ & 1.6-2.4 \\ & 1.4-2 \\ & 1.4-2 \\ & \hline \end{aligned}$ | 5 5 5 5 | NF <br> NF <br> NF <br> NF | $\begin{array}{r} 1.5 \mathrm{DB} \\ 1 \mathrm{DB} \\ 1.5 \mathrm{DB} \\ 1 \mathrm{DB} \end{array}$ | $\begin{aligned} & 1 K \\ & 1 K \end{aligned}$ |

## TRANSISTOR INTERCHANGEABILITY REGISTERED FIELD-EFFECT TRANSISTORS

| TYFENuMER |  |  |  | $\pi$ erenacement OR NEABEST ECUTVALENT | RATED DRANGATE VOLTACE | Electincal charactentics |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  |  | bss ${ }^{\prime \prime} \mathrm{D}(\mathrm{~m})$ | brad | $c_{b}$ <br> max <br> (pf) | OTHER PARMMETER |  |  |
|  |  |  |  |  |  | $\left\|\begin{array}{ll} \text { min } & \text { max } \\ (\mathrm{ma}) & (\mathrm{ma}) \end{array}\right\|$ | $\begin{array}{\|cl\|} \hline \text { min } & \text { max } \\ \text { (manho) } & \text { (mmanol } \end{array}$ |  | SYmbor | max | $\begin{aligned} & \text { e } \\ & \left(\mathrm{H}_{\mathrm{z}}\right) \end{aligned}$ |
| 2N3969 <br> 2N3969A <br> 2N3970 <br> 2N3971 | $\begin{aligned} & \mathbf{N} \\ & \mathbf{N} \\ & \mathbf{N} \\ & \mathbf{N} \end{aligned}$ | $\begin{aligned} & \mathbf{\jmath} \\ & \mathbf{j} \\ & \mathbf{j} \end{aligned}$ | $\begin{array}{\|l\|l} \hline \mathbf{F E} \\ \mathbf{F E} \\ \mathbf{F E} \\ \mathbf{F E} \end{array}$ | 2N3821 <br> 2N3821 <br> 2N3970 <br> 2N3971 | $\begin{aligned} & 30 \\ & 30 \\ & 40 \\ & 40 \end{aligned}$ | $\begin{aligned} & .4 .2 \\ & .4-2 \\ & 50-150 \\ & 25-75 \end{aligned}$ | $\begin{aligned} & .95-1.4 \\ & .95-1.4 \end{aligned}$ | $\begin{array}{r} 5 \\ 5 \\ 25 \\ 25 \end{array}$ | $\begin{gathered} \mathbf{N F} \\ \mathbf{N F} \\ \text { CRSS } \\ \text { CRSS } \end{gathered}$ | $\begin{aligned} & 1.5 \mathrm{DE} \\ & 1 \mathrm{DB} \\ & 6 \mathrm{PF} \\ & 6 \mathrm{PF} \end{aligned}$ | $\begin{aligned} & 1 K \\ & 1 M \\ & 1 M \end{aligned}$ |
| 2N3972 <br> 2N3993 <br> 2N3993A <br> 2N3994 | $\begin{array}{\|l\|l} \mathrm{N} \\ \mathrm{P} \\ \mathbf{P} \\ \mathrm{P} \end{array}$ | $\begin{aligned} & \mathbf{\jmath} \\ & \mathbf{j} \\ & \mathbf{j} \end{aligned}$ | FE FE FE FE | 2N3972 <br> 2N3993 <br> 2N3993A <br> 2N3994 | $\begin{aligned} & 40 \\ & 25 \\ & 25 \\ & 25 \end{aligned}$ | $\begin{gathered} 5.30 \\ 10- \\ 10- \\ 2 . \end{gathered}$ |  | $\begin{aligned} & 25 \\ & 16 \\ & 12 \\ & 16 \end{aligned}$ | $\begin{aligned} & \text { CRSS } \\ & \text { CRSS } \\ & \text { CRSS } \\ & \text { CRSS } \end{aligned}$ | $\begin{array}{r} 6 \mathrm{PF} \\ 4.5 \mathrm{PF} \\ 3 \mathrm{PF} \\ 5 \mathrm{PFF} \end{array}$ | IM |
| 2N3994A <br> 2N4038 <br> 2N4039 <br> 2N4065 | $\begin{aligned} & \mathbf{P} \\ & \mathbf{N} \\ & \mathbf{N} \\ & \mathbf{P} \end{aligned}$ | $\begin{aligned} & \text { J } \\ & \text { IG } \\ & \text { IG } \\ & \text { IG } \end{aligned}$ | $\begin{aligned} & \mathbf{F E} \\ & \mathbf{F E} \\ & \mathbf{F E} \\ & \mathbf{F E} \end{aligned}$ | 2N3994A <br> 3N174 | $\begin{aligned} & 25 \\ & 50 \\ & 50 \\ & 25 \end{aligned}$ | 2. <br> . 1 <br> .1-1.5 <br> 3-6 | $\begin{gathered} 1.5-2.5 \\ 1.5-2.5 \\ .4 .5 \end{gathered}$ | 12 <br> 4.5 | CRSS <br> CRSS | 3.5 PF $.7 \mathrm{PF}$ |  |
| 2N4066 2N4067 2N4082 2N4083 | $\left\lvert\, \begin{aligned} & \mathbf{p} \\ & \mathbf{p} \\ & \mathbf{N} \\ & \mathbf{N} \end{aligned}\right.$ | $\begin{aligned} & \text { IG } \\ & \text { IG } \\ & \mathbf{J} \end{aligned}$ | $\begin{array}{\|l\|l} \mathbf{F E} \\ \mathbf{F E} \\ \mathbf{F E} \\ \mathbf{F E} \\ \mathbf{F E} \end{array}$ | $\begin{aligned} & \text { 3N207 } \\ & \text { 3N207 } \end{aligned}$ | $\begin{aligned} & 30 \\ & 30 \\ & 50 \\ & 50 \end{aligned}$ | $\begin{array}{r} +10-50 \\ *-10-50 \\ .25-1.3 \\ .25-1.3 \end{array}$ | $\begin{gathered} 2.5- \\ 2.5 \\ .3- \\ .3- \end{gathered}$ | $7$ | $\begin{gathered} \text { CRSS } \\ \text { CRSS } \\ \mathrm{NF} \\ \mathrm{NF} \end{gathered}$ | $\begin{array}{r} 1.5 \mathrm{PF} \\ 1.5 \mathrm{PF} \\ 2 \mathrm{DB} \\ 2 \mathrm{DB} \end{array}$ | ${ }_{1 M}$ |
| 2N4OP4 <br> 2 N4O85 <br> 2 N 4088 <br> 2N4089 | $\left\lvert\, \begin{aligned} & \mathbf{N} \\ & \mathbf{N} \\ & \mathbf{P} \\ & \mathbf{P} \end{aligned}\right.$ | $\begin{aligned} & \mathbf{\jmath} \\ & \mathbf{j} \\ & \mathbf{j} \end{aligned}$ | $\begin{array}{\|l\|l} \hline \mathbf{F E} \\ \mathbf{F E} \\ \mathbf{F E} \\ \mathbf{F E} \end{array}$ | $\begin{aligned} & \text { 2N5545 } \\ & \text { 2N5546 } \\ & \text { 2N3331 } \\ & \text { 2N3330 } \end{aligned}$ | $\begin{aligned} & 50 \\ & 50 \\ & 30 \\ & 30 \end{aligned}$ | $\begin{aligned} & 1-10 \\ & 1-10 \\ & 5.15 \\ & 2.8 \end{aligned}$ | $\begin{array}{r} 1.5-7.5 \\ 1.5-7.5 \\ 1.1 .6 \\ .8-1.1 \end{array}$ | $\begin{aligned} & 18 \\ & 18 \\ & 10 \\ & 10 \end{aligned}$ | NF NF NF NF | $\begin{array}{r} 2 \mathrm{DE} \\ 2 \mathrm{DB} \\ 1.5 \mathrm{DB} \\ 1.5 \mathrm{DE} \end{array}$ | $\begin{aligned} & \mathbf{1 K} \\ & \mathbf{K} \end{aligned}$ |
| 2N4090 2N4091 <br> 2N4091A <br> 2N4092 | P $\mathbf{N}$ $\mathbf{N}$ $\mathbf{N}$ | $\begin{aligned} & \mathrm{\jmath} \\ & \mathbf{\jmath} \\ & \mathbf{j} \end{aligned}$ | $\begin{aligned} & \mathbf{F E} \\ & \mathbf{F E} \\ & \mathbf{F E} \\ & \mathbf{F E} \end{aligned}$ | $\begin{aligned} & \text { 2N3329 } \\ & \text { 2N4091 } \\ & \text { 2N4091 } \\ & \text { 2N4092 } \end{aligned}$ | $\begin{aligned} & 30 \\ & 40 \\ & 50 \\ & 40 \end{aligned}$ | $\begin{aligned} & .4-2.5 \\ & 30 . \\ & 30 \\ & 15- \end{aligned}$ | .5-9 | $\begin{aligned} & 10 \\ & 16 \\ & 16 \\ & 16 \end{aligned}$ | $\begin{aligned} & \text { NF } \\ & \text { CRSS } \\ & \text { CRSS } \\ & \text { CRSS } \end{aligned}$ | $\begin{array}{r} 1.5 \mathrm{DB} \\ 5 \mathrm{Pf} \\ 5 \mathrm{PF} \\ 5 \mathrm{PF} \end{array}$ | $\begin{aligned} & 1 M \\ & 1 M \\ & 1 M \end{aligned}$ |
| 2N4092A <br> 2 N 4093 <br> 2N4093A <br> 2N4094 | $\begin{aligned} & \mathbf{N} \\ & \mathbf{N} \\ & \mathbf{N} \\ & \mathbf{N} \end{aligned}$ | $\begin{aligned} & j \\ & j \\ & j \\ & j \end{aligned}$ | $\begin{array}{\|l\|l} \mathbf{F E} \\ \mathbf{F E} \\ \mathbf{F E} \\ \mathbf{F E} \\ \mathbf{F E} \end{array}$ | $\begin{aligned} & \text { 2N4092 } \\ & \text { 2N4093 } \\ & \text { 2N4093 } \\ & \text { 2N4856 } \end{aligned}$ | $\begin{aligned} & 50 \\ & 40 \\ & 50 \\ & 40 \end{aligned}$ | $\begin{gathered} 15- \\ 8- \\ 8- \\ 75- \end{gathered}$ |  | $\begin{aligned} & 16 \\ & 16 \\ & 16 \\ & 32 \end{aligned}$ | CRSS CRSS CRSS CRSS | $\begin{aligned} & 5 \mathrm{PF} \\ & 5 \mathrm{PF} \\ & 5 \mathrm{Pf} \\ & 7 \mathrm{Pf} \end{aligned}$ | $\mathrm{Im}_{1 \mathrm{~m}}^{1 \mathrm{~m}}$ |
| 2N4095 <br> 2N4117 <br> 2N4117A <br> 2N4118 | $\begin{aligned} & \mathbf{N} \\ & \mathbf{N} \\ & \mathbf{N} \\ & \mathbf{N} \end{aligned}$ | $\begin{aligned} & \mathrm{d} \\ & \mathrm{\jmath} \\ & \mathrm{j} \end{aligned}$ | $\begin{array}{\|l\|l} \mathbf{F E} \\ \mathbf{F E} \\ \mathbf{F E} \\ \mathbf{F E} \end{array}$ | 2N4857 | $\begin{aligned} & 40 \\ & 40 \\ & 40 \\ & 40 \end{aligned}$ | $\begin{aligned} & 20 \\ & .03 .09 \\ & .03 .09 \\ & .08-.24 \end{aligned}$ | $\begin{aligned} & .07-.21 \\ & .07-21 \\ & .08-.25 \end{aligned}$ | $\begin{array}{r} 32 \\ 3 \\ 3 \\ 3 \end{array}$ | CRSS <br> CRSS <br> CRSS <br> CRSS | $\begin{array}{r} 7 \mathrm{Pf} \\ 1.5 \mathrm{PF} \\ 1.5 \mathrm{PF} \\ 1.5 \mathrm{PF} \end{array}$ | 19 19 19 |
| 2N4118A 2N4119 2N4119A 2N4120 | $\left\lvert\, \begin{aligned} & \mathbf{N} \\ & \mathbf{N} \\ & \mathbf{N} \\ & \mathbf{p} \end{aligned}\right.$ | $\begin{gathered} J \\ j \\ j \\ 16 \end{gathered}$ | $\begin{array}{\|l\|l} \mathbf{P E} \\ \mathbf{P E} \\ \mathbf{P E} \\ \mathbf{F E} \end{array}$ | 3N174 | $\begin{aligned} & 40 \\ & 40 \\ & 40 \\ & 25 \end{aligned}$ | $\begin{gathered} .08-.24 \\ .2 .6 \\ .2 .6 \\ 5-12 \end{gathered}$ | $\begin{aligned} & .08 .25 \\ & .1 .33 \\ & .1 . .33 \\ & .7- \end{aligned}$ | $\begin{array}{r} 3 \\ 3 \\ 3 \\ 4.5 \end{array}$ | CRSS CRSS CRSS CRSS | $\begin{aligned} & 1.5 \mathrm{PF} \\ & 1.5 \mathrm{PF} \\ & 1.5 \mathrm{PF} \\ & .7 \mathrm{PF} \end{aligned}$ | 19 19 19 |
| 2N4139 <br> 2N4220 <br> 2N4220A <br> 2N4221 | $\begin{array}{\|l\|} \mathbf{N} \\ \mathbf{N} \\ \mathbf{N} \\ \mathbf{N} \\ \hline \end{array}$ | $\begin{aligned} & \mathrm{J} \\ & \mathrm{j} \\ & \mathrm{~J} \\ & \hline \end{aligned}$ | $\begin{array}{\|l\|l} \mathbf{F E} \\ \mathbf{P E} \\ \mathbf{F E} \\ \mathbf{F E} \\ \hline \end{array}$ | $\begin{aligned} & \text { 2N3458 } \\ & \text { 2N4220 } \\ & \text { 2N4220A } \\ & \text { 2N4221 } \\ & \hline \end{aligned}$ | $\begin{aligned} & 50 \\ & 30 \\ & 30 \\ & 30 \\ & \hline \end{aligned}$ | $\begin{aligned} & 8-11 \\ & .5-3 \\ & .5-3 \\ & .2-6 \\ & \hline \end{aligned}$ | $\begin{gathered} 3.5-7 \\ 1-4 \\ .75-4 \\ 2.5 \\ \hline \end{gathered}$ | $\begin{array}{r} 18 \\ 6 \\ 6 \\ 6 \\ \hline \end{array}$ | $\begin{gathered} \text { NF } \\ \text { CRSS } \\ \text { NF } \\ \text { CRss } \\ \hline \end{gathered}$ | $\begin{array}{r} 2 \mathrm{DB} \\ 2 \mathrm{PF} \\ 2.5 \mathrm{DB} \\ 2 \mathrm{PF} \\ \hline \end{array}$ | $\begin{array}{r}100 \\ 1 K \\ \hline\end{array}$ |

TRANSISTOR INTERCHANGEABILITY REGISTERED FIELD-EFFECT TRANSISTORS

| TYPE NUMEER |  |  | TI <br> REPLACEMENT <br> OR NEAREST ECUIVALENT | RATED DRAINGATE VOLTACE | ELECTRICAL CHARACTERISTICS |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  | $\begin{aligned} & \text { IDSs } \\ & \text { ID(on) } \end{aligned}$ | brad | $C_{i s s}$ | OTH: | IER PARAM | TER |
|  |  |  |  |  | $\left\lvert\, \begin{array}{ll} \mathrm{M} N & \mathrm{MAX} \\ (\mathrm{~mA}) & (\mathrm{mA}) \end{array}\right.$ | MIN MAX <br> (mmho) (mmho) | $\begin{aligned} & \text { MAX } \\ & \text { ( } \mathrm{PF} \text { ) } \end{aligned}$ | SYMBOL | MAX | $\begin{aligned} & f \\ & \left(\mathrm{H}_{2}\right) \end{aligned}$ |
| $\begin{aligned} & \text { 2N4221A } \\ & \text { 2N4222 } \\ & \text { 2N4222A } \\ & \text { 2N4223 } \end{aligned}$ | $\begin{array}{ll} \mathbf{N} & J \\ \mathbf{N} & J \\ \mathbf{N} & J \\ \mathbf{N} & J \end{array}$ | $\begin{aligned} & \mathrm{FE} \\ & \mathrm{FE} \\ & \mathrm{FE} \\ & \mathrm{FE} \end{aligned}$ | $\begin{aligned} & \text { 2N4221A } \\ & \text { 2N4222 } \\ & \text { 2N4222A } \\ & \text { 2N4223 } \end{aligned}$ | $\begin{aligned} & 30 \\ & 30 \\ & 30 \\ & 30 \end{aligned}$ | $\begin{aligned} & 2-6 \\ & 2-6 \\ & 5-15 \\ & 3-18 \end{aligned}$ | $\begin{aligned} & .75- \\ & 2.5-6 \\ & .75- \\ & 3-7 \end{aligned}$ | $\begin{aligned} & 6 \\ & 6 \\ & 6 \\ & 6 \end{aligned}$ | $\begin{array}{r} \text { NF } \\ \text { CRSS } \\ \mathbf{N F} \\ \mathbf{N F} \end{array}$ | $\begin{array}{r} 2.5 \mathrm{DB} \\ 2 \mathrm{PF} \\ 2.5 \mathrm{DB} \\ 5 \mathrm{DB} \end{array}$ | $\begin{array}{r} 100 \\ 1 K \\ 100 \\ 200 \mathrm{M} \end{array}$ |
| $\begin{aligned} & \text { 2N4223A } \\ & \text { 2N4224 } \\ & \text { 2N4224A } \\ & \text { 2N4267 } \end{aligned}$ | $\left\lvert\, \begin{array}{cc} \mathbf{N} & J \\ \mathbf{N} & J \\ \mathbf{N} & J \\ \mathbf{P} & \mathbf{I G} \end{array}\right.$ | $\begin{aligned} & \mathrm{FE} \\ & \mathrm{FE} \\ & \mathrm{FE} \\ & \mathrm{FE} \end{aligned}$ | 3N160 | $\begin{aligned} & 30 \\ & \mathbf{3 0} \\ & 30 \\ & \mathbf{3 0} \end{aligned}$ | $\begin{gathered} 3-18 \\ 2-20 \\ 2-20 \\ * 20-100 \end{gathered}$ | $\begin{aligned} & 2.7 \\ & 1.7 \\ & 1.7 \end{aligned}$ | $\begin{array}{r} 6 \\ 6 \\ 6 \\ 14 \end{array}$ | $\begin{array}{r} \text { NF } \\ \text { CRSS } \\ \text { CRSS } \\ \text { CRSS } \end{array}$ | 5 DB 2 PF 2 PF 3 PF | 200M <br> 1 M <br> 1 M |
| 2N4268 <br> 2N4302 <br> 2N4303 <br> 2N4304 | $\left\|\begin{array}{ll} p & \mathbf{I} \\ N & J \\ N & J \\ N & J \end{array}\right\|$ | $\begin{aligned} & \text { FE } \\ & \text { FE } \\ & \text { FE } \\ & \text { FE } \end{aligned}$ | $\begin{aligned} & \text { 3N160 } \\ & \text { 2N5953 } \\ & \text { 2N5952 } \\ & \text { 2N5951 } \end{aligned}$ | $\begin{aligned} & 30 \\ & 30 \\ & 30 \\ & 30 \end{aligned}$ | $\begin{gathered} 20-100 \\ .5-5 \\ 4-10 \\ .5-15 \end{gathered}$ | $1-$ $2-1$ $1-$ | $\begin{array}{r} 14 \\ 6 \\ 6 \\ 6 \end{array}$ | CRSS <br> NF <br> NF <br> NF | $\begin{aligned} & 3 \mathrm{PF} \\ & 2 \mathrm{DB} \\ & 2 \mathrm{DB} \\ & 3 \mathrm{DB} \end{aligned}$ | $\begin{aligned} & \text { 1K } \\ & \text { 1K } \\ & 1 K \end{aligned}$ |
| 2N4338 <br> 2N4339 <br> 2N4340 <br> 2N4341 | $\begin{array}{ll} \mathbf{N} & J \\ N & J \\ N & J \\ N & J \end{array}$ |  | $\begin{aligned} & \text { 2N3460 } \\ & \text { 2N3459 } \\ & \text { 2N3458 } \end{aligned}$ | $\begin{aligned} & 50 \\ & 50 \\ & 50 \\ & 50 \end{aligned}$ | $\begin{gathered} .2-.6 \\ .5-1.5 \\ 1.2-3.6 \\ 3-9 \end{gathered}$ | $\begin{gathered} .6-1.8 \\ .8-2.4 \\ 1.3-3 \\ 2-4 \end{gathered}$ | $\begin{aligned} & 7 \\ & 7 \\ & 7 \\ & 7 \end{aligned}$ | NF <br> NF <br> NF <br> NF | $\begin{aligned} & 1 \mathrm{DB} \\ & 1 \mathrm{DB} \\ & 1 \mathrm{DB} \\ & 1 \mathrm{DB} \end{aligned}$ | $\begin{aligned} & 1 K \\ & 1 K \\ & 1 K \\ & 1 K \end{aligned}$ |
| 2N4342 <br> 2N4343 <br> 2N4343 <br> 2N4351 | $\begin{array}{lc} P & J \\ P & J \\ P & J \\ N & I G \end{array}$ | $\begin{aligned} & \mathbf{A F} \\ & \mathbf{A F} \\ & \mathbf{F E} \\ & \mathbf{F E} \end{aligned}$ | 2N3994 <br> 2N3993 <br> 2N3993 <br> 3N169 | $\begin{aligned} & 25 \\ & 25 \\ & 25 \\ & 25 \end{aligned}$ | $\begin{array}{r} 4-12 \\ 10-30 \\ 10-30 \\ 3- \end{array}$ | $\begin{aligned} & 2-6 \\ & 4-8 \\ & 4-8 \end{aligned}$ | $\begin{array}{r} 20 \\ 20 \\ 20 \\ 6 \end{array}$ | $\begin{array}{r} \text { NF } \\ \mathbf{N F} \\ \mathbf{N F} \\ \text { CRSS } \end{array}$ | $\begin{aligned} & 1.5 \mathrm{DB} \\ & 1.5 \mathrm{DB} \\ & 1.5 \mathrm{DB} \\ & 1.5 \mathrm{PF} \end{aligned}$ | $\begin{aligned} & 100 \\ & 100 \\ & 1 \mathrm{M} \end{aligned}$ |
| 2N4352 <br> 2N4353 <br> 2N4360 <br> 2N4381 | $\begin{array}{ll} P & I G \\ P & I G \\ P & J \\ P & J \end{array}$ | FE <br> FE <br> AF <br> FE | 3N160 <br> 3N161 <br> A5T5482 | $\begin{aligned} & 25 \\ & 30 \\ & 20 \\ & 25 \end{aligned}$ | $\begin{aligned} & * 30- \\ & 3-30 \\ & 10-30 \end{aligned}$ | $\begin{aligned} & 1-4 \\ & 2-8 \\ & 2- \end{aligned}$ | $\begin{array}{r} 5 \\ 12 \\ 20 \\ 20 \end{array}$ | $\begin{array}{r} \text { CRSS } \\ \text { CRSS } \\ \text { NF } \\ \text { CRSS } \end{array}$ | $\begin{array}{r} 1.3 \mathrm{PF} \\ 4 \mathrm{PF} \\ 5 \mathrm{DB} \\ 5 \mathrm{PF} \end{array}$ | 100 |
| $\begin{aligned} & \text { 2N4382 } \\ & \text { 2N4391 } \\ & \text { 2N4392 } \\ & \text { 2N4393 } \end{aligned}$ | $\begin{array}{ll} \mathbf{P} & \mathbf{J} \\ \mathbf{N} & J \\ \mathbf{N} & J \\ \mathbf{N} & \mathbf{J} \end{array}$ | FE <br> FE <br> FE <br> FE | 2N4391 <br> 2N4392 <br> 2N4393 | $\begin{aligned} & 25 \\ & 40 \\ & 40 \\ & 40 \end{aligned}$ | $\begin{gathered} 10-30 \\ 50-150 \\ 25-75 \\ 5-30 \end{gathered}$ | 4. | $\begin{aligned} & 20 \\ & 14 \\ & 14 \\ & 14 \end{aligned}$ | CRSS CRSS CRSS CRSS | $\begin{array}{r} \text { 5 PF } \\ \text { 3.5 PF } \\ \text { 3.5 PF } \\ \text { 3.5 PF } \end{array}$ | $\begin{aligned} & 1 M \\ & 1 M \\ & 1 M \end{aligned}$ |
| 2N4416 2N4416A 2N4417 2N4445 | $\left\lvert\, \begin{array}{ll} \mathbf{N} & J \\ \mathbf{N} & J \\ \mathbf{N} & J \\ \mathbf{N} & J \end{array}\right.$ | FE FE FE FE | 2N4416 2N4416A | $\begin{aligned} & 30 \\ & 35 \\ & 30 \\ & 25 \end{aligned}$ | $\begin{array}{r} 5-15 \\ 5-15 \\ 5-15 \\ 150- \end{array}$ | $\begin{array}{r} 4.5-7.5 \\ 4.5-7.5 \\ 4.5-7.5 \end{array}$ | $\begin{array}{r} 4 \\ 4 \\ 3.5 \\ 50 \end{array}$ | $\begin{array}{r} \mathrm{NF} \\ \mathrm{NF} \\ \mathrm{NF} \\ \text { CRSS } \end{array}$ | $\begin{gathered} 2 \mathrm{DB} \\ 2 \mathrm{DB} \\ 2 \mathrm{DB} \\ 25 \mathrm{PF} \end{gathered}$ | $\begin{aligned} & 100 \mathrm{~m} \\ & 100 \mathrm{M} \\ & 100 \mathrm{~m} \end{aligned}$ |
| 2N446 <br> 2N4447 <br> 2N4448 <br> 2N4856 | $\begin{array}{ll} \mathbf{N} & J \\ \mathbf{N} & J \\ \mathbf{N} & J \\ \mathbf{N} & J \end{array}$ | FE <br> FE <br> FE <br> FE | 2N4856 | $\begin{aligned} & 25 \\ & 20 \\ & 20 \\ & 40 \end{aligned}$ | 100. 150. 100 $50-$ |  | $\begin{aligned} & 50 \\ & 50 \\ & 50 \\ & 18 \end{aligned}$ | CRSS CRSS CRSS CRSS | $\begin{array}{r} 25 \mathrm{PF} \\ 25 \mathrm{PF} \\ 25 \mathrm{PF} \\ 8 \mathrm{PF} \end{array}$ | $1 \mathrm{M}$ |
| $\begin{aligned} & \text { 2N4856A } \\ & \text { 2N4857 } \\ & \text { 2N4857A } \\ & \text { 2N4858 } \\ & \hline \end{aligned}$ | $\begin{array}{ll} N & J \\ N & J \\ N & J \\ N & J \end{array}$ | $\begin{aligned} & \text { FE } \\ & \text { FE } \\ & \text { FE } \\ & \text { FE } \end{aligned}$ | 2N4856A <br> 2N4857 <br> 2N4857A <br> 2N4858 | $\begin{aligned} & 40 \\ & 40 \\ & 40 \\ & 40 \end{aligned}$ | $\begin{aligned} & 50- \\ & 20-100 \\ & 20-100 \\ & 8-80 \end{aligned}$ |  | $\begin{aligned} & 10 \\ & 18 \\ & 10 \\ & 18 \\ & \hline \end{aligned}$ | CRSS <br> CRSS <br> CRSS <br> CRSS | $\begin{array}{r} 4 \mathrm{PF} \\ 8 \mathrm{PF} \\ 3.5 \mathrm{PF} \\ 8 \mathrm{PF} \\ \hline \end{array}$ | $\begin{aligned} & 1 M \\ & 1 M \\ & 1 M \\ & 1 M \end{aligned}$ |

# TRANSISTOR INTERCHANGEABILITY REGISTERED FIELD-EFFECT TRANSISTORS 

| TYPE Mumbent |  | $\frac{e_{2}^{2}}{6}$ | 333338 | 7 <br> RTPLACEMENT <br> OR MEAREST <br> ECUVALENT | RATED DEANK GATE VOLTACE | EECTRACAL CHARACTENSTICS |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  |  | $\begin{aligned} & \text { LDSs } \\ & \text { *D(en) } \end{aligned}$ | Iral | $\mathbf{C}_{\mathrm{ides}}$ | OTHER PARANETER |  |  |
|  |  |  |  |  |  | $\begin{array}{ll} \text { MNN } & M A X \\ (m A) & (m A) \end{array}$ | $\begin{array}{\|rl\|} \text { MiN } & \text { max } \\ \text { (mmho) } & \text { (manho) } \end{array}$ | MAX <br> ( p F) | symicol | max | - f <br> ( Hz ) |
| $\begin{aligned} & \text { 2N4858A } \\ & \text { 2N4859 } \\ & \text { 2N4859A } \\ & \text { 2N4860 } \end{aligned}$ | N $\mathbf{N}$ $\mathbf{N}$ $\mathbf{N}$ | $J$ $J$ $J$ $J$ | $\begin{aligned} & \text { FE } \\ & \text { FE } \\ & \text { FE } \\ & \text { FE } \end{aligned}$ | $\begin{aligned} & \text { 2N4858A } \\ & \text { 2N4859 } \\ & \text { 2N4859A } \\ & \text { 2N4860 } \end{aligned}$ | $\begin{aligned} & 40 \\ & 30 \\ & 30 \\ & 30 \end{aligned}$ | $\begin{aligned} & 8-80 \\ & 50- \\ & 50- \\ & 20-100 \end{aligned}$ |  | $\begin{aligned} & 10 \\ & 18 \\ & 10 \\ & 18 \end{aligned}$ | CR5S <br> CRSS <br> CRSS <br> CRSS | $\begin{array}{r} 3.5 \mathrm{PF} \\ 8 \mathrm{PF} \\ 4 \mathrm{PF} \\ 8 \mathrm{PF} \end{array}$ | $\begin{aligned} & 1 \mathrm{M} \\ & 1 \mathrm{M} \\ & 1 \mathrm{M} \\ & 1 \mathrm{M} \end{aligned}$ |
| $\begin{aligned} & \text { 2N4B60A } \\ & 2 N 4861 \\ & 2 N 4861 A \\ & 2 N 4867 \end{aligned}$ | N $\mathbf{N}$ $\mathbf{N}$ $\mathbf{N}$ | $J$ $J$ $j$ $j$ | $\begin{array}{\|l\|} \hline \text { FE } \\ \text { FE } \\ \text { FE } \\ \text { FE } \end{array}$ | 2N4860A <br> 2N4861 <br> 2N4861A | $\begin{aligned} & 30 \\ & 30 \\ & 30 \\ & 40 \end{aligned}$ | $\begin{gathered} 20-100 \\ 8-80 \\ 8-80 \\ .4-1.2 \end{gathered}$ | .7-2 | $\begin{aligned} & 10 \\ & 18 \\ & 10 \\ & 25 \end{aligned}$ | CRSS CRSS CRSS NF | $\begin{array}{r} 3.5 \mathrm{PF} \\ \text { 8 PF } \\ 3.5 \mathrm{PF} \\ 1 \mathrm{DB} \end{array}$ | $\begin{aligned} & 1 M \\ & 1 M \\ & 1 M \\ & 1 K \end{aligned}$ |
| $\begin{aligned} & \text { 2N4867A } \\ & \text { 2N4868 } \\ & \text { 2N4868A } \\ & \text { 2N4869 } \end{aligned}$ | $\mathbf{N}$ $\mathbf{N}$ $\mathbf{N}$ $\mathbf{N}$ | $\begin{aligned} & \mathbf{J} \\ & \mathbf{J} \\ & \mathbf{J} \\ & \mathbf{J} \end{aligned}$ | FE <br> FE <br> FE <br> FE |  | $\begin{aligned} & 40 \\ & 40 \\ & 40 \\ & 40 \end{aligned}$ | $\begin{gathered} 4-1.2 \\ 1-3 \\ 1-3 \\ 2.5-7.5 \end{gathered}$ | $\begin{array}{r} .7 \cdot 2 \\ 1-3 \\ 1-3 \\ 1.3-4 \end{array}$ | $\begin{aligned} & 25 \\ & 25 \\ & 25 \\ & 25 \end{aligned}$ | $\begin{aligned} & \mathbf{N F} \\ & \mathbf{N F} \\ & \mathbf{N F} \\ & \mathbf{N F} \end{aligned}$ | $\begin{aligned} & 1 \mathrm{DB} \\ & 1 \mathrm{DB} \\ & 1 \mathrm{DB} \\ & 1 \mathrm{DB} \end{aligned}$ | IK IK IK IK |
| 2N4069A 2N4881 <br> 2 N 4082 <br> 2N4883 | N $\mathbf{N}$ $\mathbf{N}$ $\mathbf{N}$ | $\begin{aligned} & \mathbf{J} \\ & \mathbf{j} \\ & \mathbf{j} \end{aligned}$ | FE <br> ft <br> FE <br> FE | $\begin{aligned} & \text { 2N5361 } \\ & \text { 2N6449 } \\ & \text { 2N6449 } \\ & \text { 2N6450 } \end{aligned}$ | $\begin{array}{r} 40 \\ 300 \\ 300 \\ 200 \end{array}$ | $\begin{gathered} 2.5-7.5 \\ .4-2 \\ 1.5-7.5 \\ .4-2 \end{gathered}$ | $\begin{aligned} & 1.3-4 \\ & .35-1 \\ & .6-1.5 \\ & .35-1 \end{aligned}$ | $\begin{aligned} & 25 \\ & 15 \\ & 15 \\ & 15 \end{aligned}$ | $\begin{aligned} & \mathbf{N F} \\ & \mathbf{N F} \\ & \mathbf{N F} \\ & \mathbf{N F} \end{aligned}$ | $\begin{aligned} & 1 \\ & 1 \\ & 3 \\ & \text { DB } \\ & 3 \\ & 3 \\ & 3 \end{aligned}$ | 1 K |
| 2N4884 <br> 2N4885 <br> 2N4086 <br> 2 N 4977 | $\mathbf{N}$ $\mathbf{N}$ $\mathbf{N}$ $\mathbf{N}$ | $\begin{aligned} & \mathbf{j} \\ & \mathbf{j} \\ & \mathbf{j} \\ & \mathbf{j} \end{aligned}$ | FE <br> FE <br> FE <br> FE | $\begin{aligned} & \text { 2NG450 } \\ & \text { 2N6450 } \\ & \text { 2N6450 } \end{aligned}$ | $\begin{array}{r} -200 \\ 125 \\ 125 \\ 30 \end{array}$ | $\begin{gathered} 1.5-7.5 \\ .4-2 \\ 1.5-7.5 \\ 50 . \end{gathered}$ | $\begin{gathered} .6-1.5 \\ .35-1 \\ .6-1.5 \end{gathered}$ | $\begin{aligned} & 15 \\ & 15 \\ & 15 \\ & 35 \end{aligned}$ | $\begin{array}{r} \text { MF } \\ \text { NF } \\ \text { NF } \\ \text { CRSS } \end{array}$ | $\begin{aligned} & 3 \mathrm{DB} \\ & 3 \mathrm{DB} \\ & 3 \mathrm{DB} \\ & 8 \mathrm{PF} \end{aligned}$ |  |
| $\begin{aligned} & \text { 2N4978 } \\ & \text { 2N4979 } \\ & \text { 2N5018 } \\ & \text { 2N5019 } \end{aligned}$ |  | $\begin{aligned} & \mathbf{J} \\ & \mathbf{J} \\ & \mathbf{J} \\ & \mathbf{J} \end{aligned}$ | FE <br> FE <br> FE <br> FE | 2N3993 | $\begin{aligned} & 30 \\ & 30 \\ & 30 \\ & 30 \end{aligned}$ | $\begin{array}{r} 15 \\ 7.5 \\ 10 \\ 5 \end{array}$ |  | $\begin{aligned} & 35 \\ & 35 \\ & 45 \\ & 45 \end{aligned}$ | CRSS <br> CRSS <br> CRSS <br> CRSS | $\begin{array}{r} 8 \mathrm{PF} \\ 8 \mathrm{PF} \\ 10 \mathrm{PF} \\ 10 \mathrm{PF} \end{array}$ |  |
| $\begin{aligned} & \text { 2N5020 } \\ & \text { 2N5021 } \\ & \text { 2N5033 } \\ & \text { 2N5045 } \end{aligned}$ |  | $\begin{aligned} & \mathbf{J} \\ & \mathbf{J} \\ & \mathbf{J} \\ & \mathbf{j} \end{aligned}$ | FE <br> FE <br> GP <br> FE | $\begin{aligned} & \text { A5T5460 } \\ & \text { 2N5045 } \end{aligned}$ | $\begin{aligned} & 25 \\ & 25 \\ & 20 \\ & 50 \end{aligned}$ | $\begin{aligned} & .3-1.2 \\ & 1-3.5 \\ & .3-3.5 \\ & .5-8 \end{aligned}$ | $\begin{gathered} 1-3.5 \\ 1.5-5 \\ 1 . \\ 1.5-6 \end{gathered}$ | $\begin{array}{r} 25 \\ 25 \\ 25 \\ 8 \end{array}$ | $\begin{array}{r} \text { NF } \\ \text { CRSS } \\ \mathbf{N F} \\ \mathbf{N F} \end{array}$ | $\begin{aligned} & 3 \mathrm{DB} \\ & 7 \mathrm{PF} \\ & 2 \mathrm{DB} \\ & 5 \mathrm{DB} \end{aligned}$ | 1K <br> 10 |
| $\begin{aligned} & \text { 2N5046 } \\ & \text { 2N5047 } \\ & \text { 2N5078 } \\ & \text { 2N5103 } \end{aligned}$ | $\begin{aligned} & N \\ & N \\ & N \\ & N \end{aligned}$ | $\begin{aligned} & \mathbf{J} \\ & \mathbf{j} \\ & \mathbf{J} \\ & \mathbf{J} \end{aligned}$ | $\begin{aligned} & \text { FE } \\ & \text { FE } \\ & \text { FE } \\ & \text { FE } \end{aligned}$ | $\begin{aligned} & \text { 2N5046 } \\ & \text { 2N5047 } \\ & \text { 2NH16 } \end{aligned}$ | $\begin{aligned} & 50 \\ & 50 \\ & 30 \\ & 25 \end{aligned}$ | $\begin{aligned} & .5-8 \\ & .5-8 \\ & 4-25 \\ & 1-8 \end{aligned}$ | $\begin{gathered} 1.5-6 \\ 1.5-6 \\ 4- \\ 2-8 \end{gathered}$ | $\begin{aligned} & 8 \\ & 8 \\ & 6 \\ & 5 \end{aligned}$ | NF <br> NF <br> NF | $\begin{array}{r} 5 \mathrm{DE} \\ 4 \mathrm{DB} \\ \mathrm{I} .5 \mathrm{DB} \end{array}$ | $\begin{aligned} & 10 \\ & 100 \end{aligned}$ |
| 2N5104 2N5103 2N5114 2N5115 | N $\mathbf{N}$ $\mathbf{P}$ $\mathbf{P}$ | $\begin{aligned} & \mathbf{J} \\ & \mathbf{J} \\ & \mathbf{j} \\ & \mathbf{j} \end{aligned}$ | $\begin{aligned} & \text { FE } \\ & \text { FE } \\ & \text { FE } \\ & \text { FE } \end{aligned}$ | 2N4416 | $\begin{aligned} & 25 \\ & 25 \\ & 30 \\ & 30 \end{aligned}$ | $\begin{array}{r} 2-6 \\ 5-15 \\ 30-90 \\ 15-60 \end{array}$ | $\begin{gathered} 3.5-7.5 \\ 5.10 \end{gathered}$ | $\begin{array}{r} 5 \\ 5 \\ 25 \\ 25 \end{array}$ | $\begin{gathered} \mathrm{NF} \\ \mathrm{MF} \\ \text { Cass } \\ \text { CRSS } \end{gathered}$ | $\begin{array}{r} 1.5 \mathrm{DB} \\ 1.5 \mathrm{DB} \\ 7 \mathrm{PF} \\ 7 \mathrm{PF} \end{array}$ | $\begin{aligned} & 100 \\ & 100 \end{aligned}$ |
| 2N5116 <br> 2N5158 <br> 2N5159 <br> 2N5163 | $\begin{aligned} & \mathrm{P} \\ & \mathrm{~N} \\ & \mathrm{~N} \\ & \mathrm{~N} \end{aligned}$ | $\begin{aligned} & \mathbf{J} \\ & \mathbf{j} \\ & \mathbf{j} \\ & \mathbf{j} \\ & \hline \end{aligned}$ | $\begin{aligned} & \text { FE } \\ & \text { FE } \\ & \text { FE } \\ & \text { RF } \\ & \hline \end{aligned}$ | 2N5246 | $\begin{array}{r} 30 \\ 40 \\ 40 \\ 25 \\ \hline \end{array}$ | $\begin{aligned} & 5-25 \\ & 100- \\ & 200- \\ & 1-40 \end{aligned}$ | $2-9$ | $\begin{aligned} & 25 \\ & 50 \\ & 50 \\ & 20 \end{aligned}$ | CRSS <br> CRSS <br> CRSS <br> CRSS | $\begin{array}{r} 7 \mathrm{PF} \\ 25 \mathrm{PF} \\ 25 \mathrm{PF} \\ 5 \mathrm{PF} \end{array}$ | $1 \mathrm{M}$ |

## TRANSISTOR INTERCHANGEABILITY REGISTERED FIELD-EFFECT TRANSISTORS



# TRANSISTOR INTERCHANGEABILITY REGISTERED FIELD-EFFECT TRANSISTORS 

| TYF NUMEER |  | 世E皆8 | $\begin{aligned} & 8 \\ & \frac{8}{8} \\ & 8 \\ & 8 \\ & 8 \end{aligned}$ | $\begin{gathered} \text { II } \\ \text { REPACEMENT } \\ \text { OR NIAREST } \\ \text { ECUTVALENT } \end{gathered}$ | RateD DRAIN. OATE VOLTACE | EECTRICAL CHARACTEXHTICS |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  |  | IDss <br> ${ }^{-1} \mathrm{D}(\mathrm{m})$ | lat | MAX <br> ( ${ }^{(p)}$ | OTHER PARAMIER |  |  |
|  |  |  |  |  |  | $\begin{array}{\|ll\|} \hline \text { MNN } & M A X \\ (\mathrm{~mA}) & (\mathrm{mA}) \\ \hline \end{array}$ | $\begin{array}{\|cc\|} \hline \text { MiN } & \text { MaX } \\ \text { (mmho) } & \text { (mmahe) } \\ \hline \end{array}$ |  | SYMEO <br> max <br> (Hz) |  |  |
| $\begin{aligned} & \text { 2N5454 } \\ & \text { 2N5457 } \\ & \text { 2N5458 } \\ & \text { 2N5459 } \end{aligned}$ | N $\mathbf{N}$ $\mathbf{N}$ $\mathbf{N}$ | J J J J | $\begin{aligned} & \text { FE } \\ & \text { FE } \\ & \text { FE } \\ & \text { FE } \end{aligned}$ | 2N5546 <br> 2N5953 <br> 2N5952 <br> 2N5951 | $\begin{aligned} & 50 \\ & 25 \\ & 25 \\ & 25 \end{aligned}$ | $\begin{aligned} & .5-5 \\ & 1-5 \\ & 2-9 \\ & 4-16 \end{aligned}$ | $\begin{gathered} 1-3 \\ 1-5 \\ 1.5-5.5 \\ 2-6 \end{gathered}$ | $\begin{aligned} & 4 \\ & 7 \\ & 7 \\ & 7 \end{aligned}$ | $\begin{aligned} & \text { NF } \\ & \text { CRSS } \\ & \text { CRSS } \\ & \text { CRSS } \end{aligned}$ | 5 DP 3 PF 3 PF 3 PF | $\begin{aligned} & 1 M \\ & 1 M \\ & 1 M \end{aligned}$ |
| $\begin{aligned} & \text { 2N5460 } \\ & \text { 2N5461 } \\ & \text { 2N5462 } \\ & \text { 2N5463 } \end{aligned}$ |  | J $\mathbf{J}$ J J | FE AF AF AF | 2N5460 2N5461 2N5462 | $\begin{aligned} & 40 \\ & 40 \\ & 40 \\ & 60 \end{aligned}$ | $\begin{aligned} & 1-5 \\ & 2-9 \\ & 4-16 \\ & 1-5 \end{aligned}$ | $\begin{array}{r} 1-4 \\ 1.5-5 \\ 2-6 \\ 1-4 \end{array}$ | $\begin{aligned} & 7 \\ & 7 \\ & 7 \\ & 7 \end{aligned}$ | NF <br> NF <br> NF <br> NF | $\begin{aligned} & 2.5 \mathrm{DB} \\ & 2.5 \mathrm{DB} \\ & 2.5 \mathrm{DB} \\ & 2.5 \mathrm{DB} \end{aligned}$ | $\begin{aligned} & 100 \\ & 100 \\ & 100 \\ & 100 \end{aligned}$ |
| $\begin{aligned} & \text { 2N5464 } \\ & \text { 2N5465 } \\ & \text { 2N5471 } \\ & \text { 2N5472 } \end{aligned}$ | P | J J J J | AF AF FE FE |  | $\begin{aligned} & 60 \\ & 60 \\ & 40 \\ & 40 \end{aligned}$ | $\begin{gathered} 2.9 \\ 4.16 \\ .02 .06 \\ .05-.12 \end{gathered}$ | $\begin{aligned} & 1.5-5 \\ & .2-6 \\ & .06-18 \\ & .09-.225 \end{aligned}$ | $\begin{aligned} & 7 \\ & 7 \\ & 5 \\ & 5 \end{aligned}$ | $\begin{aligned} & \mathbf{N F} \\ & \mathbf{N F} \\ & \mathbf{N F} \\ & \mathbf{N F} \end{aligned}$ | $\begin{aligned} & 2.5 \mathrm{DB} \\ & 2.5 \mathrm{DB} \\ & \text { 2.5 DB } \\ & 2.5 \mathrm{DB} \end{aligned}$ | $\begin{array}{r} 100 \\ 100 \\ 1 K \\ 1 K \end{array}$ |
| $\begin{aligned} & \text { 2N5473 } \\ & \text { 2N5474 } \\ & \text { 2N5475 } \\ & \text { 2N5476 } \end{aligned}$ | Pr | j J J J | FE FE FE FE |  | $\begin{array}{r} 40 \\ 40 \\ 40 \\ 40 \end{array}$ | $\begin{aligned} & .1-.25 \\ & .2-.5 \\ & .4-1 \\ & .8-2 \end{aligned}$ | $\begin{gathered} .12 .3 \\ .16-.4 \\ .2-.5 \\ .26-.65 \end{gathered}$ | $\begin{aligned} & 5 \\ & 5 \\ & 5 \\ & 5 \end{aligned}$ | $\begin{array}{r} \text { NF } \\ \text { CRSS } \\ \text { CRSS } \\ \text { CRSS } \end{array}$ | $\begin{array}{r} 2.5 \mathrm{DB} \\ 1 \mathrm{PF} \\ 1 \mathrm{PF} \\ 1 \mathrm{PF} \end{array}$ | 1K |
| 2N5484 2N5485 <br> 2N5486 <br> 2N5505 | N $\mathbf{N}$ $\mathbf{N}$ $\mathbf{P}$ | $J$ $J$ $J$ $J$ | $\begin{aligned} & \text { RF } \\ & \text { RF } \\ & \hline \mathbf{R F} \\ & \hline \mathbf{F E} \end{aligned}$ | $\begin{aligned} & \text { 2N5246 } \\ & \text { 2N5245 } \\ & \text { 2N5247 } \end{aligned}$ | $\begin{aligned} & \mathbf{2 5} \\ & \mathbf{2 5} \\ & \mathbf{2 5} \\ & 30 \end{aligned}$ | $\begin{gathered} 1-5 \\ 4-10 \\ 8-20 \\ * .8-7 \end{gathered}$ | $\begin{gathered} 3-6 \\ 3.5-7 \\ 4-8 \\ 1-3.5 \end{gathered}$ | $\begin{array}{r} 5 \\ 5 \\ 5 \\ 16 \end{array}$ | NF <br> NF <br> NF <br> NF | $\begin{array}{r} 2.5 \mathrm{DB} \\ 2.5 \mathrm{DB} \\ 2.5 \mathrm{DB} \\ 2 \mathrm{DB} \end{array}$ | $\begin{aligned} & 1 K \\ & 1 K \\ & 1 K \\ & 1 K \end{aligned}$ |
| 2N5506 <br> 2N5507 <br> 2N5508 <br> 2N5509 | P | J J J J | FE FE FE FE |  | $\begin{aligned} & 30 \\ & 30 \\ & 30 \\ & 30 \end{aligned}$ | $\begin{aligned} & .8-7 \\ & .8-7 \\ & .8-7 \\ & . .8-7 \end{aligned}$ | $\begin{aligned} & 1-3.5 \\ & 1-3.5 \\ & 1-3.5 \\ & 1-3.5 \end{aligned}$ | $\begin{aligned} & 16 \\ & 16 \\ & 16 \\ & 16 \end{aligned}$ | $\begin{aligned} & \text { NF } \\ & \text { NF } \\ & \mathbf{N F} \\ & \mathbf{N F} \end{aligned}$ | $\begin{aligned} & 2 \mathrm{DB} \\ & 2 \mathrm{DB} \\ & 2 \mathrm{DB} \\ & 2 \mathrm{DB} \end{aligned}$ | $1 K$ $1 K$ $1 K$ $1 K$ |
| 2N5514 <br> 2N5515 <br> 2N5516 <br> 2N5517 |  | $J$ $J$ $J$ $J$ | FE FE FE FE | $\begin{aligned} & \text { 2N5545 } \\ & \text { 2N5546 } \end{aligned}$ | $\begin{aligned} & 30 \\ & 40 \\ & 40 \\ & 40 \end{aligned}$ | $\begin{gathered} 30-90 \\ .5-7.5 \\ .5-7.5 \\ .5-7.5 \end{gathered}$ | $\begin{aligned} & 1-4 \\ & 1-4 \\ & 1-4 \end{aligned}$ | $\begin{aligned} & 25 \\ & 25 \\ & 25 \\ & 25 \end{aligned}$ | CRSS <br> CRSS <br> CRSS <br> CRSS | $\begin{aligned} & 7 \mathrm{PF} \\ & 5 \mathrm{PF} \\ & 5 \mathrm{PF} \\ & 5 \mathrm{PF} \end{aligned}$ | $\begin{aligned} & 1 M \\ & 1 M \\ & 1 M \end{aligned}$ |
| $\begin{aligned} & \text { 2N5518 } \\ & \text { 2N5519 } \\ & \text { 2N5520 } \\ & \text { 2N5521 } \end{aligned}$ | $N$ $N$ $N$ $N$ | $\begin{aligned} & \mathbf{J} \\ & \mathbf{J} \\ & \mathbf{J} \\ & \mathbf{J} \end{aligned}$ | FE FE FE FE | $\begin{aligned} & \text { 2N5547 } \\ & \text { 2N5045 } \\ & \text { 2N5545 } \end{aligned}$ | $\begin{array}{r} 40 \\ 40 \\ 40 \\ 40 \end{array}$ | $\begin{array}{r} .5-7.5 \\ .5-7.5 \\ .5-7.5 \\ .5-7.5 \end{array}$ | $\begin{aligned} & 1-4 \\ & 1-4 \\ & 1-4 \\ & 1-4 \end{aligned}$ | $\begin{aligned} & 25 \\ & 25 \\ & \mathbf{2 5} \\ & \mathbf{2 5} \end{aligned}$ | CRSS <br> CRSS <br> CRSS <br> CRSS | $\begin{aligned} & 5 \mathrm{PF} \\ & 5 \mathrm{PF} \\ & 5 \mathrm{PF} \\ & 5 \mathrm{PF} \end{aligned}$ | $\begin{aligned} & 1 M \\ & 1 M \\ & 1 M \\ & 1 M \end{aligned}$ |
| $\begin{aligned} & \text { 2N5522 } \\ & \text { 2N5523 } \\ & \text { 2N5524 } \\ & \text { 2N5543 } \end{aligned}$ | $\begin{aligned} & \mathbf{N} \\ & \mathbf{N} \\ & \mathbf{N} \\ & \mathbf{N} \end{aligned}$ | $\begin{aligned} & \mathbf{J} \\ & \mathbf{j} \\ & \mathbf{j} \\ & \mathbf{j} \end{aligned}$ | FE FE FE FE | $\begin{aligned} & \text { 2N5546 } \\ & \text { 2N5547 } \\ & \text { 2N5045 } \\ & \text { 2N6449 } \end{aligned}$ | $\begin{aligned} & 40 \\ & 40 \\ & 40 \\ & 75 \end{aligned}$ | $\begin{gathered} .5-7.5 \\ .5-7.5 \\ .5-7.5 \\ 2-10 \end{gathered}$ | $\begin{gathered} 1-4 \\ 1-4 \\ 1-4 \\ .75-3 \end{gathered}$ | $\begin{aligned} & \mathbf{2 5} \\ & \mathbf{2 5} \\ & \mathbf{2 5} \\ & 10 \end{aligned}$ | CRSS <br> CRSS <br> CRSS <br> CRSS | $\begin{aligned} & 5 \mathrm{PF} \\ & 5 \mathrm{PF} \\ & 5 \mathrm{PF} \\ & 2 \mathrm{PF} \end{aligned}$ | $\begin{aligned} & 1 M \\ & 1 M \\ & 1 M \\ & 1 M \end{aligned}$ |
| $\begin{aligned} & \text { 2N5544 } \\ & \text { 2N5545 } \\ & \text { 2N5546 } \\ & \text { 2N5547 } \\ & \hline \end{aligned}$ | $\begin{aligned} & \mathbf{N} \\ & \mathbf{N} \\ & \mathbf{N} \\ & \mathbf{N} \end{aligned}$ | $\begin{aligned} & \mathrm{J} \\ & \mathbf{j} \\ & \mathrm{~J} \\ & \mathrm{j} \\ & \hline \end{aligned}$ | $\begin{aligned} & \text { FE } \\ & \text { FE } \\ & \text { FE } \\ & \text { fE } \\ & \hline \end{aligned}$ | 2N6450 <br> 2N5545 <br> 2N5546 <br> 2N5547 | $\begin{aligned} & 50 \\ & 50 \\ & 50 \\ & 50 \\ & \hline \end{aligned}$ | $\begin{aligned} & 2-10 \\ & .5-8 \\ & .5-8 \\ & .5-8 \\ & \hline \end{aligned}$ | $\begin{aligned} & .75-3 \\ & 1.5-6 \\ & 1.5-6 \\ & 1.5-6 \end{aligned}$ | $\begin{array}{r} 10 \\ 6 \\ 6 \\ 6 \\ \hline \end{array}$ | $\begin{array}{r} \text { CRSS } \\ \mathrm{NF} \\ \mathrm{NF} \\ \text { CRSS } \end{array}$ | $\begin{array}{r} 2 \mathrm{PF} \\ 3.5 \mathrm{DB} \\ 5 \mathrm{DB} \\ 2 \mathrm{PF} \end{array}$ | $\begin{aligned} & 1 M \\ & 10 \\ & 10 \\ & 10 \end{aligned}$ |

## TRANSISTOR INTERCHANGEABILITY REGISTERED FIELD-EFFECT TRANSISTORS

| TYPE NUMEER |  | 88888 | 7 <br> REPLACEMENT <br> OR NEAREST ECUTVALENT | RATED DRAN GATE VOLTACE <br> (V) | ETECTILCAL CHARACTENSTICS |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  | $\begin{aligned} & \text { IDss } \\ & \text { ID(en) } \end{aligned}$ | brad | $C_{\text {ine }}$ <br> max <br> ( P ) | OTHER PARAMETE |  |  |
|  |  |  |  |  | $\left\lvert\, \begin{array}{ll} \min & \operatorname{Max} \\ (\mathrm{ma}) & (\mathrm{ma}) \end{array}\right.$ | $\begin{array}{\|rl\|} \hline \text { MiN } & \text { MAX } \\ \text { (mmho) } & \text { (mmuhe) } \\ \hline \end{array}$ |  | SYMAOL MAX  <br>   <br>  (Hz) |  |  |
| $\begin{aligned} & \text { 2N5548 } \\ & \text { 2N5549 } \\ & \text { 2N5555 } \\ & \text { 2N5556 } \end{aligned}$ | $\left\lvert\, \begin{array}{cc} P & 1 G \\ N & J \\ N & J \\ N & J \end{array}\right.$ | SW FE <br> SW FE | $\begin{aligned} & \text { 2N5549 } \\ & \text { 2N5949 } \\ & \text { 2N3821 } \end{aligned}$ | $\begin{aligned} & 25 \\ & 40 \\ & 25 \\ & 30 \end{aligned}$ | $\begin{aligned} & * 40-120 \\ & 10-60 \\ & 15- \\ & .5-2.5 \end{aligned}$ | $\begin{gathered} 3.5-6.5 \\ 6-15 \\ 1.5-6.5 \end{gathered}$ | $\begin{array}{r} 10 \\ 8 \\ 5 \\ 6 \end{array}$ | CRSS <br> CRSS <br> CRSS <br> CRSS | $\begin{array}{r} 4 \mathrm{PF} \\ 2 \mathrm{PF} \\ 1.2 \mathrm{PF} \\ 3 \mathrm{PF} \end{array}$ | IM <br> 1 M <br> 1 M |
| $\begin{aligned} & \text { 2N5557 } \\ & \text { 2N5558 } \\ & \text { 2N5561 } \\ & \text { 2N5562 } \end{aligned}$ | $\left\lvert\, \begin{array}{ll} \mathbf{N} & J \\ \mathbf{N} & J \\ \mathbf{N} & J \\ \mathbf{N} & J \end{array}\right.$ | $\begin{aligned} & \text { FE } \\ & \text { FE } \\ & F E \\ & F E \end{aligned}$ | $\begin{aligned} & \text { 2N5361 } \\ & \text { 2N5362 } \\ & \text { 2N5545 } \end{aligned}$ | $\begin{aligned} & 30 \\ & 30 \\ & 50 \\ & 50 \end{aligned}$ | $\begin{aligned} & 2-5 \\ & 4-10 \\ & 1-10 \\ & 1-10 \end{aligned}$ | $\begin{gathered} 1.5-6.5 \\ 1.5-6.5 \\ 1.5- \\ 2-3 \end{gathered}$ | $\begin{aligned} & 6 \\ & 6 \\ & 7 \\ & 7 \end{aligned}$ | $\begin{gathered} \text { CRSS } \\ \text { CRSS } \\ \mathrm{NF} \\ \mathrm{NF} \end{gathered}$ | $\begin{aligned} & 3 \mathrm{PF} \\ & 3 \mathrm{PF} \\ & 1 \mathrm{DE} \\ & 1 \mathrm{DE} \end{aligned}$ | $\begin{aligned} & 10 \\ & 10 \end{aligned}$ |
| $\begin{aligned} & \text { 2N5563 } \\ & \text { 2N5564 } \\ & \text { 2N5565 } \\ & \text { 2N5566 } \end{aligned}$ | $\begin{array}{ll} \mathbf{N} & J \\ \mathbf{N} & J \\ \mathbf{N} & J \\ \mathbf{N} & J \end{array}$ | $\begin{array}{l\|l\|} \hline F E \\ \text { FE } \\ \hline F E \\ \hline \end{array}$ | 2N5547 | $\begin{aligned} & 50 \\ & 40 \\ & 40 \\ & 40 \end{aligned}$ | $\begin{aligned} & 1-10 \\ & 5-30 \\ & 5-30 \\ & 5-30 \end{aligned}$ | $\begin{gathered} 2-3 \\ 7.5-12.5 \\ 7.5-12.5 \\ 7.5-12.5 \end{gathered}$ | $\begin{array}{r} 7 \\ 12 \\ 12 \end{array}$ | NF <br> NF <br> NF | $\begin{aligned} & 108 \\ & 1008 \\ & 108 \end{aligned}$ | 10 10 10 |
| 2N5592 <br> 2N5593 <br> 2N5594 <br> 2N5638 | $\begin{array}{ll} \mathbf{N} & J \\ \mathbf{N} & J \\ \mathbf{N} & J \\ \mathbf{N} & J \end{array}$ | $\begin{array}{\|l} \mathrm{FE} \\ \mathrm{FE} \\ \mathrm{FE} \\ \mathrm{SW} \end{array}$ | T1573 | $\begin{aligned} & 50 \\ & 50 \\ & 50 \\ & 30 \end{aligned}$ | $\begin{aligned} & 1.10 \\ & 1.10 \\ & 1.10 \\ & 50 \end{aligned}$ | $2-7$ $2-7$ $2-7$ | $\begin{aligned} & 20 \\ & 20 \\ & 20 \\ & 10 \end{aligned}$ | $\begin{array}{r} \text { NF } \\ \text { NF } \\ \text { NF } \\ \text { CRSS } \end{array}$ | $\begin{array}{r} 2.6 \mathrm{DB} \\ 1 \mathrm{DE} \\ 10 \mathrm{DB} \\ 4 \mathrm{PF} \end{array}$ | IM |
| 2N5639 <br> 2N5640 <br> 2N5647 <br> 2N5648 | $\begin{array}{ll} \mathbf{N} & J \\ N & J \\ N & J \\ N & J \end{array}$ | sw <br> 5W <br> FE <br> FE | $\begin{aligned} & \text { TIS74 } \\ & \text { TIS75 } \end{aligned}$ | $\begin{aligned} & 30 \\ & 30 \\ & 50 \\ & 50 \end{aligned}$ | $\begin{gathered} 25- \\ 5- \\ .3-.6 \\ .5-1 \end{gathered}$ | $\begin{aligned} & .3-65 \\ & .4 .8 \end{aligned}$ | $\begin{array}{r} 10 \\ 10 \\ 3 \\ 3 \end{array}$ | CRSS <br> CRS5 <br> NF <br> NF | $\begin{aligned} & 4 \mathrm{PF} \\ & 4 \mathrm{PF} \\ & 1 \mathrm{DB} \\ & 1 \mathrm{DB} \end{aligned}$ | $\begin{aligned} & 1 M \\ & 1 M \\ & 1 K \\ & 1 K \end{aligned}$ |
| 2N5649 <br> 2N5653 <br> 2N5654 <br> 2N5668 | $\begin{array}{ll} \mathbf{N} & J \\ \mathbf{N} & J \\ \mathbf{N} & J \\ \mathbf{N} & J \end{array}$ | FE SW SW RF | TIS74 T1575 2N5953 | $\begin{aligned} & 50 \\ & 30 \\ & 30 \\ & 25 \end{aligned}$ | $\begin{aligned} & .8-1.6 \\ & 40- \\ & 15- \\ & 1-5 \end{aligned}$ | $\begin{aligned} & .45-.9 \\ & 1.5-6.5 \end{aligned}$ | $\begin{array}{r} 3 \\ 10 \\ 10 \\ 7 \end{array}$ | $\begin{array}{r} \text { NF } \\ \text { CRSS } \\ \text { CRSS } \\ \mathrm{NF} \end{array}$ | $\begin{aligned} & 1 \mathrm{DB} \\ & 3.5 \mathrm{PF} \\ & 3.5 \mathrm{PF} \\ & 2.5 \mathrm{DB} \end{aligned}$ | $\begin{array}{r} 1 K \\ 1 \mathrm{M} \\ 1 \mathrm{M} \\ 100 \mathrm{~m} \end{array}$ |
| $\begin{aligned} & \text { 2N5669 } \\ & \text { 2N5670 } \\ & \text { 2N5716 } \\ & \text { 2N5717 } \end{aligned}$ | $\begin{array}{ll}\mathbf{N} & J \\ \mathbf{N} & J \\ \mathbf{N} & J \\ \mathbf{N} & J\end{array}$ | $\begin{aligned} & \text { RF } \\ & \text { RF } \\ & \text { AF } \\ & \text { AF } \end{aligned}$ | $\begin{aligned} & \text { 2N5952 } \\ & \text { 2N5950 } \end{aligned}$ | $\begin{aligned} & 25 \\ & 25 \\ & 40 \\ & 40 \end{aligned}$ | $\begin{array}{r} 4-10 \\ 8-20 \\ .05-.2 \\ .2-1 \end{array}$ | $\begin{aligned} & 2-6.5 \\ & 3-7.5 \\ & .2-1 \\ & .4-1.6 \end{aligned}$ | $\begin{aligned} & 7 \\ & 7 \\ & 5 \\ & 5 \end{aligned}$ | $\begin{array}{r} \text { NF } \\ \text { NF } \\ \text { CRSS } \\ \text { CRSS } \end{array}$ | $\begin{aligned} & 2.5 \mathrm{DB} \\ & 2.5 \mathrm{DB} \\ & 1.5 \mathrm{PF} \\ & 1.5 \mathrm{PF} \end{aligned}$ | $\begin{array}{r} 100 \mathrm{M} \\ 100 \mathrm{M} \\ \mathrm{IM} \\ 1 \mathrm{M} \end{array}$ |
| $\begin{aligned} & \text { 2N5718 } \\ & \text { 2N5797 } \\ & \text { 2N5798 } \\ & \text { 2N5799 } \end{aligned}$ | $\begin{array}{ll}\text { N } & J \\ P & J \\ \mathbf{P} & J \\ P & \\ \end{array}$ | AF <br> FE <br> FE <br> FE | 2N5953 | $\begin{aligned} & 40 \\ & 40 \\ & 40 \\ & 40 \end{aligned}$ | $\begin{aligned} & .8-4 \\ & .02-.10 \\ & .08-.40 \\ & .25-1 \end{aligned}$ | $\begin{gathered} .5-2 \\ .06-.22 \\ .1-.4 \\ .16 .5 \end{gathered}$ | $\begin{aligned} & 5 \\ & 5 \\ & 5 \\ & 5 \end{aligned}$ | CRSS <br> CRSS <br> CRSS <br> CRSS | $\begin{array}{r} 1.5 \mathrm{PF} \\ 1 \mathrm{PF} \\ 1 \mathrm{PF} \\ 1 \mathrm{PF} \end{array}$ | 1 m |
| $\begin{aligned} & \text { 2N5800 } \\ & \text { 2N5801 } \\ & \text { 2N5802 } \\ & \text { 2N5803 } \end{aligned}$ | $\begin{array}{ll} P & J \\ N & J \\ \mathbf{N} & J \\ \mathbf{N} & J \end{array}$ | $\begin{aligned} & \text { FE } \\ & \text { FE } \\ & \text { FE } \\ & \text { FE } \end{aligned}$ | 2N4858 <br> 2N5549 <br> 2N5549 | $\begin{aligned} & 40 \\ & 40 \\ & 40 \\ & 40 \end{aligned}$ | $\begin{array}{r} 70-2 \\ 2-15 \\ 10-40 \\ 30-80 \end{array}$ | $\begin{aligned} & .25-.7 \\ & 4.5-12 \\ & 6.5-14 \\ & 8-17 \end{aligned}$ | $\begin{array}{r} 5 \\ 15 \\ 15 \\ 15 \end{array}$ | $\begin{array}{r} \text { CRSS } \\ \mathrm{NF} \\ \mathrm{NF} \\ \mathrm{NF} \end{array}$ | $\begin{aligned} & 1 \mathrm{PF} \\ & 1 \mathrm{DB} \\ & 1 \mathrm{DE} \\ & 1 \mathrm{DE} \end{aligned}$ |  |
| $\begin{aligned} & \text { 2N5902 } \\ & \text { 2N5903 } \\ & \text { 2N5904 } \\ & \text { 2N5905 } \\ & \hline \end{aligned}$ | $\begin{array}{ll} \mathbf{N} & J \\ \mathbf{N} & J \\ \mathbf{N} & J \\ N & J \end{array}$ | FE <br> FE <br> FE <br> FE |  | $\begin{aligned} & 40 \\ & 40 \\ & 40 \\ & 40 \end{aligned}$ | $\begin{aligned} & .03-.5 \\ & .03-.5 \\ & .03-.5 \\ & .03-.5 \end{aligned}$ | $\begin{aligned} & .07-.25 \\ & .07-.25 \\ & .07 .25 \\ & .07-.25 \end{aligned}$ | $\begin{aligned} & 3 \\ & 3 \\ & 3 \\ & 3 \end{aligned}$ | NF $\mathbf{N F}$ $\mathbf{N F}$ $\mathbf{N F}$ | $\begin{aligned} & 3 \mathrm{DB} \\ & 3 \mathrm{DB} \\ & 3 \mathrm{DB} \\ & 3 \mathrm{DB} \\ & \hline \end{aligned}$ | $\begin{aligned} & 100 \\ & 100 \\ & 100 \\ & 100 \\ & \hline \end{aligned}$ |

## TRANSISTOR INTERCHANGEABILITY REGISTERED FIELD-EFFECT TRANSISTORS

| TYPE NUMBER |  |  | 3000$\frac{1}{5}$55 | II <br> REPLACEMENT <br> OR NEAREST ECUFVALENT | RATED DRAINGATE VOLTAGE <br> (V) | ELECTRICAL CHARACTERISTICS |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  |  | $\begin{aligned} & \text { IDSS } \\ & \text { *ID(on) } \end{aligned}$ | brad | $C_{135}$ <br> MAX <br> (pF) | OTHER PARAMETER |  |  |
|  |  |  |  |  |  | $\begin{array}{ll} \mathrm{MIN} & \mathrm{MaX} \\ (\mathrm{~mA}) & (\mathrm{mA}) \\ \hline \end{array}$ | $\begin{array}{\|rl\|} \text { MBN } & \text { MAX } \\ \text { (mmol } & \text { (mmmo) } \\ \hline \end{array}$ |  | SYMEOL <br> MAX <br> - $f$ <br> (Hz) |  |  |
| $\begin{aligned} & \text { 2N5906 } \\ & \text { 2N5907 } \\ & \text { 2N5908 } \\ & \text { 2N5909 } \end{aligned}$ | N $\mathbf{N}$ $\mathbf{N}$ $\mathbf{N}$ | $\begin{aligned} & \mathbf{J} \\ & \mathbf{J} \\ & \mathbf{j} \\ & \mathbf{J} \end{aligned}$ | FE <br> FE <br> FE <br> FE |  | $\begin{aligned} & 40 \\ & 40 \\ & 40 \\ & 40 \end{aligned}$ | $\begin{aligned} & .03-.5 \\ & .03-.5 \\ & .03-.5 \\ & .03-.5 \end{aligned}$ | $\begin{aligned} & .07-.25 \\ & .07-.25 \\ & .07-.25 \\ & .07-.25 \end{aligned}$ | $\begin{aligned} & \mathbf{3} \\ & \mathbf{3} \\ & \mathbf{3} \\ & \mathbf{3} \end{aligned}$ | NF <br> NF <br> NF <br> NF | $\begin{aligned} & 1 \text { DB } \\ & 1 \text { DB } \\ & 1 \text { DB } \\ & 1 \text { DB } \end{aligned}$ | $\begin{aligned} & 100 \\ & 100 \\ & 100 \\ & 100 \end{aligned}$ |
| $\begin{aligned} & \text { 2N5911 } \\ & \text { 2N5912 } \\ & \text { 2N5949 } \\ & \text { 2N5950 } \end{aligned}$ | $\begin{aligned} & \mathbf{N} \\ & \mathbf{N} \\ & \mathbf{N} \\ & \mathbf{N} \end{aligned}$ | $\begin{aligned} & \mathbf{J} \\ & \mathbf{j} \\ & \mathbf{j} \end{aligned}$ | $\begin{aligned} & \text { FE } \\ & \text { FE } \\ & \text { GP } \\ & \text { GP } \end{aligned}$ | $\begin{aligned} & \text { 2N5949 } \\ & \text { 2N5950 } \end{aligned}$ | $\begin{aligned} & 25 \\ & \mathbf{2 5} \\ & 30 \\ & 30 \end{aligned}$ | $\begin{array}{r} 7.40 \\ 7.40 \\ 12-18 \\ 10-15 \end{array}$ | $\begin{array}{r} 5-10 \\ 5-10 \\ 3.5-7.5 \\ 3.5-7.5 \end{array}$ | $\begin{aligned} & 5 \\ & 5 \\ & 6 \\ & 6 \end{aligned}$ | NF <br> NF <br> NF <br> NF | $\begin{aligned} & 1 \mathrm{DB} \\ & 1 \mathrm{DB} \\ & 2 \mathrm{DB} \\ & 2 \mathrm{DB} \end{aligned}$ | $\begin{array}{r} 10 K \\ 10 K \\ 1 K \\ 1 K \end{array}$ |
| 2N5951 <br> 2N5952 <br> 2N5953 <br> 2N6449 | $\begin{aligned} & N \\ & N \\ & N \\ & N \end{aligned}$ | $\begin{aligned} & \mathbf{J} \\ & \mathbf{J} \\ & \mathbf{J} \\ & \mathbf{j} \end{aligned}$ | $\begin{aligned} & \text { GP } \\ & \text { GP } \\ & \text { GP } \\ & \text { FE } \end{aligned}$ | 2N5951 <br> 2N5952 <br> 2N5953 <br> 2N6449 | $\begin{array}{r} 30 \\ 30 \\ 30 \\ 300 \end{array}$ | $\begin{gathered} 7-13 \\ 4-8 \\ 2.5-5 \\ 2-10 \end{gathered}$ | $\begin{aligned} & 3.5-6.5 \\ & 2-6.5 \\ & 2-6.5 \\ & .5-3 \end{aligned}$ | $\begin{array}{r} 6 \\ 6 \\ 6 \\ 10 \end{array}$ | $\begin{array}{r} \mathrm{NF} \\ \mathbf{N F} \\ \mathbf{N F} \\ \text { CRSS } \end{array}$ | $\begin{aligned} & 2 \mathrm{DB} \\ & 2 \mathrm{DB} \\ & 2 \mathrm{DB} \\ & 5 \mathrm{PF} \end{aligned}$ | $\begin{aligned} & \mathbf{1 K} \\ & \mathbf{1 K} \\ & \mathbf{1 K} \end{aligned}$ |
| 2N6450 <br> 2N6d51 <br> 2N6452 <br> 2N6453 | $\begin{aligned} & N \\ & N \\ & N \\ & N \end{aligned}$ | $\begin{aligned} & \mathbf{j} \\ & \mathbf{j} \\ & \mathbf{j} \\ & \mathbf{j} \end{aligned}$ | $\begin{aligned} & \text { FE } \\ & \text { FE } \\ & \text { FE } \\ & \text { FE } \end{aligned}$ | 2N6450 <br> 2N6451 <br> 2N6452 <br> 2N6453 | $\begin{array}{r} 200 \\ 20 \\ 20 \\ 20 \end{array}$ | $\begin{array}{r} 2-10 \\ 5-20 \\ 5-20 \\ 15-50 \end{array}$ | $\begin{gathered} .5-3 \\ 15-30 \\ 15-30 \\ 15-30 \end{gathered}$ | $\begin{aligned} & 10 \\ & \mathbf{2 5} \\ & \mathbf{2 5} \\ & 25 \end{aligned}$ | CRSS VN VN VN | $\begin{array}{r} 5 \mathrm{PF} \\ 5 \mathrm{NV} \\ 10 \mathrm{NV} \\ 5 \mathrm{NV} \end{array}$ |  |
| 2N6454 <br> 3N89 <br> 3N96 <br> 3N97 |  | $\begin{aligned} & \mathbf{J} \\ & \mathbf{J} \\ & \mathbf{J} \\ & \mathbf{J} \end{aligned}$ | FE <br> FE <br> FE <br> FE | 2N6454 | $\begin{aligned} & \mathbf{2 5} \\ & \mathbf{3 0} \\ & \mathbf{3 0} \\ & \mathbf{3 0} \end{aligned}$ | $\begin{array}{r} 15-50 \\ .5-2.5 \\ .5-2.5 \\ .5-2.5 \end{array}$ | $\begin{aligned} & 20-40 \\ & .45-1.3 \\ & .45-1.3 \\ & .45-1.3 \end{aligned}$ | $25$ | VN <br> NF <br> NF | $\begin{aligned} & 10 \mathrm{NV} \\ & 4 \mathrm{DB} \\ & 4 \mathrm{DB} \end{aligned}$ | 1K <br> 1K |
| 3N98 <br> 3N99 <br> 3N124 <br> 3N125 | $\begin{aligned} & \mathbf{N} \\ & \mathbf{N} \\ & \mathbf{N} \\ & \mathbf{N} \end{aligned}$ | $\begin{aligned} & \text { IG } \\ & \text { IG } \\ & \text { J } \\ & \text { J } \end{aligned}$ | $\begin{aligned} & \mathrm{FE} \\ & \mathrm{FE} \\ & \mathrm{FE} \\ & \mathrm{FE} \end{aligned}$ | 3N128 | $\begin{aligned} & 32 \\ & 32 \\ & \mathbf{5 0} \\ & \mathbf{5 0} \end{aligned}$ | $\begin{gathered} 3.5-7.7 \\ 5-10 . \\ .2-2 \\ 1.5-4.5 \end{gathered}$ | $\begin{gathered} 1-3 \\ 1-4 \\ .25-1 \\ .4-1.6 \end{gathered}$ | $\begin{array}{r} 7 \\ 7 \\ 14 \\ 14 \end{array}$ | $\begin{array}{r} \text { CRSS } \\ \text { CRSS } \\ \text { NF } \\ \text { NF } \end{array}$ | $\begin{aligned} & .5 \mathrm{PF} \\ & .5 \mathrm{PF} \\ & 4 \mathrm{DB} \\ & 4 \mathrm{DB} \end{aligned}$ | IK IK |
| 3N126 <br> 3N128 <br> 3N138 <br> 3N139 | $\begin{aligned} & N \\ & N \\ & N \\ & N \end{aligned}$ | $\begin{aligned} & \text { J } \\ & \text { IG } \\ & \text { IG } \\ & \text { IG } \end{aligned}$ | fE <br> FE <br> FE <br> FE | 3N128 <br> 3N203 | $\begin{aligned} & 50 \\ & 20 \\ & 45 \\ & 45 \end{aligned}$ | $\begin{aligned} & 3-9 \\ & 5-25 \\ & 5-25 \end{aligned}$ | $\begin{gathered} .6-2.7 \\ 5-12 \\ 3-7.5 \end{gathered}$ | $\begin{array}{r} 14 \\ 7 \\ 5 \\ 7 \end{array}$ | $\begin{array}{r} \mathbf{N F} \\ \mathbf{N F} \\ \text { CRSS } \end{array}$ | $\begin{array}{r} 4 \mathrm{DB} \\ 5 \mathrm{DB} \\ .25 \mathrm{PF} \end{array}$ | 200M 1 M |
| 3N140 <br> 3N141 <br> 3N142 <br> 3N143 | N $\mathbf{N}$ $\mathbf{N}$ N | $\begin{aligned} & \text { IG } \\ & \text { IG } \\ & \text { IG } \\ & \text { IG } \end{aligned}$ | FE <br> FE <br> FE <br> FE | $\begin{aligned} & \text { 3N201 } \\ & \text { 3N201 } \\ & \text { 3N201 } \\ & \text { 3N128 } \end{aligned}$ | $\begin{aligned} & 20 \\ & 20 \\ & 20 \\ & 20 \end{aligned}$ | $\begin{aligned} & 5-30 \\ & 5-30 \\ & 5-25 \\ & 5-30 \end{aligned}$ | $\begin{aligned} & 6-1.8 \\ & 5- \\ & 5-12 \end{aligned}$ |  | $\begin{aligned} & \mathbf{N F} \\ & \mathbf{N F} \end{aligned}$ | 4.5 DB <br> 5 DB | $\begin{aligned} & 200 \mathrm{M} \\ & 100 \mathrm{~m} \end{aligned}$ |
| 3N145 <br> 3N146 <br> 3N147 <br> 3N148 | P <br> $\mathbf{P}$ | $\begin{aligned} & \text { IG } \\ & \text { IG } \\ & \text { IG } \end{aligned}$ | FE <br> FE <br> FE <br> FE | $\begin{aligned} & \text { 3N174 } \\ & \text { 3N174 } \\ & \text { 3N208 } \\ & \text { 3N208 } \end{aligned}$ | $\begin{aligned} & 30 \\ & 30 \\ & 30 \\ & 30 \end{aligned}$ | $\begin{aligned} & * 3 \\ & * 3 \\ & * 8 \\ & * \\ & * \\ & * \end{aligned}$ |  |  |  |  |  |
| $\begin{aligned} & \text { 3N149 } \\ & \text { 3N150 } \\ & \text { 3N151 } \\ & \text { 3N152 } \end{aligned}$ | P <br> $\mathbf{P}$ <br> $\mathbf{P}$ <br> $\mathbf{N}$ | $\begin{aligned} & \text { IG } \\ & \text { IG } \\ & \text { IG } \\ & \text { IG } \end{aligned}$ | $\begin{aligned} & \hline \text { FE } \\ & \text { FE } \\ & \text { FE } \\ & \text { FE } \end{aligned}$ | 3N161 <br> 3N161 <br> 3N128 | $\begin{aligned} & 30 \\ & 30 \\ & 30 \\ & 20 \\ & \hline \end{aligned}$ | $\begin{aligned} & \text { *16- } \\ & * 16- \\ & * 3- \\ & 5-30 \end{aligned}$ | $\begin{aligned} & .5-3 \\ & 5-12 \\ & \hline \end{aligned}$ | 12 | $\begin{aligned} & \mathbf{N F} \\ & \mathbf{N F} \end{aligned}$ | $\begin{array}{r} 10 \mathrm{DB} \\ \text { 3.5 DB } \\ \hline \end{array}$ | $\begin{array}{r} 100 \\ 200 \mathrm{M} \end{array}$ |

## TRANSISTOR INTERCHANGEABILITY <br> REGISTERED FIELD-EFFECT TRANSISTORS

| TYPE MUMEER |  | CLASSIFCATION | 7 <br> REPACEMENT <br> OR NEAREST ECUIVALENT | RATED DRABF GATE VOLTACE <br> (V) | EECTILCAL CHARACTERETICS |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  | $\begin{aligned} & \text { loss } \\ & \text { *LD(on) } \end{aligned}$ | bay | $c_{\text {bes }}$ <br> max <br> (pr) | OTMER PARAMETER |  |  |
|  |  |  |  |  | $\left\|\begin{array}{ll} \min & \max \\ (\mathrm{mA}) & (\mathrm{mA}) \end{array}\right\|$ | $\begin{array}{\|rl\|} \text { MIN } & \text { MAX } \\ \text { (mmho) } & \text { (mandho) } \end{array}$ |  | SYMBOL MAX © f <br> (14s) |  |  |
| 3N153 <br> 3N154 <br> 3N155 <br> 3N155A | $\begin{array}{ll} N & I G \\ N & I G \\ P & I G \\ P & 1 G \end{array}$ | $\begin{aligned} & \hline \mathbf{F E} \\ & \text { FE } \\ & \hline \mathbf{F E} \\ & \hline \mathbf{F E} \end{aligned}$ | $\begin{aligned} & \text { 3N153 } \\ & \text { 3N128 } \\ & \text { 3N155 } \\ & \text { 3N155A } \end{aligned}$ | $\begin{aligned} & 20 \\ & 20 \\ & 50 \\ & 50 \end{aligned}$ | $\begin{aligned} & * 5- \\ & 10-25 \\ & * 5- \\ & * 5- \end{aligned}$ | 5-12 | $8$ | $\begin{gathered} \text { CRSS } \\ \text { NF } \\ \text { CRSS } \\ \text { CRSS } \end{gathered}$ | $\begin{array}{r} .6 \mathrm{PF} \\ 5 \mathrm{DB} \\ 1.3 \mathrm{PF} \\ 1.3 \mathrm{PF} \end{array}$ | $\begin{array}{r} 1 \mathrm{M} \\ 200 \mathrm{M} \\ 140 \mathrm{~K} \\ 140 \mathrm{~K} \end{array}$ |
| $\begin{aligned} & \text { 3N156 } \\ & \text { 3N156A } \\ & \text { 3N157 } \\ & \text { 3N157A } \end{aligned}$ | $\left\lvert\, \begin{array}{ll} P & I G \\ P & I G \\ P & I G \\ P & I G \end{array}\right.$ | FE <br> FE <br> FE <br> FE | 3N156 <br> 3N156A <br> 3N157 <br> 3N157A | $\begin{aligned} & 50 \\ & 50 \\ & 50 \\ & 50 \end{aligned}$ | $\begin{aligned} & * 5 \\ & * 5- \\ & * 5 \\ & * 5 \end{aligned}$ | $1.4$ | $\begin{aligned} & 5 \\ & 5 \\ & 5 \\ & 5 \end{aligned}$ | CRSS <br> CRSS <br> CRSS <br> CRSS | $\begin{aligned} & \text { 1.3 PF } \\ & \text { 1.3 PF } \\ & \text { 1.3 PF } \\ & \text { 1.3 PF } \end{aligned}$ | $\begin{aligned} & 140 K \\ & 140 K \\ & 140 K \\ & 140 K \end{aligned}$ |
| $\begin{array}{\|l} \text { 3N158 } \\ \text { 3N158A } \\ \text { 3N159 } \\ \text { 3N160 } \end{array}$ | $\begin{cases}P & 1 G \\ P & 1 G \\ N & I G \\ P & 1 G\end{cases}$ | $\begin{aligned} & \mathrm{FE} \\ & \mathrm{FE} \\ & \mathrm{FE} \\ & \mathrm{FE} \end{aligned}$ | 3N158 <br> 3N158A <br> 3N160 | $\begin{aligned} & 50 \\ & 50 \\ & 20 \\ & 25 \end{aligned}$ | $\begin{gathered} * 5- \\ \cdot 5- \\ 5-30 \\ * 40-120 \end{gathered}$ | $\begin{gathered} 1-4 \\ 1-4 \\ 7-18 \\ 3.5-6.5 \end{gathered}$ | $\begin{array}{r} 5 \\ 5 \\ 7 \\ 10 \end{array}$ | $\begin{gathered} \text { CRSS } \\ \text { CRSS } \\ \text { NF } \\ \text { CRSS } \end{gathered}$ | $\begin{gathered} 1.3 \mathrm{PF} \\ 1.3 \mathrm{PF} \\ 3.5 \mathrm{DB} \\ 4 \mathrm{PF} \end{gathered}$ | $\begin{array}{r} 140 \mathrm{~K} \\ 140 \mathrm{~K} \\ 200 \mathrm{~K} \\ 1 \mathrm{M} \end{array}$ |
| $\begin{aligned} & 3 N 161 \\ & 3 N 162 \\ & 3 N 163 \\ & 3 N 164 \end{aligned}$ | $P$ IG <br> $P$ IG <br> $P$ IG <br> $P$ IG | $\begin{aligned} & \text { FE } \\ & \text { FE } \\ & \text { FE } \\ & \text { FE } \end{aligned}$ | 3N161 <br> 3N162 <br> 3N163 <br> 3N164 | $\begin{aligned} & 25 \\ & \mathbf{2 5} \\ & \mathbf{4 0} \\ & 30 \end{aligned}$ | $\begin{aligned} & * 40-120 \\ & * 25- \\ & * 5-30 \\ & * 3-30 \end{aligned}$ | $\begin{gathered} 3.5-6.5 \\ 2-4 \\ 1-4 \end{gathered}$ | $\begin{aligned} & 10 \\ & 20 \\ & 2.5 \\ & 2.5 \end{aligned}$ | CRSS <br> CRSS <br> CRSS <br> CRSS | $\begin{array}{r} 4 \mathrm{PF} \\ 10 \mathrm{PF} \\ .7 \mathrm{PF} \\ .7 \mathrm{PF} \end{array}$ | $\begin{aligned} & 1 M \\ & 1 M \\ & 1 M \\ & 1 M \end{aligned}$ |
| $\begin{aligned} & \text { 3N165 } \\ & 3 N 166 \\ & \text { 3N167 } \\ & \text { 3N168 } \end{aligned}$ | $\begin{array}{ll} P & I G \\ P & I G \\ P & I G \\ P & I G \end{array}$ | $\begin{aligned} & \text { FE } \\ & \text { FE } \\ & \text { FE } \\ & \text { FE } \end{aligned}$ | 3N160 | $\begin{aligned} & 40 \\ & 40 \\ & 30 \\ & 25 \end{aligned}$ | $\begin{aligned} & * 5-30 \\ & * 5-30 \\ & 200- \\ & 100- \end{aligned}$ | $\begin{aligned} & 1.5-3 \\ & 1.5-3 \end{aligned}$ | $\begin{array}{r} 3 \\ 3 \\ 35 \\ \mathbf{3 5} \end{array}$ | CRSS <br> CRSS <br> CRSS <br> CRSS | $\begin{aligned} & .7 \mathrm{PF} \\ & .7 \mathrm{PF} \\ & .3 \mathrm{PF} \\ & .3 \mathrm{PF} \end{aligned}$ | $\begin{aligned} & 1 M \\ & 1 M \\ & 1 M \\ & 1 M \end{aligned}$ |
| 3N169 <br> 3N170 <br> 3N171 <br> 3N172 | $\left\lvert\, \begin{array}{ll} N & 1 G \\ N & 1 G \\ N & 1 G \\ P & 1 G \end{array}\right.$ | $\begin{aligned} & \text { FE } \\ & \text { FE } \\ & \text { FE } \\ & \text { FE } \end{aligned}$ | 3N169 <br> 3N170 <br> 3N171 <br> 3N161 | $\begin{aligned} & 35 \\ & 35 \\ & 35 \\ & 40 \end{aligned}$ | * 10 <br> - 10 <br> - 10 -5-30 | 1.5-4 | $\begin{array}{r} 5 \\ 5 \\ 5 \\ 3.5 \end{array}$ | CRSS CRSS CRSS CRSS | $\begin{array}{r} 1.3 \mathrm{PF} \\ \text { 1.3 PF } \\ 1.3 \mathrm{PF} \\ 1 \mathrm{PF} \end{array}$ | $\begin{aligned} & 1 M \\ & 1 M \\ & 1 M \\ & 1 M \end{aligned}$ |
| 3N173 <br> 3N174 <br> 3N175 <br> 3N176 | $\begin{array}{ll} P & 1 G \\ P & 1 G \\ N & 1 G \\ N & 1 G \end{array}$ | FE <br> FE <br> FE <br> FE | 3N161 <br> 3N174 <br> 3N170 <br> 3N170 | $\begin{aligned} & 40 \\ & 30 \\ & 30 \\ & 25 \end{aligned}$ | $\begin{aligned} & * 5-30 \\ & * 3-12 \\ & * 20 \\ & * 15 \end{aligned}$ | $\begin{gathered} 1.4 \\ .4 \end{gathered}$ | $\begin{array}{r} 3.5 \\ 4 \\ 5 \\ 5 \end{array}$ | CRSS <br> CRSS <br> CRSS <br> CRSS | $\begin{aligned} & 1 \mathrm{PF} \\ & .7 \mathrm{PF} \\ & .5 \mathrm{PF} \\ & .5 \mathrm{PF} \end{aligned}$ | $\begin{aligned} & 1 M \\ & 1 M \\ & 1 M \\ & 1 M \end{aligned}$ |
| $\begin{aligned} & 3 \mathrm{~N} 177 \\ & \text { 3N178 } \\ & \text { 3N179 } \\ & \text { 3N180 } \end{aligned}$ | $\begin{array}{ll} N & 1 G \\ P & 1 G \\ P & 1 G \\ P & 1 G \end{array}$ | FE <br> FE <br> FE <br> FE | 3N171 <br> 3N174 | $\begin{aligned} & 20 \\ & 75 \\ & 60 \\ & 40 \end{aligned}$ | $\begin{array}{r} 10 \\ 3 \\ 3 \\ 3 \\ 3 \end{array}$ |  | $\begin{array}{r} 7 \\ 3.5 \\ 4.5 \\ 5 \end{array}$ | CRSS <br> CRSS <br> CRSS <br> CRSS | $\begin{array}{r} .75 \mathrm{PF} \\ .25 \mathrm{PF} \\ .35 \mathrm{PF} \\ .5 \mathrm{PF} \end{array}$ | $\begin{aligned} & 1 M \\ & 1 M \\ & 1 M \\ & 1 M \end{aligned}$ |
| 3N181 <br> 3N182 <br> 3N183 <br> 3N184 | $\begin{array}{ll} P & I G \\ P & 1 G \\ P & 1 G \\ P & 1 G \end{array}$ | $\begin{array}{\|l\|l} \text { FE } \\ \text { FE } \\ \text { FE } \\ \text { FE } \\ \text { FE } \end{array}$ |  | $\begin{aligned} & 30 \\ & 30 \\ & \mathbf{2 5} \\ & \mathbf{3 5} \end{aligned}$ | $\begin{aligned} & 40- \\ & +40 \\ & * 25- \\ & * 20- \end{aligned}$ |  | $\begin{array}{r} 25 \\ 25 \\ 30 \\ 9 \end{array}$ | CRSS <br> CRSS <br> CRSS <br> CRSS | $\begin{array}{r} 8 \mathrm{PF} \\ 10 \mathrm{PF} \\ 12 \mathrm{PF} \\ 3.5 \mathrm{PF} \end{array}$ | $\begin{aligned} & 1 M \\ & 1 M \\ & 1 M \\ & 1 M \end{aligned}$ |
| 3N185 <br> 3N186 <br> 3N188 <br> 3N189 | $\left\lvert\, \begin{array}{ll} p & 16 \\ p & 1 G \\ p & 1 G \\ p & 1 G \end{array}\right.$ | FE FE FE FE |  | $\begin{aligned} & 30 \\ & 25 \\ & 40 \\ & 40 \end{aligned}$ | $\begin{aligned} & \text { 15- } \\ & \cdot 10 \\ & * 5-30 \\ & * 5-30 \\ & \hline \end{aligned}$ | $\begin{aligned} & 1.5-4 \\ & 1.5-4 \end{aligned}$ | $\begin{array}{r} 10 \\ 11 \\ 4.5 \\ 4.5 \\ \hline \end{array}$ | CRSS <br> CRSS <br> CRSS <br> Chss | $\begin{aligned} & \text { 4.5 PF } \\ & \text { 5.5 PF } \\ & 1.5 \mathrm{PF} \\ & 1.5 \mathrm{PF} \\ & \hline \end{aligned}$ | $\begin{aligned} & 1 M \\ & 1 M \\ & 1 M \\ & 1 M \end{aligned}$ |

## TRANSISTOR INTERCHANGEABILITY REGISTERED FIELD-EFFECT TRANSISTORS

| TVFE Mumes |  | $\begin{aligned} & 8 \\ & \frac{8}{8} \\ & 8 \\ & 8 \end{aligned}$ | IIREPACEMENTOR MEARESTECUNAMENT | LATED DRAMGATE Voltace | EECTRICAL CHAMACTERISTICS |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  | IDSS <br> - b(en) | Irad | $c_{\text {ins }}$ | OTM | mer Para | TER |
|  |  |  |  |  | $\begin{array}{\|ll\|} \hline \operatorname{MNN} & \operatorname{MAX} \\ (m A) & (m A) \\ \hline \end{array}$ | $\begin{array}{\|rl\|} \hline \text { mind } & \text { max } \\ \text { (manho) } & \text { (mumho) } \\ \hline \end{array}$ | max <br> (pl) | symear | max | $\begin{gathered} 1 \\ \left(H_{z}\right) \end{gathered}$ |
| 3N190 3N191 3N192 3N193 | $\begin{array}{ll}P & 1 G \\ P & 1 G \\ N & 1 G \\ N & 1 G\end{array}$ | $\begin{aligned} & \text { FE } \\ & \text { FE } \\ & \text { FE } \\ & \text { FE } \end{aligned}$ |  | $\begin{array}{r} 40 \\ 40 \\ 20 \\ 20 \end{array}$ | $\begin{array}{r} \text { } 5-30 \\ +5-30 \\ 3-30 \\ 1-20 \end{array}$ | $\begin{gathered} 1.5-4 \\ 1.5-4 \\ 8-24 \\ 6-22 \end{gathered}$ | $\begin{array}{r} 4.5 \\ 4.5 \\ 6 \\ 7 \end{array}$ | CRSS <br> CRSS <br> CRSS <br> CRSS | $\begin{array}{r} 1 \mathrm{PF} \\ 1 \mathrm{PF} \\ .6 \mathrm{PF} \\ .6 \mathrm{PF} \end{array}$ | $\begin{aligned} & 1 M \\ & 1 M \\ & 44 M \\ & 44 M \end{aligned}$ |
| $\begin{aligned} & \text { 3N200 } \\ & \text { 3N201 } \\ & \text { 3N202 } \\ & \text { 3N203 } \end{aligned}$ | $\begin{array}{ll} N & 1 G \\ N & 1 G \\ N & 1 G \\ N & 1 G \end{array}$ | FE <br> FE <br> FE <br> FE | 3N201 <br> 3N202 <br> 3N203 | $\begin{aligned} & 20 \\ & 30 \\ & 30 \\ & 30 \end{aligned}$ | $\begin{gathered} .5-12 \\ 6-30 \\ 6-30 \\ 3-15 \end{gathered}$ | $\begin{array}{r} 10-20 \\ 8-20 \\ 8-20 \\ 7-15 \end{array}$ |  | CRSS <br> CRSS <br> CRSS <br> CRSS | $\begin{aligned} & .03 \mathrm{PF} \\ & .03 \mathrm{PF} \\ & .03 \mathrm{PF} \\ & .03 \mathrm{PF} \end{aligned}$ | $\begin{aligned} & 1 M \\ & 1 M \\ & 1 M \\ & 1 M \end{aligned}$ |
| $\left\lvert\, \begin{aligned} & \text { 3N204 } \\ & \text { 3N205 } \\ & \text { 3N206 } \\ & \text { 3N207 } \end{aligned}\right.$ | $\begin{array}{ll} N & I G \\ N & I G \\ N & I G \\ P & I G \end{array}$ | $\begin{aligned} & \text { FE } \\ & \text { FE } \\ & \text { FE } \\ & \text { FE } \end{aligned}$ | $\begin{aligned} & \text { 3N204 } \\ & \text { 3N205 } \\ & \text { 3N206 } \\ & \text { 3N207 } \end{aligned}$ | $\begin{aligned} & 30 \\ & 30 \\ & 30 \\ & \mathbf{2 5} \end{aligned}$ | $\begin{aligned} & 6.30 \\ & 6-30 \\ & 3.15 \\ & 1.5- \end{aligned}$ | $\begin{array}{r} 10-22 \\ 10-22 \\ 7-17 \end{array}$ | 4 | $\begin{array}{r} \text { NF } \\ \text { CRSS } \\ \text { NF } \\ \text { CRSS } \end{array}$ | $\begin{array}{r} 3.5 \mathrm{DB} \\ .03 \mathrm{PF} \\ 4 \mathrm{DB} \\ 2.5 \mathrm{PF} \end{array}$ | $\begin{array}{r} 1 \mathrm{M} \\ 45 \mathrm{~m} \\ 1 \mathrm{M} \end{array}$ |
| $\begin{aligned} & \text { 3N208 } \\ & \text { 3N211 } \\ & \text { 3N212 } \\ & \text { 3N213 } \end{aligned}$ | $\left\lvert\, \begin{array}{ll} P & I G \\ N & I G \\ N & I G \\ N & I G \end{array}\right.$ | FE <br> FE <br> FE <br> FE | $\begin{aligned} & \text { 3N208 } \\ & \text { 3N211 } \\ & \text { 3N212 } \\ & \text { 3N213 } \end{aligned}$ | $\begin{aligned} & 25 \\ & 35 \\ & 35 \\ & 40 \end{aligned}$ | 1.5-6-40 $6-40$ $6-40$ | $\begin{aligned} & 17-40 \\ & 17-40 \\ & 15-35 \end{aligned}$ | 4 | $\begin{gathered} \text { CRSS } \\ \text { NF } \\ \text { CRSS } \\ \text { CRSS } \end{gathered}$ | $\begin{gathered} \text { 2.5 PF } \\ \text { 3.5 DB } \\ .05 \mathrm{PF} \\ .05 \mathrm{PF} \end{gathered}$ | $\begin{array}{r} 1 \mathrm{M} \\ 200 \mathrm{M} \\ 1 \mathrm{M} \\ 1 \mathrm{M} \end{array}$ |
| $\left\lvert\, \begin{aligned} & \text { 3N214 } \\ & \text { 3N215 } \\ & \text { 3N216 } \\ & \text { 3N217 } \end{aligned}\right.$ | $\begin{array}{ll} N & 1 G \\ N & 1 G \\ N & 1 G \\ N & 1 G \end{array}$ | $\begin{aligned} & \text { FE } \\ & \text { FE } \\ & \text { FE } \\ & \text { FE } \end{aligned}$ | 3N214 <br> 3N215 <br> 3N216 <br> 3N217 | $\begin{aligned} & 20 \\ & 20 \\ & 20 \\ & 20 \end{aligned}$ | $\begin{aligned} & 50 \\ & .50- \\ & 50 \\ & 50 \\ & \text { - } \end{aligned}$ |  | $\begin{aligned} & 6 \\ & 6 \\ & 6 \\ & 6 \end{aligned}$ | CRSS <br> CRSS <br> CRSS <br> CRSS | $\begin{aligned} & 2 \mathrm{PF} \\ & 2 \mathrm{PF} \\ & 2 \mathrm{PF} \\ & 2 \mathrm{PF} \end{aligned}$ | $\begin{aligned} & 1 M \\ & 1 M \\ & 1 M \\ & 1 M \end{aligned}$ |

## TRANSISTOR INTERCHANGEABILITY <br> NONREGISTERED FIELD-EFFECT TRANSISTORS



## TRANSISTOR INTERCHANGEABILITY NONREGISTERED FIELD-EFFECT TRANSISTORS

| TME MUMOE: |  |  |  | $\begin{aligned} & 8 \\ & \frac{8}{8} \\ & \frac{8}{8} \\ & 8 \end{aligned}$ | TIREDACBMENTOR NBARESTEOUVALENT | RATED DRANF GATE VOLTACE <br> (V) | EECTRICAL CHARACTERISTICS |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  | loss $\omega_{0}(o n)$ |  |  | lyad | $C_{\text {ivs }}$ <br> max <br> (pF) | OTHEA PARAMTER |  |  |
|  |  |  |  | $\begin{array}{\|ll\|} \hline \text { min } & \text { max } \\ (\mathrm{ma}) & (\mathrm{ma}) \\ \hline \end{array}$ |  |  | $\begin{array}{\|rl\|} \hline \text { MMN } & \text { MAX } \\ \text { (mmho) } & \text { (mmho) } \\ \hline \end{array}$ |  | SYMBOL <br> MaX <br> - $f$ <br> ( Hz ) |  |  |
| CM644 CM645 CM646 CMO47 | $C R$ $C R$ $C R$ $C R$ |  | $\begin{aligned} & \mathbf{J} \\ & \mathbf{J} \\ & \mathbf{J} \\ & \mathbf{J} \end{aligned}$ |  |  | 2N4858 <br> 2N4857 <br> 2N4856 <br> 2N4856 | $\begin{aligned} & 30 \\ & 30 \\ & 30 \\ & 30 \end{aligned}$ | $\begin{aligned} & 10- \\ & 15- \\ & 30- \\ & 50- \end{aligned}$ |  |  | CRSS <br> CRSS <br> CRSS <br> CRSS | 5 PF 5 PF 5 PF 5 PF | $\begin{aligned} & 1 M \\ & 1 M \\ & 1 M \\ & 1 M \end{aligned}$ |
| CM697 <br> CMX740 <br> DU4339 <br> DU4340 |  |  | $\begin{aligned} & \mathbf{J} \\ & \mathbf{J} \\ & \mathbf{J} \\ & \mathbf{J} \end{aligned}$ |  |  | 2N5047 | $\begin{aligned} & 25 \\ & 30 \\ & 50 \\ & 50 \end{aligned}$ | $\begin{gathered} 30- \\ 500 \\ .5-1.5 \\ 1.2-3.6 \end{gathered}$ | $\begin{gathered} .8-2.4 \\ 1.3-3 \end{gathered}$ | $\begin{aligned} & 7 \\ & 7 \end{aligned}$ | CRSS <br> CRSS <br> CRSS <br> CRSS | $\begin{array}{r} 20 \mathrm{PF} \\ 60 \mathrm{PF} \\ 3 \mathrm{PF} \\ 3 \mathrm{PF} \end{array}$ | $\begin{aligned} & 1 M \\ & 1 M \\ & 1 M \\ & 1 M \end{aligned}$ |
| $E 100$ <br> E101 <br> E102 <br> E103 |  |  | $\begin{aligned} & \mathbf{J} \\ & \mathbf{j} \\ & \mathbf{j} \\ & \mathbf{j} \end{aligned}$ |  | 2N5950 <br> A5T3821 <br> 2N5953 <br> 2N5950 | $\begin{aligned} & 30 \\ & 30 \\ & 30 \\ & 30 \end{aligned}$ | $\begin{aligned} & .2-20 \\ & .2-1 \\ & .9-4.5 \\ & 4-20 \end{aligned}$ | $\begin{array}{r} .5 \\ .5 \\ 1- \\ 1.5- \end{array}$ | $\begin{aligned} & 8 \\ & 8 \\ & 8 \\ & 8 \end{aligned}$ | CRSS <br> CRSS <br> CRSS <br> CRSS | $\begin{aligned} & 3 \mathrm{PF} \\ & 3 \mathrm{PF} \\ & 3 \mathrm{PF} \\ & 3 \mathrm{PF} \end{aligned}$ | $\begin{aligned} & 1 M \\ & 1 M \\ & 1 M \\ & 1 M \end{aligned}$ |
| E108 <br> E109 <br> El10 <br> $E 111$ | $\begin{aligned} & \mathbb{N} \\ & \mathbb{N} \\ & \mathbb{N} \\ & \mathbb{N} \end{aligned}$ |  | $\begin{aligned} & \text { J } \\ & \mathbf{j} \\ & \mathbf{J} \\ & \mathbf{J} \end{aligned}$ |  | T1573 | $\begin{aligned} & 20 \\ & 20 \\ & 20 \\ & 25 \end{aligned}$ | $\begin{aligned} & 80- \\ & 40 . \\ & 10 . \\ & 20- \end{aligned}$ |  | $\begin{aligned} & 85 \\ & 85 \\ & 85 \\ & 28 \end{aligned}$ | CRSS <br> CRSS <br> CRSS <br> CRSS | $\begin{array}{r} 15 \mathrm{PF} \\ 15 \mathrm{PF} \\ 15 \mathrm{PF} \\ 5 \mathrm{PF} \end{array}$ | $\begin{aligned} & 1 M \\ & 1 M \\ & 1 M \\ & 1 M \end{aligned}$ |
| $\begin{aligned} & \text { E112 } \\ & \text { E113 } \\ & \text { E300 } \\ & \text { PE0654A } \end{aligned}$ | $\left(\begin{array}{l} \mathbb{N} \\ \mathbb{N} \\ \mathbb{N} \\ \mathbf{N} \end{array}\right.$ |  | $\begin{aligned} & \mathbf{J} \\ & \mathbf{J} \\ & \mathbf{J} \\ & \mathbf{J} \end{aligned}$ |  | $\begin{aligned} & \text { TIS74 } \\ & \text { Tis75 } \\ & \text { 2N5245 } \\ & \text { 2N5950 } \end{aligned}$ | $\begin{aligned} & 25 \\ & 25 \\ & 25 \\ & 25 \end{aligned}$ | $\begin{aligned} & 5- \\ & 2- \\ & 6-30 \\ & 10-40 \end{aligned}$ | $\begin{aligned} & 4.5- \\ & 4.5-9 \end{aligned}$ | $\begin{array}{r} 28 \\ 28 \\ 5.5 \\ 20 \end{array}$ | CRSS <br> CRSS <br> CRSS <br> CRSS | $\begin{array}{r} 5 \mathrm{PF} \\ 5 \mathrm{PF} \\ 1.7 \mathrm{PF} \\ 5 \mathrm{PF} \end{array}$ | $\begin{aligned} & 1 M \\ & 1 M \\ & 1 M \\ & 1 M \end{aligned}$ |
| Pt06548 <br> FE3819 <br> FE5245 <br> FR5246 | F |  | $\begin{aligned} & \mathbf{J} \\ & \mathbf{J} \\ & \mathbf{J} \\ & \mathbf{j} \end{aligned}$ |  | $\begin{aligned} & \text { 2N5951 } \\ & \text { 2N5953 } \\ & \text { 2N5245 } \\ & \text { 2N5246 } \end{aligned}$ | $\begin{aligned} & \mathbf{2 5} \\ & \mathbf{2 5} \\ & 30 \\ & 30 \end{aligned}$ | $\begin{aligned} & 3-12 \\ & 2-20 \\ & 5-15 \\ & 1.5-7 \end{aligned}$ | $\begin{aligned} & 3.5-8 \\ & 2-6.5 \\ & 4- \\ & 2.5- \end{aligned}$ | $\begin{array}{r} 20 \\ 8 \\ 4.5 \\ 4.5 \end{array}$ | $\begin{aligned} & \text { CRSS } \\ & \text { CRSS } \\ & \text { CRSS } \\ & \text { CRSS } \end{aligned}$ | $\begin{array}{r} 5 \mathrm{PF} \\ 4 \mathrm{PF} \\ 1.2 \mathrm{PF} \\ 1.2 \mathrm{PF} \end{array}$ | $\begin{aligned} & 1 M \\ & 1 M \\ & 1 M \\ & 1 M \end{aligned}$ |
| FES247 <br> FES457 <br> FES458 <br> FES459 | F | N N N N | $\begin{aligned} & \mathbf{J} \\ & \mathbf{J} \\ & \mathbf{j} \\ & \mathbf{J} \end{aligned}$ |  | $\begin{aligned} & \text { 2N5247 } \\ & \text { 2N5953 } \\ & \text { 2N5952 } \\ & \text { 2N5950 } \end{aligned}$ | $\begin{aligned} & 30 \\ & 25 \\ & 25 \\ & 25 \end{aligned}$ | $\begin{aligned} & 8-2.4 \\ & 1-5 \\ & 2.9 \\ & 4-16 \end{aligned}$ | $\begin{gathered} 4 . \\ 1.5 \\ 1.5-5.5 \\ 2-6 \end{gathered}$ | $\begin{array}{r} 4.5 \\ 7 \\ 7 \\ 7 \end{array}$ | CRSS <br> CR5S <br> CRSS <br> CRSS | $\begin{array}{r} 1.2 \mathrm{PF} \\ 3 \mathrm{PF} \\ 3 \mathrm{PF} \\ 3 \mathrm{PF} \end{array}$ | $\begin{aligned} & 1 M \\ & 1 M \\ & 1 M \\ & 1 M \end{aligned}$ |
| FES484 <br> PES485 <br> PES486 <br> F065AA | FF <br>  <br> $F$ <br> $F$ | N $\mathbf{N}$ $\mathbf{N}$ N | $\begin{aligned} & \mathrm{J} \\ & \mathrm{~J} \\ & \mathrm{~J} \\ & \mathrm{~J} \end{aligned}$ |  | 2N5953 2N5952 <br> 2N5949 | $\begin{aligned} & 25 \\ & 25 \\ & 25 \\ & 50 \end{aligned}$ | $\begin{gathered} 1-5 \\ 1-5 \\ 4-10 \\ 10-40 \end{gathered}$ | $\begin{gathered} 2.5- \\ 2.5- \\ 3- \\ 4.5-9 \end{gathered}$ | $\begin{array}{r} 5 \\ 5 \\ 5 \\ 20 \end{array}$ | CRSS <br> CRSS <br> CRSS <br> CRSS | $\begin{array}{r} \text { 1.2 PF } \\ \text { 1.2 PF } \\ \text { 1.2 PF } \\ 5 \mathrm{PF} \end{array}$ | $\begin{aligned} & 1 M \\ & 1 M \\ & 1 M \\ & 1 M \end{aligned}$ |
| FT06548 <br> FT0654C <br> FT0654D <br> FT701 | F F F F | $\begin{aligned} & \mathbf{N} \\ & \mathbf{N} \\ & \mathbf{N} \\ & \mathbf{P} \end{aligned}$ | $\begin{aligned} & \mathrm{J} \\ & \mathrm{~J} \\ & \mathrm{~J} \end{aligned}$ |  | 3N207 | $\begin{aligned} & 50 \\ & 50 \\ & 50 \\ & 30 \end{aligned}$ | $\begin{array}{r} 10-40 \\ 3-12 \\ 3-12 \end{array}$ | $\begin{aligned} & 4.5-9 \\ & 3.5-8 \\ & 3.5-8 \\ & 1.2- \end{aligned}$ | $\begin{aligned} & 20 \\ & 20 \\ & 20 \end{aligned}$ | CRSS CRSS CRSS | $\begin{aligned} & 5 \mathrm{PF} \\ & 5 \mathrm{PF} \\ & 5 \mathrm{PF} \end{aligned}$ | $\begin{aligned} & 1 M \\ & 1 M \\ & 1 M \end{aligned}$ |
| $\begin{aligned} & \text { F7703 } \\ & \text { PT704 } \\ & \text { FT3820 } \\ & \text { LMF3954 } \end{aligned}$ | F $\mathbf{F}$ $\mathbf{F}$ $\mathbf{I N}$ | $\begin{aligned} & P \\ & \mathbf{P} \\ & \mathbf{p} \\ & \mathbf{N} \end{aligned}$ | $\begin{aligned} & \text { IG } \\ & \text { IG } \\ & \text { J } \\ & \text { J } \end{aligned}$ |  | 3N160 <br> 3N163 <br> A5T5460 <br> 2N5545 | $\begin{aligned} & 30 \\ & 30 \\ & 20 \\ & 40 \end{aligned}$ | $\begin{aligned} & .3-15 \\ & .5-5 \\ & \hline \end{aligned}$ | $\begin{gathered} 2.5- \\ .3- \\ .8-5 \\ 1- \end{gathered}$ | $\begin{array}{r} 15 \\ 4.5 \\ 32 \end{array}$ | $\begin{aligned} & \text { CRSS } \\ & \text { CRSS } \\ & \text { CRSS } \end{aligned}$ | $\begin{aligned} & 3 \mathrm{PF} \\ & .7 \mathrm{PF} \end{aligned}$ $16 \text { PF }$ | $\begin{aligned} & 1 M \\ & 1 M \\ & 1 M \end{aligned}$ |

## TRANSISTOR INTERCHANGEABILITY <br> NONREGISTERED FIELD-EFFECT TRANSISTORS



## TRANSISTOR INTERCHANGEABILITY NONREGISTERED FIELD-EFFECT TRANSISTORS

|  |  |  | $\begin{aligned} & \frac{\mathbf{E}}{E} \\ & \text { 总 } \end{aligned}$ |  | $\pi$ remacement OR MEAREST EquIVALENT | RATED DRAIN. GATE voltace | LLCTILCAL CHARACTIRESTICS |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  |  |  | loss ${ }^{4} \mathrm{O}(\mathrm{on})$ | \|rat | $\begin{aligned} & c_{\text {iss }} \\ & \text { max } \\ & \text { (pF) } \end{aligned}$ | Otheis paramitir |  |  |
|  |  |  |  |  |  |  | $\begin{array}{ll} \text { MIN } & \max \\ (\mathrm{mA}) & (\mathrm{mA}) \end{array}$ | MIN MaX <br> (mmmho) (mumho) |  | symber | max | ( Hz ) |
| $\begin{aligned} & \hline \text { KELO92 } \\ & \text { KEL093 } \\ & \text { KEE220 } \\ & \text { KEL221 } \\ & \hline \end{aligned}$ | IN | N | $\begin{aligned} & \mathbf{J} \\ & \mathbf{j} \\ & \mathbf{j} \end{aligned}$ |  | TIS74 T1575 A5T3821 A5T3822 | $\begin{aligned} & 40 \\ & 40 \\ & 30 \\ & 30 \end{aligned}$ | $\begin{gathered} 15- \\ 8- \\ .5-3 \\ 2-6 \end{gathered}$ | $\begin{aligned} & 1-4 \\ & 2-5 \end{aligned}$ | $\begin{array}{r} 16 \\ 16 \\ 6 \\ 6 \end{array}$ | CRSS <br> CRSS <br> CRSS <br> CRSS | $\begin{aligned} & 5 \mathrm{PF} \\ & 5 \mathrm{PF} \\ & 2 \mathrm{PF} \\ & 2 \mathrm{PF} \end{aligned}$ | $\begin{aligned} & \mathrm{IM} \\ & \mathrm{IM} \\ & \mathrm{IM} \\ & \mathrm{IM} \end{aligned}$ |
| $\begin{array}{\|l\|l\|} \hline K E 4222 \\ \text { KE4223 } \\ \text { KE4224 } \\ K E 4391 \end{array}$ | IN IN IN IN IN | N $\mathbf{N}$ $\mathbf{N}$ | $\begin{aligned} & J \\ & j \\ & j \end{aligned}$ |  | A5T3822 <br> 2N5950 <br> 2N5949 <br> TIS73 | $\begin{aligned} & 30 \\ & 30 \\ & 30 \\ & 40 \end{aligned}$ | $\begin{gathered} 5-15 \\ 3-18 \\ 2-20 \\ 50-150 \end{gathered}$ | $\begin{aligned} & 2.5-6 \\ & 2.7 \\ & 1.7 \end{aligned}$ | $\begin{array}{r} 6 \\ 6 \\ 6 \\ 14 \end{array}$ | CRSS CRSS CRSS CRSS | $\begin{array}{r} 2 \mathrm{PF} \\ 2 \mathrm{PF} \\ 2 \mathrm{PF} \\ 3.5 \mathrm{PF} \end{array}$ | $\begin{aligned} & 1 \mathrm{M} \\ & \mathrm{im} \\ & \mathrm{im} \\ & \mathrm{im} \end{aligned}$ |
| $\begin{array}{\|l\|l\|} \mathrm{KE} E 4392 \\ \mathrm{KEA393} \\ \mathrm{KEA416} \\ \mathrm{KEAB56} \end{array}$ | IN IN IN IN N | $N$ $N$ $N$ $N$ $N$ | $\begin{aligned} & j \\ & j \\ & j \end{aligned}$ |  | $\begin{aligned} & \text { TIS74 } \\ & \text { TS75 } \\ & \text { 2N5245 } \\ & \text { TIS73 } \end{aligned}$ | $\begin{aligned} & 40 \\ & 40 \\ & 30 \\ & 40 \end{aligned}$ | $\begin{array}{r} 25-75 \\ 5-30 \\ 5-15 \\ 50 \end{array}$ | 4. | $\begin{gathered} 14 \\ 14 \\ 4 \\ 18 \end{gathered}$ | $\begin{aligned} & \text { CRSS } \\ & \text { CRSS } \\ & \text { CRSS } \\ & \text { CRSS } \end{aligned}$ | $\begin{aligned} & \text { 3.5 PF } \\ & 3.5 \mathrm{PF} \\ & 1.2 \mathrm{PP} \\ & 8 \mathrm{PF} \end{aligned}$ | $\begin{aligned} & 1 \mathrm{M} \\ & \mathrm{IM} \\ & \mathrm{IM} \\ & \mathrm{IM} \end{aligned}$ |
| KEA857 KE4858 KE4859 KE4860 | IN IN IN IN IN N | $N$ $N$ $N$ $N$ $N$ | $\begin{aligned} & \text { J } \\ & \text { j } \\ & \text { j } \end{aligned}$ |  | TIS74 <br> T1575 <br> TIS73 <br> T1574 | $\begin{aligned} & 40 \\ & 40 \\ & 30 \\ & 30 \end{aligned}$ | $\begin{aligned} & 20-100 \\ & 8-80 \\ & 50 \\ & 20-100 \end{aligned}$ |  | $\begin{aligned} & 18 \\ & 18 \\ & 18 \\ & 18 \end{aligned}$ | $\begin{aligned} & \text { CRSS } \\ & \text { CRSS } \\ & \text { CRSS } \\ & \text { CRSS } \end{aligned}$ | 8 PF <br> 8 PF <br> 8 PF <br> 8 PF | 1 M <br> 1 M <br> $1 M$ <br> 1M |
| $\begin{aligned} & \text { KEA861 } \\ & \text { KES103 } \\ & \text { KES104 } \\ & \text { KES105 } \end{aligned}$ | IN IN IN N IN | N $N$ $N$ $N$ $N$ | j |  | $\begin{aligned} & \text { 71575 } \\ & \text { 2N5952 } \\ & \text { 2N5953 } \\ & \text { 2N5245 } \end{aligned}$ | $\begin{aligned} & 30 \\ & 25 \\ & 25 \\ & 25 \end{aligned}$ | $\begin{aligned} & 8-80 \\ & 1-8 \\ & 2-6 \\ & 5-15 \end{aligned}$ | $\begin{gathered} 2.8 \\ 3.5-7.5 \\ 5-10 \end{gathered}$ | $\begin{array}{r} 18 \\ 5 \\ 5 \\ 5 \end{array}$ | CRSS <br> CR5S <br> CRSS <br> CRSS | $\begin{array}{r} 8 \mathrm{PF} \\ 1.2 \mathrm{PF} \\ 1.2 \mathrm{PF} \\ \text { 1.2 PF } \end{array}$ | 19 19 19 19 |
| $\begin{aligned} & \text { M100 } \\ & \text { M101 } \\ & \text { M103 } \\ & \text { M104 } \end{aligned}$ | St $\mathbf{S I}$ $\mathbf{s i}$ $\mathbf{S I}$ | N | $\begin{aligned} & \text { IG } \\ & \text { IG } \\ & \text { IG } \\ & \text { IG } \end{aligned}$ |  | $\begin{aligned} & \text { 3N161 } \\ & \text { 3N161 } \end{aligned}$ | $\begin{aligned} & 20 \\ & 20 \\ & 30 \\ & 30 \end{aligned}$ | $1.5-4.5$ 4.12 | $\begin{array}{r} 1-2.2 \\ 1.5-3.3 \end{array}$ | $\begin{aligned} & 7.5 \\ & 7.5 \end{aligned}$ | $\begin{aligned} & \text { CRSS } \\ & \text { CRSS } \end{aligned}$ | $\begin{gathered} 4 \mathrm{PF} \\ .5 \mathrm{PF} \end{gathered}$ | 1 M |
| M106 <br> M107 <br> M108 <br> M113 | $\begin{array}{\|l\|l\|} \hline \mathbf{s i} \\ \mathbf{s i} \\ \mathbf{s I} \\ \mathbf{s I} \end{array}$ | P | $\begin{aligned} & \mathbf{I G} \\ & \mathbf{I G} \\ & \mathbf{I G} \\ & \mathbf{I G} \end{aligned}$ |  | $\begin{aligned} & \text { 3N208 } \\ & \text { 3N208 } \\ & \text { 3N207 } \\ & \text { 3N156 } \end{aligned}$ | $\begin{aligned} & 30 \\ & 30 \\ & 30 \\ & 30 \end{aligned}$ | $\begin{array}{r} 10 \\ \cdot 10 \\ \cdot 10 \end{array}$ | $2-$ $2-$ $2-$ |  | CRSS CRSS CRSS CRSS | $\begin{aligned} & 4 \mathrm{PF} \\ & 4 \mathrm{PF} \\ & 4 \mathrm{PF} \\ & 4 \mathrm{PF} \end{aligned}$ | 19 19 $1 M$ $1 M$ |
| M114 M116 M117 M119 | $\begin{aligned} & \text { SI } \\ & \text { SI } \\ & \text { SI } \\ & \text { SI } \end{aligned}$ | P $\begin{aligned} & \text { P } \\ & N \\ & N \\ & \mathbf{N}\end{aligned}$ | $\begin{aligned} & \text { IG } \\ & 1 G \\ & 1 G \\ & 1 G \end{aligned}$ |  | $\begin{aligned} & \text { 3N160 } \\ & \text { 3N161 } \\ & \text { 3N160 } \\ & \text { 3N161 } \end{aligned}$ | $\begin{aligned} & 40 \\ & 30 \\ & 50 \\ & 80 \end{aligned}$ | -8.200 | 2-4 | $\begin{aligned} & 2.5 \\ & 2.5 \end{aligned}$ | $\begin{aligned} & \text { CRSS } \\ & \text { CRSS } \\ & \text { CRSS } \\ & \text { CRSS } \\ & \hline \end{aligned}$ | $\begin{array}{r} 4 \mathrm{Pf} \\ 10 \mathrm{PF} \\ 8 \mathrm{PF} \\ 8 \mathrm{PF} \end{array}$ | $\begin{aligned} & 1 M \\ & 1 M \\ & 1 M \\ & 1 M \end{aligned}$ |
| M511 <br> MSIIA <br> M517 <br> MEM51 | SI SI SI GI | P | $\begin{aligned} & \text { IG } \\ & \text { IG } \\ & \text { IG } \\ & \text { IG } \end{aligned}$ |  | 3N161 <br> 3N161 <br> 3N161 <br> 3N174 | $\begin{aligned} & 30 \\ & 30 \\ & 30 \\ & 30 \end{aligned}$ | $\begin{gathered} .01 \\ -.01 \\ .3- \end{gathered}$ | $\begin{aligned} & 1 . \\ & 1 . \\ & 1 . \end{aligned}$ |  | CRSS CRSS CRSS CRSS | $\begin{array}{r} \text { 4 PF } \\ 2.5 \mathrm{PF} \\ 7 \mathrm{PF} \\ 2.5 \mathrm{PF} \end{array}$ | $\begin{aligned} & 1 M \\ & 1 M \\ & 1 M \\ & 1 M \end{aligned}$ |
| MEMSIIC MEM517 MEMS17A MEMS17C | $\begin{aligned} & \mathbf{G I} \\ & \mathbf{G I} \\ & \mathbf{G I} \\ & \mathbf{G I} \end{aligned}$ | P $\begin{aligned} & \text { P } \\ & p \\ & p\end{aligned}$ | $\begin{array}{r} 1 G \\ \text { IG } \\ \text { IG } \\ \text { IG } \end{array}$ |  | 3N174 | $\begin{aligned} & 25 \\ & 25 \\ & 25 \\ & 25 \\ & \hline \end{aligned}$ | $\begin{array}{r} 32 \\ * 25- \\ * 25 \\ * 20 \\ \hline \end{array}$ | $\begin{array}{r} 1- \\ 1.2- \\ 1.2- \\ 1.2- \\ \hline \end{array}$ |  | $\begin{aligned} & \text { CRSS } \\ & \text { CRSS } \\ & \text { CRSS } \\ & \text { CRSS } \\ & \hline \end{aligned}$ | $\begin{array}{r} 4 \mathrm{PF} \\ 10 \mathrm{PF} \\ 10 \mathrm{PF} \\ 15 \mathrm{PF} \\ \hline \end{array}$ | $\begin{aligned} & 1 M \\ & 1 M \\ & 1 M \\ & 1 M \end{aligned}$ |

TRANSISTOR INTERCHANGEABILITY NONREGISTERED FIELD-EFFECT TRANSISTORS

| TYPE NUMBER |  | $\begin{aligned} & 5 \\ & 5 \\ & \hline \end{aligned}$ |  | $\begin{aligned} & \frac{8}{8} \\ & \frac{5}{3} \\ & \frac{5}{8} \\ & 8 \end{aligned}$ | $\pi$ <br> REPLACEMENT OR NBAREST ECUIVALENT | Rated DRAINOATE VOLTACE <br> (V) | EECTRICAL CHARACTERISTICS |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  |  |  | $\begin{aligned} & \text { Ioss } \\ & \text { *Io(on) } \end{aligned}$ | \|rad | $C_{155}$ <br> max <br> ( PF ) | OTHEX PARAMETE |  |  |
|  |  |  |  |  |  |  | $\begin{array}{\|ll\|} \hline M I N & M A X \\ (m A) & (m A) \\ \hline \end{array}$ | $\begin{array}{\|rl\|} \hline \text { MIN } & \text { MaX } \\ \text { (mmho) } & \text { (mmho) } \\ \hline \end{array}$ |  | $\qquad$ |  |  |
| MEM520 <br> MEM520C <br> MEM550 <br> MEMS50C | GI GI GI GI |  | $\begin{aligned} & I G \\ & I G \\ & I G \\ & I G \end{aligned}$ |  | $\begin{aligned} & \text { 3N174 } \\ & \text { 3N174 } \\ & \text { 3N208 } \\ & \text { 3N207 } \end{aligned}$ | $\begin{aligned} & 40 \\ & 25 \\ & 30 \\ & 25 \end{aligned}$ | $\begin{array}{r} 3- \\ 3 \\ \cdot 1.5 \\ \cdot 1.5 \end{array}$ | 1. <br> 1. <br> . 5 |  | CRSS <br> CRSS <br> CRSS <br> CRSS | $\begin{array}{r} 2.5 \mathrm{PF} \\ 4 \mathrm{PF} \\ 1.1 \mathrm{PF} \\ 4 \mathrm{PF} \end{array}$ | $\begin{aligned} & 1 M \\ & 1 M \\ & 1 M \\ & 1 M \end{aligned}$ |
| MEM551 <br> MEM551C <br> MEM554 <br> MEM554C | $\begin{aligned} & \mathbf{G I} \\ & \mathbf{G I} \\ & \mathbf{G} \\ & \mathbf{G I} \end{aligned}$ |  | $\begin{aligned} & \text { IG } \\ & \text { IG } \\ & \text { IG } \\ & \text { IG } \end{aligned}$ |  | $\begin{aligned} & \text { 3N208 } \\ & \text { 3N207 } \\ & \text { 3N201 } \\ & \text { 3N2O1 } \end{aligned}$ | $\begin{aligned} & 30 \\ & 25 \\ & 20 \\ & 20 \end{aligned}$ | *1.5- <br> *1.5- $\begin{aligned} & 3-30 \\ & 3-30 \end{aligned}$ | $\begin{aligned} & .5- \\ & .5- \\ & 10-13 \\ & 8-11 \end{aligned}$ |  | $\begin{aligned} & \text { CRSS } \\ & \text { CRSS } \end{aligned}$ | $\begin{array}{r} 1.1 \mathrm{PF} \\ 4 \mathrm{PF} \end{array}$ | $\begin{aligned} & 1 M \\ & 1 M \end{aligned}$ |
| MEM556 <br> MEM556C <br> MEM557 <br> MEM557C | $\left\lvert\, \begin{aligned} & \mathbf{G I} \\ & \mathbf{G I} \\ & \mathbf{G I} \\ & \mathbf{G I} \end{aligned}\right.$ |  | $\begin{aligned} & \text { IG } \\ & \text { IG } \\ & \text { IG } \\ & \text { IG } \end{aligned}$ |  | $\begin{aligned} & \text { 3N174 } \\ & 3 \mathrm{~N} 174 \end{aligned}$ | $\begin{aligned} & 50 \\ & 45 \\ & 20 \\ & 20 \end{aligned}$ | 3 <br> +3 <br> 3 <br> $3-$ <br> $3-$ | 8 .8 $8-$ $6-$ | 5 | CRSS <br> CRSS | $\begin{aligned} & .5 \mathrm{PF} \\ & .7 \mathrm{PF} \end{aligned}$ | $\begin{aligned} & 1 M \\ & 1 M \end{aligned}$ |
| MEM560 <br> MEM560C <br> MEM562 <br> MEM562C | GI <br> GI <br> GI <br> GI |  | $\begin{aligned} & \text { IG } \\ & \text { IG } \\ & \text { IG } \\ & \text { IG } \end{aligned}$ |  | 3NI61 <br> 3N161 | $\begin{aligned} & 35 \\ & 30 \\ & 30 \\ & 30 \end{aligned}$ | $\begin{array}{r} 15- \\ * 10 \\ * 5 \\ * 5 \end{array}$ | $\begin{aligned} & 2- \\ & 2- \\ & 1 . \\ & 1 . \end{aligned}$ | $\begin{array}{r} 9 \\ 11 \\ 4 \\ 5 \end{array}$ | CRSS <br> CRSS <br> CRSS <br> CRSS | $\begin{array}{r} \text { 3.5 PF } \\ \text { 4.5 PF } \\ \text {. } 5 \mathrm{PF} \\ .6 \mathrm{PF} \end{array}$ | $\begin{aligned} & 1 M \\ & 1 M \\ & 1 M \\ & 1 M \end{aligned}$ |
| MEM563 MEM564C MEM57IC MEM575 | $\begin{aligned} & \mathbf{G} 1 \\ & \mathbf{G} 1 \\ & \mathbf{G} 1 \\ & \mathbf{G} \mid \end{aligned}$ |  | $\begin{aligned} & \text { IG } \\ & \text { IG } \\ & \text { IG } \\ & \text { IG } \end{aligned}$ |  |  | $\begin{aligned} & 30 \\ & 20 \\ & 30 \\ & 25 \end{aligned}$ | $\begin{array}{r} 15- \\ 3- \\ 3- \\ * 50 \end{array}$ | $\begin{array}{r} 2- \\ 8- \\ 8- \\ 10 \end{array}$ | $\begin{array}{r} 5 \\ 8 \\ 6 \\ 50 \end{array}$ | CRSS <br> CRSS <br> CRSS <br> CRSS | $\begin{aligned} & .6 \mathrm{PF} \\ & .5 \mathrm{PF} \\ & 20 \mathrm{PF} \end{aligned}$ | $\begin{aligned} & 1 M \\ & 1 M \\ & 1 M \\ & 1 M \end{aligned}$ |
| MEM614 MEM655 MEM660 MFE2000 | GI <br> GI <br> GI <br> M |  | IG IG IG J |  | $\begin{aligned} & 3 \mathrm{~N} 203 \\ & \text { 3N214 } \\ & \text { 2N4416 } \end{aligned}$ | $\begin{aligned} & 20 \\ & 20 \\ & 20 \\ & 25 \end{aligned}$ | $\begin{array}{r} 1-20 \\ 1-20 \\ -10 \\ 4-10 \end{array}$ | $\begin{aligned} & 6-10 \\ & 6 \\ & 2.5-6 \end{aligned}$ | $\begin{aligned} & 8 \\ & 7 \\ & 7 \\ & 5 \end{aligned}$ | CR5S | $\begin{aligned} & 1 \mathrm{PF} \\ & 1 \mathrm{PF} \end{aligned}$ | $1 \mathrm{M}$ |
| MFE2001 <br> MFE2004 <br> MFE2005 <br> MFE2006 | $\begin{aligned} & M \\ & M \\ & M \\ & M \end{aligned}$ |  | $\begin{aligned} & \mathbf{J} \\ & \mathbf{j} \\ & \mathbf{j} \\ & \mathbf{j} \end{aligned}$ |  | $\begin{aligned} & \text { 2N5247 } \\ & \text { 2N4860 } \\ & \text { 2N4859 } \\ & \text { 2N4859 } \end{aligned}$ | $\begin{aligned} & 25 \\ & 30 \\ & 30 \\ & 30 \end{aligned}$ | $\begin{aligned} & 8-20 \\ & 8- \\ & 15- \\ & 30- \end{aligned}$ | 4-8 | $\begin{array}{r} 5 \\ 16 \\ 16 \\ 16 \end{array}$ | CRSS <br> CRSS <br> CRSS <br> CRSS | $\begin{aligned} & 1 \mathrm{PF} \\ & 5 \mathrm{PF} \\ & 5 \mathrm{PF} \\ & 5 \mathrm{PF} \end{aligned}$ | $\begin{aligned} & 1 M \\ & 1 M \\ & 1 M \\ & 1 M \end{aligned}$ |
| MFE2007 <br> MFE2008 <br> MFE2009 <br> MFE2010 | $\begin{aligned} & M \\ & M \\ & M \\ & M \end{aligned}$ | $N$ $N$ $N$ $N$ $N$ | $\begin{aligned} & \mathbf{J} \\ & \mathbf{j} \\ & \mathbf{J} \\ & \mathbf{j} \end{aligned}$ |  | $\begin{aligned} & \text { 2N4860 } \\ & \text { 2N4859 } \\ & \text { 2N4859 } \\ & \text { 2N4859 } \end{aligned}$ | $\begin{aligned} & \mathbf{2 5} \\ & \mathbf{2 5} \\ & \mathbf{2 5} \\ & \mathbf{2 5} \end{aligned}$ | $\begin{array}{r} 8- \\ 20- \\ 50- \\ 15- \end{array}$ |  | $\begin{aligned} & 30 \\ & 30 \\ & 30 \\ & 50 \end{aligned}$ | CRSS <br> CRSS <br> CRSS <br> CRSS | $\begin{aligned} & 15 \mathrm{PF} \\ & 15 \mathrm{PF} \\ & 15 \mathrm{PF} \\ & 20 \mathrm{PF} \end{aligned}$ | $\begin{aligned} & 1 M \\ & 1 M \\ & 1 M \\ & 1 M \end{aligned}$ |
| $\begin{aligned} & \text { MFE2011 } \\ & \text { MFE2012 } \\ & \text { MFE2093 } \\ & \text { MFE2094 } \end{aligned}$ | $\begin{aligned} & M \\ & M \\ & M \\ & M \end{aligned}$ | $\begin{aligned} & \mathbf{N} \\ & \mathbf{N} \\ & \mathbf{N} \\ & \mathbf{N} \end{aligned}$ | $\begin{aligned} & \mathrm{J} \\ & \mathrm{~J} \\ & \mathbf{J} \\ & \mathrm{~J} \end{aligned}$ |  | $\begin{aligned} & \text { 2N5358 } \\ & \text { 2N5359 } \end{aligned}$ | $\begin{aligned} & 25 \\ & 25 \\ & 50 \\ & 50 \end{aligned}$ | $\begin{gathered} 40 . \\ 100 . \\ .1-.7 \\ .4-1.4 \end{gathered}$ | $.25-.5$ | $\begin{array}{r} 50 \\ 50 \\ 6 \\ 6 \end{array}$ | CRSS <br> CRSS <br> CRSS <br> CRSS | $\begin{aligned} & 20 \mathrm{PF} \\ & 20 \mathrm{PF} \\ & 2 \mathrm{PF} \\ & 2 \mathrm{PF} \end{aligned}$ | $\begin{aligned} & 1 M \\ & 1 M \\ & 1 M \\ & 1 M \end{aligned}$ |
| MFE2095 <br> MFE2133 <br> MFE3001 <br> MFE3002 | $\begin{aligned} & M \\ & M \\ & M \\ & M \\ & \hline \end{aligned}$ |  | $\begin{aligned} & \text { J } \\ & \text { IG } \\ & \text { IG } \end{aligned}$ |  | $\begin{aligned} & \text { 2N5360 } \\ & \text { 2N4860 } \\ & \text { 3N128 } \\ & \text { 3N169 } \\ & \hline \end{aligned}$ | $\begin{aligned} & 50 \\ & 30 \\ & 30 \\ & 20 \end{aligned}$ | $\begin{gathered} 1-3 \\ 25- \\ .5-6 \end{gathered}$ | $\begin{aligned} & .4-8 \\ & 12- \\ & .7-3.5 \end{aligned}$ | $\begin{array}{r} 6 \\ 20 \\ 5 \\ 5 \\ \hline \end{array}$ | CRSS CRSS CRSS CRSS | $\begin{array}{r} 2 \mathrm{PF} \\ 5 \mathrm{PF} \\ 1.5 \mathrm{PF} \\ 1 \mathrm{PF} \end{array}$ | $\begin{aligned} & 1 M \\ & 1 M \\ & 1 M \\ & 1 M \end{aligned}$ |

## TRANSISTOR INTERCHANGEABILITY NONREGISTERED FIELD-EFFECT TRANSISTORS

| TYPE NUMAER |  | $\begin{aligned} & k \\ & \frac{k}{2} \\ & \hline \end{aligned}$ |  | $\begin{aligned} & \mathbf{Z} \\ & \frac{2}{2} \\ & \mathbf{S} \\ & \frac{2}{3} \\ & \mathbf{3} \\ & \mathbf{S} \end{aligned}$ | 7 <br> REPLACEMENT <br> OR MEAREST EQUIVALENT | RATED DRAINGATE VOLTAGE <br> (V) | EECTRICAL CHARACTERISTICS |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  | foss <br> ${ }^{*}{ }^{1}($ (on) |  |  | lval | Ciss <br> max <br> (pF) | OTHER PANAMSTER |  |  |
|  |  |  |  | $\begin{array}{\|ll\|} \hline \text { MIN } & M A X \\ (\mathrm{~mA}) & (\mathrm{mA}) \\ \hline \end{array}$ |  |  | $\begin{array}{\|rl\|} \text { MIN } & \text { MaX } \\ \text { (mohe) } & \text { (manhe) } \end{array}$ |  | $\begin{array}{cc} \text { sYMBO: MAX ef } \\ & \\ \hline \end{array}$ |  |  |
| $\begin{aligned} & \text { MFE3003 } \\ & \text { MFE3004 } \\ & \text { MFE3005 } \\ & \text { MFE3006 } \end{aligned}$ | $M$ $M$ $M$ $M$ | P $\mathbf{N}$ $\mathbf{N}$ $\mathbf{N}$ | IG IG IG IG |  |  | 3N156 <br> 3N203 | $\begin{aligned} & 20 \\ & 20 \\ & 20 \\ & 35 \end{aligned}$ | $\begin{aligned} & 2-10 \\ & 2-10 \\ & 2-18 \end{aligned}$ | 2. <br> 2. <br> 8-18 | $\begin{array}{r} 5 \\ 4.5 \\ 4.5 \\ 6 \end{array}$ | CRSS CRSS CRSS | $\begin{aligned} & 1 \mathrm{PF} \\ & .2 \mathrm{PF} \\ & .2 \mathrm{PF} \end{aligned}$ | $\begin{aligned} & 1 M \\ & 1 M \\ & 1 M \end{aligned}$ |
| $\begin{aligned} & \text { MFE3007 } \\ & \text { MFE3008 } \\ & \text { MFE3020 } \\ & \text { MFE3021 } \end{aligned}$ | $M$ $M$ $M$ $M$ | N $\mathbf{N}$ $\mathbf{P}$ $\mathbf{P}$ | $\begin{aligned} & \text { IG } \\ & \text { IG } \\ & \text { IG } \\ & \text { IG } \end{aligned}$ |  |  | 3 N 2 OI <br> 3N203 <br> 3N207 | $\begin{aligned} & 35 \\ & 35 \\ & 25 \\ & 25 \end{aligned}$ | $\begin{array}{r} 5-20 \\ 2-20 \\ * 10-75 \\ * 10-75 \end{array}$ | $\begin{aligned} & 10-18 \\ & 8-18 \\ & .5- \\ & .5- \end{aligned}$ | $\begin{array}{r} 5.5 \\ 6 \\ 7 \\ 7 \end{array}$ | $\begin{aligned} & \text { CRSS } \\ & \text { CRSS } \end{aligned}$ | $\begin{aligned} & \text { 1.5 PF } \\ & \text { 1.5 PF } \end{aligned}$ | $\begin{aligned} & 1 M \\ & 1 M \end{aligned}$ |
| $\begin{aligned} & \text { MFE4007 } \\ & \text { MFE4008 } \\ & \text { MFE4009 } \\ & \text { MFE4010 } \end{aligned}$ | $M$ $M$ $M$ $M$ |  | $\begin{aligned} & \mathbf{j} \\ & \mathbf{j} \\ & \mathbf{j} \end{aligned}$ |  |  | $\begin{aligned} & 40 \\ & 40 \\ & 40 \\ & 40 \end{aligned}$ | $\begin{aligned} & .5-1 \\ & .8-1.6 \\ & 1.5-3 \\ & 2.5-5 \end{aligned}$ | $\begin{gathered} .9-2.7 \\ 1-3 \\ 1.5-3.5 \\ 2-4 \end{gathered}$ | $\begin{aligned} & 7 \\ & 7 \\ & 7 \\ & 7 \end{aligned}$ | CRSS <br> CRSS <br> CRSS <br> CRSS | $\begin{aligned} & 2 \mathrm{PF} \\ & 2 \mathrm{PF} \\ & 2 \mathrm{PF} \\ & 2 \mathrm{PF} \end{aligned}$ | $\begin{aligned} & 1 M \\ & 1 M \\ & 1 M \\ & 1 M \end{aligned}$ |
| MFELOII <br> MPF 102 <br> MPF108 <br> MFE4012 | $M$ $M$ $M$ $M$ |  | $\begin{aligned} & \mathbf{j} \\ & \mathbf{j} \\ & \mathbf{j} \end{aligned}$ |  | $\begin{aligned} & \text { 2N3819 } \\ & \text { 2N3819 } \end{aligned}$ | $\begin{aligned} & 40 \\ & 25 \\ & 25 \\ & 40 \end{aligned}$ | $\begin{array}{r} 4-8 \\ 2-20 \\ 1.5-24 \\ 7-14 \end{array}$ | $\begin{array}{r} 2.2-4.5 \\ 2-7.5 \\ 2-7.5 \\ 2.5-5 \end{array}$ | $\begin{array}{r} 7 \\ 7 \\ 6.5 \\ 7 \end{array}$ | CRSS <br> CRSS <br> CRSS <br> CRSS | $\begin{array}{r} 2 \mathrm{PF} \\ 3 \mathrm{PF} \\ 2.5 \mathrm{PF} \\ 2 \mathrm{PF} \end{array}$ | $\begin{aligned} & 1 M \\ & 1 M \\ & 1 M \\ & 1 M \end{aligned}$ |
| MMT3823 <br> MPF102 <br> MPF103 <br> MPF104 | $\begin{aligned} & M \\ & M \\ & M \\ & M \end{aligned}$ | N $\mathbf{N}$ $\mathbf{N}$ $\mathbf{N}$ | $\begin{aligned} & \mathbf{j} \\ & \mathbf{j} \\ & \mathbf{j} \\ & \mathbf{j} \end{aligned}$ | RF | 2N3823 <br> 2N3819 <br> 2N5953 <br> 2N5952 | $\begin{aligned} & 30 \\ & 25 \\ & 25 \\ & 25 \end{aligned}$ | $\begin{aligned} & 5-20 \\ & 2-20 \\ & 1-5 \\ & 2-9 \end{aligned}$ | $\begin{gathered} 3-8 \\ 2-7.5 \\ 1-5 \\ 1.5-5.5 \end{gathered}$ | $\begin{aligned} & 7 \\ & 7 \\ & 7 \\ & 7 \end{aligned}$ | $\begin{aligned} & \text { CRSS } \\ & \text { CRSS } \\ & \text { CRSS } \\ & \text { CRSS } \end{aligned}$ | $\begin{aligned} & 3 \mathrm{PF} \\ & 3 \mathrm{PF} \\ & 3 \mathrm{PF} \\ & 3 \mathrm{PF} \end{aligned}$ | $\begin{aligned} & 1 M \\ & 1 M \\ & 1 M \\ & 1 M \end{aligned}$ |
| MPF105 MPF106 MPF107 MPF108 | $\begin{aligned} & M \\ & M \\ & M \\ & M \end{aligned}$ | N $\mathbf{N}$ $\mathbf{N}$ $\mathbf{N}$ | $\begin{aligned} & \mathbf{J} \\ & \mathbf{J} \\ & \mathbf{J} \\ & \mathbf{J} \end{aligned}$ | RF | 2N5951 <br> 2N5952 <br> 2N5950 <br> 2N3819 | $\begin{aligned} & 25 \\ & 25 \\ & 25 \\ & 25 \end{aligned}$ | $\begin{array}{r} 4-16 \\ 4-10 \\ 8-20 \\ 1.5-24 \end{array}$ | $\begin{aligned} & 2-6 \\ & 2.5- \\ & 4- \\ & 2-7.5 \end{aligned}$ | $\begin{array}{r} 7 \\ 5 \\ 5 \\ 6.5 \end{array}$ | CRSS <br> CR5S <br> CRSS <br> Nf | $\begin{array}{r} \text { 3 PF } \\ \text { 1.2 PF } \\ \text { 1.2 PF } \\ \text { 2.5 } \mathrm{DB} \end{array}$ | $\begin{aligned} & 1 M \\ & 1 M \\ & 1 M \\ & 1 K \end{aligned}$ |
| MPF109 <br> MPF111 <br> MPFI 12 <br> MPF1 20 | $\begin{aligned} & M \\ & M \\ & M \\ & M \end{aligned}$ | N $\mathbf{N}$ $\mathbf{N}$ $\mathbf{N}$ | $\begin{gathered} \text { J } \\ \text { J } \\ \text { IG } \end{gathered}$ | GP <br> GP <br> RF | 2N3819 2N3819 2N3819 | $\begin{aligned} & 25 \\ & 20 \\ & 25 \\ & 25 \end{aligned}$ | $\begin{aligned} & .5-24 \\ & .5-20 \\ & 1-25 \\ & 2-18 \end{aligned}$ | $\begin{aligned} & .8-6 \\ & .5-3 \\ & 1.7 .5 \\ & 8-18 \end{aligned}$ | $\begin{array}{r} 7 \\ 4.5 \\ 4.5 \end{array}$ | $\begin{aligned} & \text { NF } \\ & \text { CRSS } \\ & \text { CRSS } \end{aligned}$ | $\begin{array}{r} 2.5 \mathrm{DB} \\ 1.5 \mathrm{PF} \\ 7 \mathrm{PF} \end{array}$ | $\begin{aligned} & 1 K \\ & 1 M \\ & 1 M \end{aligned}$ |
| MPF121 <br> MPF 122 <br> MPF161 <br> NF500 | $\left\|\begin{array}{l} M \\ M \\ M \\ \mathrm{NA} \end{array}\right\|$ |  | $\begin{aligned} & \text { IG } \\ & \text { IG } \\ & \text { J } \end{aligned}$ | GP | $\begin{aligned} & \text { 2N5462 } \\ & \text { 2N3823 } \end{aligned}$ | $\begin{aligned} & 25 \\ & 25 \\ & 40 \\ & 25 \end{aligned}$ | $\begin{array}{r} 5-30 \\ 2-20 \\ .5-14 \\ 1-30 \end{array}$ | $\begin{gathered} 10-20 \\ 8-18 \\ .8-6 \\ 2- \end{gathered}$ | $\begin{array}{r} 4.5 \\ 4.5 \\ 7 \\ 5 \end{array}$ | $\begin{gathered} \text { CRSS } \\ \text { CRSS } \\ \text { NF } \\ \text { CRSS } \end{gathered}$ | $\begin{array}{r} 6 \mathrm{PF} \\ 7 \mathrm{PF} \\ 2.5 \mathrm{DB} \\ 1.2 \mathrm{PF} \end{array}$ | $\begin{aligned} & 1 M \\ & 1 M \\ & 1 K \\ & 1 M \end{aligned}$ |
| NF501 <br> NF506 <br> NF510 <br> NF511 | $\left\|\begin{array}{l} \mathrm{NA} \\ \mathrm{NA} \\ \mathrm{NA} \\ \mathrm{NA} \end{array}\right\|$ | N N N N | $\begin{aligned} & \text { J } \\ & \text { J } \\ & \text { J } \end{aligned}$ |  | 2N3823 <br> 2N4418 <br> 2N4861 <br> 2N4861 | $\begin{aligned} & 15 \\ & 25 \\ & 30 \\ & 20 \end{aligned}$ | $\begin{aligned} & 1-30 \\ & 4-15 \\ & 5- \\ & 5 . \end{aligned}$ | $\begin{array}{r} 2- \\ 2.5 \end{array}$ | $\begin{array}{r} 5 \\ 4 \\ 20 \\ 20 \end{array}$ | $\begin{aligned} & \text { CRSS } \\ & \text { CRSS } \end{aligned}$ | $\begin{array}{r} 1.2 \mathrm{PF} \\ 1 \mathrm{PF} \end{array}$ | $\begin{aligned} & 1 M \\ & 1 M \end{aligned}$ |
| NF520 <br> NF521 <br> NF522 <br> NF523 | $\begin{array}{\|c\|} \mathrm{NA} \\ \mathrm{NA} \\ \mathrm{NA} \\ \mathrm{NA} \end{array}$ | $\begin{aligned} & \mathbf{N} \\ & \mathbf{N} \\ & \mathbf{N} \\ & \mathbf{N} \end{aligned}$ | $J$ $J$ $J$ |  | $\begin{aligned} & \text { 2N3822 } \\ & \text { 2N3821 } \\ & \text { 2N3822 } \\ & \text { 2N3821 } \\ & \hline \end{aligned}$ | $\begin{aligned} & 30 \\ & 30 \\ & 20 \\ & 20 \end{aligned}$ | $\begin{aligned} & 1-10 \\ & .1-2 \\ & 1-10 \\ & .1-2 \end{aligned}$ | . 5 - <br> .4 <br> .5- <br> .4 |  |  |  |  |

## TRANSISTOR INTERCHANGEABILITY <br> NONREGISTERED FIELD-EFFECT TRANSISTORS

| TYPE NUMEER | $\qquad$ |  |  | $\begin{aligned} & \frac{3}{6} \\ & \frac{2}{3} \\ & \frac{8}{3} \\ & \frac{1}{3} \\ & 3 \end{aligned}$ | II <br> REPLACEMENT OR NEAREST EQUVVALENT | RATED DRAINGATE VOLTAGE(V) | EIECTRICAL CHARACTERISTICS |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  | IDSS ${ }^{1} \mathrm{D}\left(\mathrm{~m}_{1}\right)$ |  |  | lyad | $c_{\text {iss }}$ <br> max <br> (pF) | OTHER PARAMETER |  |  |
|  |  |  |  | $\left\|\begin{array}{ll} \text { MIN } & \text { MAX } \\ (\mathrm{mA}) & (\mathrm{mA}) \end{array}\right\|$ |  |  | MIN MAX <br> (mmho) (mmho) |  | SYMBCOL | MAX | $\begin{aligned} & f \\ & (\mathrm{~Hz}) \end{aligned}$ |
| NF530 <br> NF531 <br> NF532 <br> NF533 | $\left.\begin{array}{l\|l} \mathrm{NA} \\ \mathrm{NA} \\ \mathrm{NA} \\ \mathrm{NA} \end{array} \right\rvert\,$ | N $\mathbf{N}$ N N | $\begin{aligned} & \mathbf{J} \\ & \mathbf{J} \\ & \mathbf{J} \\ & \mathbf{J} \end{aligned}$ |  |  | $\begin{aligned} & \text { 2N3459 } \\ & \text { 2N3460 } \\ & \text { 2N3459 } \\ & \text { 2N3460 } \end{aligned}$ | $\begin{aligned} & 30 \\ & 30 \\ & 20 \\ & 20 \end{aligned}$ | $\begin{aligned} & 1-10 \\ & .1-2 \\ & 1-10 \\ & .1-2 \end{aligned}$ | $\begin{aligned} & .5 \\ & .4- \\ & .5 \\ & .4 \end{aligned}$ |  |  |  |  |
| NF580 <br> NF581 <br> NF582 <br> NF583 | $\left\|\begin{array}{l} \mathrm{NA} \\ \mathrm{NA} \\ \mathrm{NA} \\ \mathrm{NA} \end{array}\right\|$ | $N$ $N$ $N$ $N$ | $\begin{aligned} & \text { J } \\ & \text { J } \\ & \text { J } \end{aligned}$ |  |  |  | $\begin{aligned} & 25 \\ & 25 \\ & 25 \\ & 25 \end{aligned}$ |  |  | $\begin{aligned} & \mathbf{2 5} \\ & \mathbf{2 5} \\ & \mathbf{2 5} \\ & \mathbf{2 5} \end{aligned}$ | CRSS <br> CRSS <br> CRSS <br> CRSS | $\begin{aligned} & 13 \mathrm{PF} \\ & 13 \mathrm{PF} \\ & 13 \mathrm{PF} \\ & 13 \mathrm{PF} \end{aligned}$ | $\begin{aligned} & 1 M \\ & 1 M \\ & 1 M \\ & 1 M \end{aligned}$ |
| NF584 <br> NF585 <br> NF4445 <br> NF4446 | $\left\|\begin{array}{l} N A \\ N A \\ N A \\ N A \end{array}\right\|$ | $N$ $N$ $N$ $N$ | $\begin{aligned} & \mathbf{J} \\ & \mathbf{J} \\ & \mathbf{J} \\ & \mathbf{J} \end{aligned}$ |  |  | $\begin{aligned} & 15 \\ & 15 \\ & 25 \\ & 25 \end{aligned}$ | $\begin{aligned} & 150 \\ & 100 \end{aligned}$ |  | $\begin{aligned} & 25 \\ & 25 \\ & 50 \\ & 50 \end{aligned}$ | CRSS CRSS CRSS CRSS | $\begin{aligned} & 13 \mathrm{PF} \\ & 13 \mathrm{PF} \\ & 25 \mathrm{PF} \\ & 25 \mathrm{PF} \end{aligned}$ | $\begin{aligned} & 1 M \\ & 1 M \\ & 1 M \\ & 1 M \end{aligned}$ |
| NF4447 <br> NF4448 <br> NF5457 <br> NF5458 | $\left\|\begin{array}{l} N A \\ N A \\ N A \\ N A \end{array}\right\|$ |  | $\begin{aligned} & \mathbf{j} \\ & \mathbf{j} \\ & \mathbf{j} \\ & \mathbf{j} \end{aligned}$ |  | $\begin{aligned} & \text { 2N3459 } \\ & \text { 2N3459 } \end{aligned}$ | $\begin{aligned} & 20 \\ & 20 \\ & 25 \\ & 25 \end{aligned}$ | $\begin{aligned} & 150- \\ & 100- \\ & 1-5 \\ & 2-9 \end{aligned}$ | $\begin{gathered} 1-5 \\ 1.5-5.5 \end{gathered}$ | $\begin{array}{r} 50 \\ 50 \\ 7 \\ 7 \end{array}$ | CRSS CRSS CRSS CRSS | $\begin{array}{r} 25 \mathrm{PF} \\ 25 \mathrm{PF} \\ 3 \mathrm{PF} \\ 3 \mathrm{PF} \end{array}$ | $\begin{aligned} & 1 M \\ & 1 M \\ & 1 M \\ & 1 M \end{aligned}$ |
| NF5459 <br> NF5485 <br> NF5486 <br> NF5555 | $\begin{aligned} & \text { NA } \\ & \text { NA } \\ & \text { NA } \\ & N A \end{aligned}$ | $N$ $\mathbf{N}$ $\mathbf{N}$ $\mathbf{N}$ | $\begin{aligned} & \mathbf{j} \\ & \mathbf{j} \\ & \mathbf{j} \\ & \mathbf{j} \end{aligned}$ |  | 2N3458 <br> 2N4416 <br> 2N4416 | $\begin{aligned} & 25 \\ & 25 \\ & 25 \\ & 25 \end{aligned}$ | $\begin{array}{r} 4-16 \\ 4-10 \\ 8-20 \\ 15- \end{array}$ | $\begin{gathered} 2-6 \\ 3- \\ 3.5- \end{gathered}$ | $\begin{aligned} & 7 \\ & 5 \\ & 5 \\ & 5 \end{aligned}$ | $\begin{aligned} & \text { CRSS } \\ & \text { CRSS } \\ & \text { CRSS } \\ & \text { CRSS } \end{aligned}$ | $\begin{array}{r} 3 \mathrm{PF} \\ 1 \mathrm{PF} \\ 1 \mathrm{PF} \\ 1.2 \mathrm{PF} \end{array}$ | $\begin{aligned} & 1 M \\ & 1 M \\ & 1 M \\ & 1 M \end{aligned}$ |
| $\begin{array}{\|l\|} \mathbf{N F 5 6 3 8} \\ \text { NF5639 } \\ \text { NF5640 } \\ \text { NF5653 } \end{array}$ | $\begin{aligned} & \mathrm{NA} \\ & \mathrm{NA} \\ & \mathrm{NA} \\ & \mathrm{NA} \end{aligned}$ | $N$ $N$ $N$ $N$ | $\begin{aligned} & \mathrm{J} \\ & \mathrm{~J} \\ & \mathrm{~J} \\ & \mathrm{~J} \end{aligned}$ |  | $\begin{aligned} & \text { 2N4391 } \\ & \text { 2N4392 } \\ & \text { 2N4393 } \\ & \text { 2N4856 } \end{aligned}$ | $\begin{aligned} & 30 \\ & 30 \\ & 30 \\ & 30 \end{aligned}$ | $\begin{array}{r} 50 \\ 25- \\ 5- \\ 40 \end{array}$ |  | $\begin{aligned} & 10 \\ & 10 \\ & 10 \\ & 10 \end{aligned}$ | CRSS <br> CRSS <br> CRSS <br> CRSS | $\begin{array}{r} 4 \mathrm{PF} \\ 4 \mathrm{PF} \\ 4 \mathrm{PF} \\ 3.5 \mathrm{PF} \end{array}$ | $\begin{aligned} & 1 M \\ & 1 M \\ & 1 M \\ & 1 M \end{aligned}$ |
| $\begin{aligned} & \text { NFS654 } \\ & \text { SU2028 } \\ & \text { SU2029 } \\ & \text { SU2031 } \end{aligned}$ | $\begin{aligned} & \mathbf{N} \mathbf{n} \\ & \mathbf{N} \\ & \mathbf{N} \\ & \mathbf{N} \\ & \mathbf{N} \end{aligned}$ | $\begin{aligned} & N \\ & N \\ & N \\ & N \end{aligned}$ | $\begin{aligned} & \mathbf{J} \\ & \mathbf{J} \\ & \mathbf{J} \\ & \mathbf{J} \end{aligned}$ |  | 2N4857 | $\begin{aligned} & 30 \\ & 50 \\ & 50 \\ & 50 \end{aligned}$ | $\begin{aligned} & 15- \\ & .25-1.3 \\ & .8-3 \\ & .8-3 \end{aligned}$ | $\begin{aligned} & .3- \\ & .4 \\ & \hline \end{aligned}$ | 10 | CRSS | 3.5 PF | 1 M |
| $\begin{aligned} & \text { SU2032 } \\ & \text { SU2033 } \\ & \text { SU2034 } \\ & \text { SU2035 } \end{aligned}$ | N IN N N IN | N $\mathbf{N}$ $\mathbf{N}$ $\mathbf{N}$ | $\begin{aligned} & \mathbf{J} \\ & \mathbf{J} \\ & \mathbf{J} \\ & \mathbf{j} \end{aligned}$ |  | 2N5545 <br> 2N5545 <br> 2N5547 <br> 2N5547 | $\begin{aligned} & 50 \\ & 50 \\ & 50 \\ & 50 \end{aligned}$ | $\begin{aligned} & 1-10 \\ & 5-20 \\ & 1-10 \\ & 5-20 \end{aligned}$ | $\begin{aligned} & 1.5- \\ & 2.5- \\ & 1.5- \\ & 2.5- \end{aligned}$ |  |  |  |  |
| $\begin{aligned} & \text { SU2098 } \\ & \text { SU2098A } \\ & \text { SU2098B } \\ & \text { SU2099 } \end{aligned}$ | IN | $\begin{aligned} & \mathrm{N} \\ & \mathrm{~N} \\ & \mathrm{~N} \\ & \mathrm{~N} \end{aligned}$ | $\begin{aligned} & \mathbf{J} \\ & \mathbf{J} \\ & \mathbf{J} \\ & \mathbf{J} \end{aligned}$ |  | 2N5545 2N5545 <br> 2N5547 | $\begin{aligned} & 30 \\ & 50 \\ & 50 \\ & 30 \end{aligned}$ | $\begin{aligned} & 1-8 \\ & 1-8 \\ & 1-8 \\ & 1-8 \end{aligned}$ | $\begin{array}{r} 1- \\ 1.5 \\ 1.5- \\ 1 \end{array}$ |  |  |  |  |
| SU2099A <br> 5X3819 <br> 5X3820 <br> TIS 14 | $\begin{aligned} & \mathrm{IN} \\ & \mathrm{TI} \\ & \mathrm{TI} \\ & \mathrm{TI} \end{aligned}$ | N $\mathbf{N}$ $\mathbf{P}$ $\mathbf{N}$ | $\begin{aligned} & \mathrm{J} \\ & \mathrm{~J} \\ & \mathrm{~J} \\ & \mathrm{~J} \end{aligned}$ | AF | 2N5547 <br> 2N5949/53 <br> A5T5460/62 <br> TIS14 | $\begin{aligned} & 50 \\ & 25 \\ & 20 \\ & 30 \end{aligned}$ | $\begin{aligned} & 1-8 \\ & 2-20 \\ & .3-15 \\ & .5-15 \end{aligned}$ | $\begin{aligned} & 1.5- \\ & 2-6.5 \\ & .8-5 \\ & 1-7.5 \end{aligned}$ | $\begin{array}{r}8 \\ 32 \\ 8 \\ \hline\end{array}$ | $\begin{aligned} & \text { CRSS } \\ & \text { CRSS } \\ & \text { CRSS } \\ & \hline \end{aligned}$ | $\begin{array}{r} 4 \mathrm{PF} \\ 16 \mathrm{PF} \\ 4 \mathrm{PF} \end{array}$ | $\begin{aligned} & 1 \mathrm{M} \\ & 1 \mathrm{M} \\ & 1 \mathrm{M} \end{aligned}$ |

## TRANSISTOR INTERCHANGEABILITY NONREGISTERED FIELD-EFFECT TRANSISTORS

| TYPE NUMEER |  | $\left\lvert\, \begin{array}{ll} \frac{2}{2} & E \\ \frac{3}{3} & E \\ 2 & 3 \end{array}\right.$ |  | 7853333 | $\begin{gathered} \text { II } \\ \text { RERACEMENT } \\ \text { OR NEAREST } \\ \text { ECUNALENT } \end{gathered}$ | RATED DRAN GATE VOLTAGE <br> (V) | EECTRICAL CHARACTEASIICS |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  | loss ${ }^{-10}\left(e_{n}\right)$ |  |  | bral | Cite <br> max <br> ( PF ) | OHTE PARAMETER |  |  |
|  |  |  |  | $\begin{array}{ll} \operatorname{MIN} & M A X \\ (\mathrm{~mA}) & (\mathrm{mA}) \end{array}$ |  |  | $\begin{array}{\|cl\|} \text { MWN } & \text { MNX } \\ \text { (nomblo) } & \text { (manho) } \\ \hline \end{array}$ |  | SYMEOL |  |  |
| $\begin{aligned} & \text { TIS25 } \\ & \text { TIS26 } \\ & \text { TIS27 } \\ & \text { TIS34 } \end{aligned}$ | $\begin{aligned} & \pi \\ & \pi \\ & \pi \\ & \pi \end{aligned}$ | $N$ $N$ $N$ $N$ $N$ | $\begin{aligned} & \mathbf{J} \\ & \mathbf{j} \\ & \mathbf{j} \\ & \mathbf{j} \end{aligned}$ |  | RF | T1525 <br> 7526 <br> TIS27 <br> 2N5248 | $\begin{aligned} & 30 \\ & 30 \\ & 30 \\ & 30 \end{aligned}$ | $\begin{aligned} & .5-8 \\ & .5-8 \\ & .5-8 \\ & 4-20 \end{aligned}$ | $\begin{array}{r} 2-6.5 \\ 2-6.5 \\ 2-6.5 \\ 3.5-6.5 \end{array}$ | $\begin{aligned} & 6 \\ & 6 \\ & 6 \\ & 6 \end{aligned}$ | CRSS <br> CRSS <br> Cass <br> CRSS | $\begin{aligned} & 2 \mathrm{PF} \\ & 2 \mathrm{PF} \\ & 2 \mathrm{PF} \\ & 2 \mathrm{PF} \end{aligned}$ | $\begin{aligned} & 1 M \\ & 1 M \\ & 1 M \\ & 1 M \end{aligned}$ |
| $\begin{aligned} & \text { TIS42 } \\ & \text { TIS58 } \\ & \text { TIS59 } \\ & \text { TS67 } \end{aligned}$ | $\begin{aligned} & \pi \\ & n \\ & \pi \\ & \pi \\ & \pi \end{aligned}$ | N $\mathbf{N}$ $\mathbf{N}$ $\mathbf{P}$ | $\begin{aligned} & \mathbf{J} \\ & \mathbf{J} \\ & \mathbf{J} \\ & \mathbf{J} \end{aligned}$ |  | SW <br> GP <br> GP <br> GP | $\begin{aligned} & \text { n575 } \\ & \text { 2N5952/53 } \\ & \text { 2N5949/51 } \end{aligned}$ | $\begin{aligned} & 25 \\ & 25 \\ & 25 \\ & 25 \end{aligned}$ | $\begin{aligned} & 10- \\ & 2.5-8 \\ & 6-25 \\ & * 40-120 \end{aligned}$ | $\begin{aligned} & 1.3-4 \\ & 2.5-5 \\ & 3.5-6.5 \end{aligned}$ | $\begin{array}{r} 18 \\ 6 \\ 6 \\ 10 \end{array}$ | CRSS <br> CRSS <br> CRSS <br> CRSS | $\begin{aligned} & 9 \mathrm{PF} \\ & 3 \mathrm{PF} \\ & 3 \mathrm{PF} \\ & 4 \mathrm{PF} \end{aligned}$ | $\begin{aligned} & 1 M \\ & 1 M \\ & 1 M \\ & 1 M \end{aligned}$ |
| TIS68 <br> TIS69 <br> TE570 <br> TIS73 | $\begin{aligned} & \pi \\ & \pi \\ & \pi \\ & \pi \end{aligned}$ | $N$ $N$ $N$ $N$ $N$ | $\left.\begin{aligned} & \mathbf{J} \\ & \mathbf{J} \\ & \mathbf{J} \\ & \mathbf{J} \end{aligned} \right\rvert\,$ | GP GP GP SW | TIS69 <br> TIS69 <br> TIS70 <br> 71573 | $\begin{aligned} & 25 \\ & 25 \\ & 25 \\ & 30 \end{aligned}$ | $\begin{aligned} & .5-8 \\ & .5-8 \\ & .5-8 \\ & 50- \end{aligned}$ | $\begin{aligned} & 1.6 \\ & 1.6 \\ & 1.6 \end{aligned}$ | $\begin{array}{r} 8 \\ 8 \\ 8 \\ 18 \end{array}$ | CRSS <br> CRSS <br> CRSS <br> CRSS | $\begin{aligned} & 4 \mathrm{PF} \\ & 4 \mathrm{PF} \\ & 4 \mathrm{PF} \\ & 8 \mathrm{PF} \end{aligned}$ | $\begin{aligned} & 1 M \\ & 1 M \\ & 1 M \\ & 1 M \end{aligned}$ |
| T1574 <br> TIS75 <br> TIS78 <br> T1579 | TI | $\mathbf{N}$ $\mathbf{N}$ $\mathbf{N}$ $\mathbf{N}$ | $\begin{aligned} & \mathbf{J} \\ & \mathbf{J} \\ & \mathbf{J} \\ & \mathbf{J} \end{aligned}$ | $\begin{aligned} & S W \\ & H V \\ & H V \end{aligned}$ | $\begin{aligned} & \text { TIS74 } \\ & \text { TIS75 } \\ & \text { A5T6449 } \\ & \text { AST6450 } \end{aligned}$ | $\begin{array}{r} 30 \\ 30 \\ 300 \\ 200 \end{array}$ | $\begin{gathered} 20-100 \\ 8-80 \\ 2-10 \\ 2-10 \end{gathered}$ | $\begin{aligned} & .75-3 \\ & .75-3 \end{aligned}$ | $\begin{aligned} & 18 \\ & 18 \\ & 15 \\ & 15 \end{aligned}$ | CRSS <br> CRSS <br> CRSS <br> CRSS | $\begin{aligned} & 8 \mathrm{PF} \\ & 8 \mathrm{PF} \\ & 3 \mathrm{PF} \\ & 3 \mathrm{PF} \end{aligned}$ | $\begin{aligned} & 1 M \\ & 1 M \\ & 1 M \\ & 1 M \end{aligned}$ |
| 71588 <br> U110 <br> U112 <br> U146 | $\left\lvert\, \begin{array}{l\|} 71 \\ S I \\ S I \\ S I \end{array}\right.$ | $\begin{aligned} & \mathbf{N} \\ & \mathbf{P} \\ & \mathbf{P} \\ & \mathbf{P} \end{aligned}$ | $\begin{aligned} & \mathrm{J} \\ & \mathrm{~J} \\ & \mathrm{~J} \\ & \mathrm{~J} \end{aligned}$ | RF | T1588 | $\begin{aligned} & 30 \\ & 20 \\ & 20 \\ & 20 \end{aligned}$ | $\begin{gathered} 5-15 \\ .1-1 \\ .9-9 \\ 025- \end{gathered}$ | $\begin{gathered} 4.5-7.5 \\ .11- \\ 1- \\ .06- \end{gathered}$ | $\begin{array}{r} 4.5 \\ 6 \\ 17 \\ 6 \end{array}$ | NF | 2 D8 | 100\% |
| U147 <br> U148 <br> U149 <br> U133 | $\left\lvert\, \begin{aligned} & \mathbf{S I} \\ & \mathbf{S I} \\ & \mathbf{S I} \\ & \mathbf{S I} \end{aligned}\right.$ | $\begin{aligned} & \mathbf{P} \\ & \mathbf{P} \\ & \mathbf{P} \\ & \mathbf{P} \end{aligned}$ | $\begin{aligned} & \mathbf{J} \\ & \mathbf{J} \\ & \mathbf{J} \\ & \mathbf{J} \end{aligned}$ |  |  | $\begin{aligned} & 20 \\ & 20 \\ & 20 \\ & 50 \end{aligned}$ | $\begin{aligned} & 065- \\ & .2 . \\ & .44 \\ & .3-1.5 \end{aligned}$ | $\begin{aligned} & .18 \\ & .54 \\ & 1.4 \\ & .33 \end{aligned}$ | $\begin{aligned} & 10 \\ & 17 \\ & 30 \\ & 10 \end{aligned}$ |  |  |  |
| U168 <br> U182 <br> U183 <br> U184 | SI <br> IN <br> SI <br> SI <br>  | $P$ $N$ $\mathbf{N}$ $\mathbf{N}$ | $\begin{aligned} & \text { J } \\ & \text { J } \\ & \mathbf{J} \\ & \text { J } \end{aligned}$ |  | $\begin{aligned} & \text { 2N2608 } \\ & \text { 2N4860 } \\ & \text { 2N3458 } \\ & \text { 2N4416 } \end{aligned}$ | $\begin{aligned} & 20 \\ & 40 \\ & 25 \\ & 25 \end{aligned}$ | $\begin{aligned} & .6-6 \\ & 40-120 \\ & 2-20 \\ & 3-30 \end{aligned}$ | .8- <br> 1.6-3-8.5 | $\begin{array}{r} 65 \\ 20 \\ 8 \\ 4 \end{array}$ | $\begin{aligned} & \text { CRSS } \\ & \text { CRSS } \\ & \text { CR5S } \end{aligned}$ | $\begin{aligned} & 6 \mathrm{PF} \\ & 4 \mathrm{PF} \\ & 1 \mathrm{PF} \end{aligned}$ | $\begin{aligned} & 1 M \\ & 1 M \\ & 1 M \end{aligned}$ |
| U197 <br> U198 <br> U199 <br> U200 | SI SI SI SI | $\begin{aligned} & \mathbf{N} \\ & \mathbf{N} \\ & \mathbf{N} \\ & \mathbf{N} \end{aligned}$ | $\begin{aligned} & \mathbf{J} \\ & \mathbf{J} \\ & \mathbf{J} \\ & \mathbf{j} \end{aligned}$ |  | $\begin{aligned} & \text { 2N3460 } \\ & \text { 2N3459 } \\ & \text { 2N3458 } \\ & \text { 2N5549 } \end{aligned}$ | $\begin{aligned} & 30 \\ & 30 \\ & 30 \\ & 30 \end{aligned}$ | $\begin{aligned} & .1-1 \\ & .6-6 \\ & .3-20 \\ & 3-25 \end{aligned}$ | $\begin{array}{r} .2 \\ .6 \\ 1.5 \end{array}$ | $\begin{array}{r} 7 \\ 7 \\ 7 \\ 30 \end{array}$ | CRSS | 8 PF | 1 M |
| U201 <br> U202 <br> U221 <br> U222 | $\left\lvert\, \begin{aligned} & \mathbf{S I} \\ & \mathbf{S I} \\ & \mathbf{S I} \\ & \mathbf{S I} \end{aligned}\right.$ | $\begin{aligned} & \mathbf{N} \\ & \mathbf{N} \\ & \mathbf{N} \\ & \mathbf{N} \end{aligned}$ | $\begin{aligned} & \mathbf{j} \\ & \mathbf{j} \\ & \mathbf{j} \\ & \mathbf{j} \end{aligned}$ |  | 2N4861 <br> 2N4860 | $\begin{aligned} & 30 \\ & 30 \\ & 50 \\ & 50 \end{aligned}$ | $\begin{array}{r} 15-75 \\ 30-150 \\ 50-110 \\ 100-250 \end{array}$ | $\begin{aligned} & 15-40 \\ & 20-50 \end{aligned}$ | $\begin{aligned} & 30 \\ & 30 \\ & 28 \\ & 28 \end{aligned}$ | CRSS <br> CRSS <br> CRSS <br> CRSS | $\begin{aligned} & 8 \mathrm{PF} \\ & 8 \mathrm{PF} \\ & 7 \mathrm{PF} \\ & 7 \mathrm{PF} \end{aligned}$ | $\begin{aligned} & 1 M \\ & 1 M \\ & 1 M \\ & 1 M \end{aligned}$ |
| $\begin{aligned} & \mathbf{U} 231 \\ & \text { U232 } \\ & \text { U233 } \\ & \text { U234 } \end{aligned}$ | $\begin{aligned} & \mathbb{N} \\ & \mathbb{N} \\ & \mathbb{N} \\ & \mathbb{N} \\ & \mathbf{N} \end{aligned}$ | $\begin{aligned} & \mathbf{N} \\ & \mathbf{N} \\ & \mathbf{N} \\ & \mathbf{N} \end{aligned}$ | $\begin{aligned} & \mathbf{j} \\ & \mathbf{j} \\ & \mathbf{j} \\ & \mathbf{j} \\ & \hline \end{aligned}$ |  | $\begin{aligned} & \text { 2N5545 } \\ & \text { 2N5546 } \\ & \text { 2N5547 } \\ & \text { 2N5547 } \end{aligned}$ | $\begin{aligned} & 50 \\ & 50 \\ & 50 \\ & 50 \end{aligned}$ | $\begin{aligned} & .5-5 \\ & .5-5 \\ & .5-5 \\ & .5-5 \\ & \hline \end{aligned}$ | $\begin{aligned} & 1 . \\ & 1 . \\ & 1 . \\ & 1 . \end{aligned}$ |  |  |  |  |

## TRANSISTOR INTERCHANGEABILITY <br> NONREGISTERED FIELD-EFFECT TRANSISTORS

| TYPE NUMBER |  |  | CLASSIFICATION | $\pi$ REPLACEMENT OR NEAREST EQUIVALENT | RATED DRANF GATE VOLTACE | EECTRICAL CHARACTERISTICS |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  |  | $\begin{gathered} \text { ldss } \\ \text { *ID(on) } \end{gathered}$ | \|yat | $C_{\text {iss }}$ | OTHER PARAMTEER |  |  |
|  |  |  |  |  |  | $\begin{array}{\|ll\|} \hline \text { MiN } & \text { MAX } \\ (\mathrm{mA}) & (\mathrm{mA}) \\ \hline \end{array}$ | MIN MAX <br> (mmho) (mmho) | MAX <br> (pF) | SYMEOL | MAX | - 1 <br> ( Hz ) |
| $\begin{aligned} & \text { U235 } \\ & \text { U240 } \\ & \text { U241 } \\ & \text { U242 } \end{aligned}$ | $\left\lvert\, \begin{aligned} & \mathbf{N} \\ & \text { SI } \\ & \text { SI } \\ & \text { SI } \end{aligned}\right.$ | $\begin{array}{ll} \mathbf{N} & J \\ \mathbf{N} & J \\ \mathbf{N} & J \\ \mathbf{N} & J \end{array}$ |  | 2N5045 | $\begin{aligned} & 50 \\ & 25 \\ & 25 \\ & 20 \end{aligned}$ | $\begin{aligned} & .5-5 \\ & 150- \\ & 10 \\ & 150- \end{aligned}$ | 1 - | $\begin{aligned} & 70 \\ & 70 \\ & 70 \end{aligned}$ | $\begin{aligned} & \text { CRSS } \\ & \text { CRSS } \\ & \text { CRSS } \end{aligned}$ | 35 PF 35 PF <br> 35 PF | $\begin{aligned} & 1 M \\ & 1 M \\ & 1 M \end{aligned}$ |
| U243 <br> U248 <br> U248A <br> U249 | SI <br> IN <br> $\mathbb{N}$ <br> IN | $\left[\begin{array}{ll} \mathbf{N} & J \\ \mathbf{N} & J \\ \mathbf{N} & J \\ \mathbf{N} & J \end{array}\right.$ |  |  | $\begin{aligned} & 20 \\ & 40 \\ & 40 \\ & 40 \end{aligned}$ | $\begin{aligned} & 100 \\ & .03-5 \\ & .03-.5 \\ & .03-.5 \end{aligned}$ |  | 70 | CRSS | 35 PF | 1 M |
| U249A <br> U250 <br> U250A <br> U251 | $\left\lvert\, \begin{aligned} & \operatorname{IN} \\ & \mathbb{N} \\ & \mathbb{N} \\ & \mathbb{N} \end{aligned}\right.$ | $\left(\begin{array}{ll} \mathbf{N} & J \\ \mathbf{N} & J \\ \mathbf{N} & J \\ \mathbf{N} & J \end{array}\right.$ |  |  | $\begin{aligned} & 40 \\ & 40 \\ & 40 \\ & 40 \end{aligned}$ | $\begin{aligned} & .03-.5 \\ & .03-.5 \\ & .03-.5 \\ & .03-.5 \end{aligned}$ |  |  |  |  |  |
| U251A <br> U252 <br> U253 <br> U254 | IN | $\left\lvert\, \begin{array}{ll} N & J \\ N & J \\ N & J \\ N & J \end{array}\right.$ |  | 2N4859 | $\begin{aligned} & 40 \\ & 25 \\ & 25 \\ & 30 \end{aligned}$ | $\begin{array}{r} .03-.5 \\ 7-40 \\ 7-40 \\ 50- \end{array}$ | $\begin{aligned} & 5-10 \\ & 5-10 \end{aligned}$ | 18 | $\begin{aligned} & \text { CRSS } \\ & \text { CRSS } \\ & \text { CRSS } \end{aligned}$ | $\begin{array}{r} 1.2 \mathrm{PF} \\ 1.2 \mathrm{PF} \\ 8 \mathrm{PF} \end{array}$ | $\begin{aligned} & 1 M \\ & 1 M \\ & 1 M \end{aligned}$ |
| $\begin{aligned} & \mathrm{U} 255 \\ & \mathrm{U} 256 \\ & \mathrm{U} 257 \\ & \mathrm{U} 273 \end{aligned}$ | IN | $\begin{array}{ll}N & J \\ N & J \\ N & J \\ N & J\end{array}$ |  |  | $\begin{aligned} & 30 \\ & 30 \\ & 25 \\ & 30 \end{aligned}$ | $\begin{gathered} 20-100 \\ 8-80 \\ 5-40 \\ .5-2 \end{gathered}$ | $\begin{aligned} & 5-10 \\ & .5- \end{aligned}$ | $\begin{array}{r} 18 \\ 18 \\ 2 \end{array}$ | CRSS CRSS CRSS CRSS | $\begin{array}{r} 8 \mathrm{PF} \\ 8 \mathrm{PF} \\ 1.2 \mathrm{PF} \\ .5 \mathrm{PF} \end{array}$ | $\begin{aligned} & 1 M \\ & 1 M \\ & 1 M \\ & 1 M \end{aligned}$ |
| U273A <br> U274 <br> U274A <br> U275 | SI | $\begin{array}{ll}N & J \\ N & J \\ N & J \\ N & J\end{array}$ |  |  | $\begin{aligned} & 30 \\ & 30 \\ & 30 \\ & 30 \end{aligned}$ | $\begin{aligned} & .5-2 \\ & 1-4 \\ & 1-4 \\ & 3-6.5 \end{aligned}$ | $\begin{aligned} & .5 \\ & .6 \\ & .6 \\ & .8 \end{aligned}$ | $\begin{aligned} & 2 \\ & 2 \\ & 2 \\ & 2 \end{aligned}$ | CRSS CRSS CRSS CRSS | $\begin{aligned} & .5 \mathrm{PF} \\ & .5 \mathrm{PF} \\ & .5 \mathrm{PF} \\ & .5 \mathrm{PF} \end{aligned}$ | $\begin{aligned} & 1 M \\ & 1 M \\ & 1 M \\ & 1 M \end{aligned}$ |
| U275A <br> U280 <br> U281 <br> U282 | SI | $\left\lvert\, \begin{array}{ll} N & J \\ N & J \\ N & J \\ N & J \end{array}\right.$ |  |  | $\begin{aligned} & 30 \\ & 50 \\ & 50 \\ & 50 \end{aligned}$ | $\begin{aligned} & 3-6.5 \\ & .5-6 \\ & .5-6 \\ & .5-6 \end{aligned}$ | $\begin{aligned} & .8 . \\ & 1-3 \\ & 1.3 \\ & 1-3 \end{aligned}$ | $\begin{aligned} & 2 \\ & 6 \\ & 6 \\ & 6 \end{aligned}$ | CRSS <br> CRSS <br> CRSS <br> CRSS | $\begin{aligned} & .5 \mathrm{PF} \\ & 1.7 \mathrm{PF} \\ & 1.7 \mathrm{PF} \\ & 1.7 \mathrm{PF} \end{aligned}$ | $\begin{aligned} & 1 M \\ & 1 M \\ & 1 M \\ & 1 M \end{aligned}$ |
| U283 <br> U284 <br> U285 <br> U290 | SI | $\left\lvert\, \begin{array}{ll} \mathbf{N} & J \\ \mathbf{N} & J \\ \mathbf{N} & J \\ \mathbf{N} & J \end{array}\right.$ |  |  | $\begin{aligned} & 50 \\ & 50 \\ & 50 \\ & 30 \end{aligned}$ | $\begin{array}{r} .5-6 \\ .5-6 \\ .5-6 \\ 500- \end{array}$ | $\begin{aligned} & 1-3 \\ & 1-3 \\ & 1-3 \end{aligned}$ | $\begin{aligned} & 6 \\ & 6 \\ & 6 \end{aligned}$ | CRSS <br> CRSS <br> CRSS <br> CRSS | 1.7 PF <br> 1.7 PF <br> 1.7 PF <br> 30 PF | $1 M$ $1 M$ $1 M$ $1 M$ |
| U291 <br> U300 <br> U301 <br> U304 | SI | $\begin{array}{ll}N & J \\ P & J \\ P & J \\ P & J\end{array}$ |  |  | $\begin{aligned} & 30 \\ & 40 \\ & 40 \\ & 30 \end{aligned}$ | $\begin{aligned} & 200 . \\ & 30-90 \\ & 15-60 \\ & 30-90 \end{aligned}$ | $\begin{aligned} & 8-12 \\ & 8-12 \end{aligned}$ | $\begin{aligned} & 20 \\ & 20 \\ & 27 \end{aligned}$ | CRSS <br> CRSS <br> CRSS <br> CRSS | $\begin{aligned} & 30 \mathrm{PF} \\ & \text { 5.5 PF } \\ & \text { 5.5 PF } \\ & 7 \mathrm{PF} \end{aligned}$ | $\begin{aligned} & 1 M \\ & 1 M \\ & 1 M \\ & 1 M \end{aligned}$ |
| $\left\lvert\, \begin{aligned} & \text { U305 } \\ & \text { U306 } \\ & \text { U310 } \\ & \text { U312 } \end{aligned}\right.$ | $\begin{aligned} & \text { SI } \\ & \hline \mathbf{S I} \\ & \mathbf{S I} \\ & \mathbf{S I} \\ & \hline \end{aligned}$ | $\begin{array}{ll} P & J \\ \mathbf{P} & J \\ N & J \\ N & J \end{array}$ |  | $\begin{aligned} & \text { 2N5549 } \\ & \text { 2N5397 } \end{aligned}$ | $\begin{aligned} & 30 \\ & 30 \\ & 25 \\ & \mathbf{2 5} \end{aligned}$ | $\begin{array}{r} 15-60 \\ 5-25 \\ 20-60 \\ 10-30 \end{array}$ | $\begin{array}{r} 10-20 \\ 6-10 \\ \hline \end{array}$ | $\begin{aligned} & 27 \\ & 27 \end{aligned}$ | CRSS <br> CRSS <br> CRSS <br> CRSS | $\begin{array}{r} 7 \mathrm{PF} \\ 7 \mathrm{PF} \\ 2.5 \mathrm{PF} \\ 1.2 \mathrm{PF} \\ \hline \end{array}$ | $\begin{aligned} & 1 M \\ & 1 M \\ & 1 M \\ & 1 M \end{aligned}$ |

## TRANSISTOR INTERCHANGEABILITY NONREGISTERED FIELD－EFFECT TRANSISTORS

\begin{tabular}{|c|c|c|c|c|c|c|c|c|c|c|c|c|}
\hline \multirow{3}{*}{TYF Numen} \& \multirow{3}{*}{} \& \multicolumn{2}{|l|}{\multirow{3}{*}{}} \& \multirow{3}{*}{\[
\begin{aligned}
\& 8 \\
\& 8 \\
\& 8 \\
\& 3 \\
\& 8 \\
\& 8
\end{aligned}
\]} \& \multirow{3}{*}{\begin{tabular}{l}
\(\pi\) \\
mpacemmit \\
On NEAKLSt EOUVALENT
\end{tabular}} \& \multirow[b]{3}{*}{LATB DRAMN GATE VOLTAEE
\[
(\mathrm{V})
\]} \& \multicolumn{6}{|c|}{} \\
\hline \& \& \& \& \& \& \& toss
*O(on) \& bed \& \(G_{10 x}\) \& OH \& ni PaRa \& TER \\
\hline \& \& \& \& \& \& \& \[
\begin{array}{|ll|}
\hline \text { MAN } \& \text { MAX } \\
\text { (mA) } \& \text { (mA) } \\
\hline
\end{array}
\] \& \[
\begin{array}{|rl|}
\hline \text { MNN } \& \text { MAX } \\
\text { (manho) } \& \text { (mamhe) } \\
\hline
\end{array}
\] \& \[
\begin{aligned}
\& \text { Max } \\
\& (p f)
\end{aligned}
\] \& SYMEOL \& max \& \begin{tabular}{l}
－ 1 \\
（ H ）
\end{tabular} \\
\hline \[
\begin{aligned}
\& U 1277 \\
\& U 1278 \\
\& U 1279 \\
\& U 1280
\end{aligned}
\] \& 隹 \& N
\(\mathbf{N}\)
\(\mathbf{N}\)
\(\mathbf{N}\) \& \(J\)
\(J\)
\(J\) \& \& \[
\begin{aligned}
\& \text { 2N5361 } \\
\& \text { 2N5359 } \\
\& \text { 2N5362 } \\
\& \text { 2N5359 }
\end{aligned}
\] \& \[
\begin{aligned}
\& 50 \\
\& 50 \\
\& 50 \\
\& 50
\end{aligned}
\] \& \[
\begin{gathered}
1.5-8 \\
.5-3 \\
.2-1.5 \\
.1-10
\end{gathered}
\] \& \[
\begin{aligned}
\& .45- \\
\& .35- \\
\& .25- \\
\& .25-
\end{aligned}
\] \& \[
\begin{aligned}
\& 6 \\
\& 6 \\
\& 6 \\
\& 6
\end{aligned}
\] \& \begin{tabular}{l}
CRSS \\
CRSS \\
CRSS \\
CRSS
\end{tabular} \& \[
\begin{aligned}
\& \text { 1.2 PF } \\
\& \text { 1.2 PF } \\
\& \text { 1.2 PF } \\
\& \text { 1.2 PF }
\end{aligned}
\] \& \[
\begin{aligned}
\& 1 M \\
\& 1 M \\
\& 1 M \\
\& 1 M
\end{aligned}
\] \\
\hline \[
\begin{array}{|l|}
\hline U 1281 \\
U 1282 \\
U 1283 \\
U 1284
\end{array}
\] \& 发 \& \(\mathbf{N}\)
\(\mathbf{N}\)
\(\mathbf{N}\)
\(\mathbf{N}\) \& \[
\begin{aligned}
\& \mathbf{\jmath} \\
\& \mathbf{J} \\
\& \mathbf{J} \\
\& \mathbf{J}
\end{aligned}
\] \& \& \begin{tabular}{l}
2N5549 \\
2N3458 \\
2N3459 \\
2N3458
\end{tabular} \& \[
\begin{aligned}
\& 50 \\
\& 50 \\
\& 50 \\
\& 50
\end{aligned}
\] \& \[
\begin{aligned}
\& 8 . \\
\& 4-20 \\
\& 1.10 \\
\& .2-40
\end{aligned}
\] \& \[
\begin{gathered}
2.5 \\
1.5 \\
1-
\end{gathered}
\] \& \[
\begin{aligned}
\& 18 \\
\& 18 \\
\& 18 \\
\& 18
\end{aligned}
\] \& \begin{tabular}{l}
CRSS \\
CRSS \\
CRSS \\
CRSS
\end{tabular} \& \[
\begin{aligned}
\& 5 \mathrm{PF} \\
\& 5 \mathrm{PF} \\
\& 5 \mathrm{PF} \\
\& 5 \mathrm{PF}
\end{aligned}
\] \& \[
\begin{aligned}
\& 1 \mathrm{~m} \\
\& \mathrm{IM} \\
\& \mathrm{IM} \\
\& \mathrm{IM}
\end{aligned}
\] \\
\hline \[
\begin{aligned}
\& U 1285 \\
\& U 1266 \\
\& U 1287 \\
\& U 1321
\end{aligned}
\] \&  \& \(\mathbf{N}\)
\(\mathbf{N}\)
\(\mathbf{N}\)
\(\mathbf{N}\) \& \[
\begin{aligned}
\& \mathbf{J} \\
\& \mathbf{j} \\
\& \mathbf{j}
\end{aligned}
\] \& \& \begin{tabular}{l}
2N3459 \\
2N4860 \\
2N3966
\end{tabular} \& 30
30
30
30 \& \[
\begin{aligned}
\& 1 . \\
\& .2
\end{aligned}
\] \& \[
\begin{aligned}
\& .2-1.2 \\
\& 1-10
\end{aligned}
\] \& \& \begin{tabular}{l}
CRSS \\
CRSS \\
Cass \\
CRSS
\end{tabular} \& \[
\begin{array}{r}
2 \mathrm{PF} \\
8 \mathrm{PF} \\
20 \mathrm{PF} \\
1.3 \mathrm{PF}
\end{array}
\] \& \[
\begin{aligned}
\& 1 M \\
\& 1 M \\
\& 1 M \\
\& 1 M
\end{aligned}
\] \\
\hline \[
\left\lvert\, \begin{aligned}
\& U 1322 \\
\& U 1323 \\
\& \text { U1324 } \\
\& \text { U1325 }
\end{aligned}\right.
\] \& 傦 \& \(N\)
\(N\)
\(N\)
\(N\) \& \[
\begin{aligned}
\& \mathbf{J} \\
\& \mathbf{J} \\
\& \mathbf{J}
\end{aligned}
\] \& \&  \& \[
\begin{aligned}
\& 30 \\
\& 30 \\
\& 30 \\
\& 30
\end{aligned}
\] \& \[
\begin{aligned}
\& 2.5-10 \\
\& 1-5 \\
\& .4-2 \\
\& .1-.5
\end{aligned}
\] \& \[
\begin{array}{r}
1.2 \\
.5
\end{array}
\] \& \[
\begin{aligned}
\& 6 \\
\& 6 \\
\& 6 \\
\& 6
\end{aligned}
\] \& \begin{tabular}{l}
CRSS \\
Cass \\
CRSS \\
CRSS
\end{tabular} \& \[
\begin{aligned}
\& 1.3 \mathrm{PF} \\
\& 1.3 \mathrm{PF} \\
\& 1.3 \mathrm{PF} \\
\& 1.3 \mathrm{PF}
\end{aligned}
\] \& \[
\begin{aligned}
\& I M \\
\& 1 M \\
\& 1 M \\
\& I M
\end{aligned}
\] \\
\hline \begin{tabular}{l}
U1714 \\
U1837E \\
U1897E \\
U1898E
\end{tabular} \& N
\(\sim\)
\(N\)
\(N\)
\(N\)
\(N\) \& \(N\)
\(N\)
\(N\)
\(N\)
\(N\) \& \[
\begin{aligned}
\& \text { J } \\
\& \text { J } \\
\& \text { J }
\end{aligned}
\] \& \& \begin{tabular}{l}
2N3459 \\
2N5245 \\
T1573 \\
11574
\end{tabular} \& \[
\begin{array}{r}
25 \\
30 \\
40 \\
40
\end{array}
\] \& \[
\begin{aligned}
\& .5-5 \\
\& 4-25 \\
\& 30- \\
\& 15-
\end{aligned}
\] \& \[
4
\] \& \[
\begin{array}{r}
3 \\
6 \\
16 \\
16
\end{array}
\] \& \begin{tabular}{l}
CRSS \\
CRSS \\
CR5S \\
CRSS
\end{tabular} \& \[
\begin{array}{r}
1.2 \mathrm{PF} \\
2 \mathrm{PF} \\
5 \mathrm{PF} \\
5 \mathrm{PF}
\end{array}
\] \& \[
\begin{aligned}
\& 1 \mathrm{M} \\
\& 1 \mathrm{M} \\
\& 1 \mathrm{M} \\
\& 1 \mathrm{M}
\end{aligned}
\] \\
\hline U1899E U1994E U3000 U3001 \& 趐 \& \(N\)
\(N\)
\(N\) \& \[
\begin{aligned}
\& \mathbf{J} \\
\& \mathbf{j} \\
\& \mathbf{J}
\end{aligned}
\] \& \& \begin{tabular}{l}
\(T 1575\) \\
2N5245 \\
2N3459 \\
2N3459
\end{tabular} \& \[
\begin{aligned}
\& 40 \\
\& 30 \\
\& 30 \\
\& 30
\end{aligned}
\] \& \[
\begin{gathered}
8- \\
5-15 \\
1.5-7.5 \\
.4-2
\end{gathered}
\] \& \[
\begin{array}{r}
4 \\
.3 \\
.25
\end{array}
\] \& \[
\begin{array}{r}
16 \\
4
\end{array}
\] \& \begin{tabular}{l}
CRSS \\
CRSS \\
CRSS \\
CRSS
\end{tabular} \& \[
\begin{aligned}
\& 5 \mathrm{PF} \\
\& 1 \mathrm{PF} \\
\& 2 \mathrm{PF} \\
\& 2 \mathrm{PF}
\end{aligned}
\] \& \[
\begin{aligned}
\& 1 \mathrm{M} \\
\& 1 \mathrm{M} \\
\& 1 \mathrm{M} \\
\& 1 \mathrm{M}
\end{aligned}
\] \\
\hline \[
\begin{aligned}
\& \text { U3002 } \\
\& \text { U3010 } \\
\& \text { U3011 } \\
\& \text { U3012 }
\end{aligned}
\] \& （1） \(\begin{aligned} \& \mathbb{N} \\ \& \mathbb{N} \\ \& \mathbf{N} \\ \& \mathbf{N} \\ \& \mathbf{N}\end{aligned}\) \& \(N\)
\(N\)
\(N\)
\(N\) \& \(J\)
\(J\)
\(J\) \& \& 2N3458
2N3459
2N3460 \& \[
\begin{aligned}
\& 30 \\
\& 30 \\
\& 30 \\
\& 30
\end{aligned}
\] \& \[
\begin{aligned}
\& .1-.5 \\
\& 3-15 \\
\& .8-4 \\
\& .2-1
\end{aligned}
\] \& \[
\begin{array}{r}
.2- \\
.75 \\
.6 \\
.5
\end{array}
\] \& \& \begin{tabular}{l}
CRSS \\
CRSS \\
CRSS \\
CRSS
\end{tabular} \& \[
\begin{aligned}
\& 2 \mathrm{PF} \\
\& 3 \mathrm{PF} \\
\& 3 \text { PF } \\
\& 3 \mathrm{PF}
\end{aligned}
\] \& \[
\begin{aligned}
\& 1 M \\
\& 1 M \\
\& 1 M \\
\& 1 M
\end{aligned}
\] \\
\hline \begin{tabular}{l}
uc20 \\
UC21 \\
UC100 \\
UC1 10
\end{tabular} \& \(\mathbb{N}\)
\(\mathbb{N}\)
\(\mathbf{N}\)
\(\mathbf{N}\)
\(\mathbf{N}\) \& N
N
N
N \& \[
\begin{aligned}
\& \mathbf{J} \\
\& \mathbf{j} \\
\& \mathbf{J} \\
\& \mathbf{j}
\end{aligned}
\] \& \& \begin{tabular}{l}
2 N 5358 \\
2N5361 \\
2 145360
\end{tabular} \& \[
\begin{aligned}
\& 30 \\
\& 30 \\
\& 30 \\
\& 30
\end{aligned}
\] \& \[
\begin{gathered}
.4-2 \\
.12 .6 \\
2.5-7.5 \\
1.3
\end{gathered}
\] \& \[
\begin{array}{r}
.3 \\
.2 \\
2 \\
1.5
\end{array}
\] \& \[
\begin{aligned}
\& 2 \\
\& 2 \\
\& 5 \\
\& 5
\end{aligned}
\] \& \[
\begin{aligned}
\& \text { CRSS } \\
\& \text { CRSS } \\
\& \text { CRSS } \\
\& \text { CRSS }
\end{aligned}
\] \& \[
\begin{array}{r}
.8 \mathrm{PF} \\
.8 \mathrm{PF} \\
1.5 \mathrm{PF} \\
1.5 \mathrm{PF}
\end{array}
\] \& \[
\begin{aligned}
\& 1 \mathrm{M} \\
\& 1 \mathrm{M} \\
\& 1 \mathrm{M} \\
\& 1 \mathrm{M}
\end{aligned}
\] \\
\hline \begin{tabular}{l}
UC1 15 \\
UC130 \\
UC155 \\
UC200
\end{tabular} \& N
\(\mathbf{N}\)
\(\mathbf{N}\)
\(\mathbf{N}\)

$\mathbf{N}$
$\mathbf{N}$ \& N
N
N
N

N \& $$
\begin{aligned}
& \mathbf{J} \\
& \mathbf{J} \\
& \mathbf{j} \\
& \mathbf{J}
\end{aligned}
$$ \& \&  \& \[

$$
\begin{aligned}
& 30 \\
& 30 \\
& 30 \\
& 50
\end{aligned}
$$

\] \& \[

$$
\begin{aligned}
& 1-3 \\
& 1-.5 \\
& 10- \\
& 10-30
\end{aligned}
$$

\] \& \[

$$
\begin{array}{r}
1.5 \\
.5 \\
6
\end{array}
$$

\] \& \[

$$
\begin{aligned}
& 5 \\
& 5 \\
& 4 \\
& 7
\end{aligned}
$$

\] \& | CRSS |
| :--- |
| CRSS |
| CRSS |
| CRSS | \& \[

$$
\begin{array}{r}
1.5 \mathrm{PF} \\
1.5 \mathrm{PF} \\
1 \mathrm{PF} \\
2 \mathrm{PF}
\end{array}
$$

\] \& \[

$$
\begin{aligned}
& 1 M \\
& 1 M \\
& 1 M \\
& 1 M
\end{aligned}
$$
\] <br>

\hline | UC201 |
| :--- |
| UC210 |
| UC220 |
| UC240 | \& \[

$$
\begin{aligned}
& \mathbf{N} \\
& \mathbb{N} \\
& \mathbf{N} \\
& \mathbf{N} \\
& \mathbf{N} \\
& \hline
\end{aligned}
$$

\] \& | $\mathbf{N}$ |
| :--- |
| $\mathbf{N}$ |
| $\mathbf{N}$ |
| $\mathbf{N}$ | \& \[

$$
\begin{aligned}
& \mathbf{J} \\
& \mathbf{j} \\
& \mathbf{j} \\
& \mathbf{j}
\end{aligned}
$$

\] \& \& \[

$$
\begin{aligned}
& \text { 2N5364 } \\
& \text { 2N5362 } \\
& \text { 2N5360 } \\
& \text { 2N3459 }
\end{aligned}
$$

\] \& \[

$$
\begin{aligned}
& 50 \\
& 50 \\
& 50 \\
& 50
\end{aligned}
$$

\] \& \[

$$
\begin{aligned}
& 15- \\
& 4-12 \\
& 1.5 \\
& 1-10 \\
& \hline
\end{aligned}
$$

\] \& \[

$$
\begin{array}{r}
4.5 \\
3 \\
1.2
\end{array}
$$

\] \& \[

$$
\begin{array}{r}
7 \\
7 \\
7 \\
18
\end{array}
$$

\] \& | CRSS |
| :--- |
| CRSS |
| CRSS |
| CRSS | \& \[

$$
\begin{aligned}
& 4 \mathrm{PF} \\
& 2 \mathrm{PF} \\
& 2 \mathrm{PF} \\
& 5 \mathrm{PF}
\end{aligned}
$$

\] \& \[

$$
\begin{aligned}
& 1 M \\
& 1 M \\
& 1 M \\
& 1 M
\end{aligned}
$$
\] <br>

\hline
\end{tabular}

TRANSISTOR INTERCHANGEABILITY
NONREGISTERED FIELD-EFFECT TRANSISTORS

| $\begin{gathered} \text { TYME } \\ \text { numbien } \end{gathered}$ |  |  |  | 8$\frac{8}{2}$$\frac{8}{2}$888 | $\pi$ <br> miplacemint OR MEAREST hounaimet | matio Deank GATI voltace |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  |  |  | loss <br> ${ }^{4} \mathrm{D}$ (on) | lvas | $\begin{aligned} & c_{\text {me }} \\ & \text { max } \\ & \text { (pr) } \end{aligned}$ | OTHER PARAMIIE |  |  |
|  |  |  |  |  |  |  | $\left\|\begin{array}{ll} \min & \max \\ (m a) & (m A) \end{array}\right\|$ | $\begin{array}{\|cc\|} \text { MIN } & \text { MaX } \\ (\text { mmho }) & \text { (mmho) } \\ \hline \end{array}$ |  | symber | max | $\begin{aligned} & 01 \\ & (1 \pm \leq) \\ & \hline \end{aligned}$ |
| UC241 UC2SO UC2S1 UC10 | $\begin{aligned} & \mathbf{N} \\ & \mathbb{N} \\ & \mathbb{N} \\ & \mathbb{N} \\ & \mathbb{N} \end{aligned}$ | N <br> $N$ <br> $N$ <br> $\mathbf{N}$ | $\begin{aligned} & \text { J } \\ & \text { J } \\ & \text { J } \end{aligned}$ |  | $\begin{aligned} & \text { 2N5361 } \\ & \text { 2N4391 } \\ & \text { 2N4392 } \\ & \text { 2N3931 } \end{aligned}$ | $\begin{aligned} & 50 \\ & 30 \\ & 30 \\ & 30 \end{aligned}$ | $\begin{gathered} 1.10 \\ 50.150 \\ 7.5-75 \\ 5.15 \end{gathered}$ | 2. <br> 3. | $\begin{aligned} & 20 \\ & 25 \\ & 25 \end{aligned}$ | $\begin{aligned} & \text { Cnss } \\ & \text { Cliss } \\ & \text { Class } \\ & \text { CRss } \end{aligned}$ | $\begin{array}{r} 5 \mathrm{FF} \\ 7 \mathrm{FF} \\ 7 \mathrm{FP} \\ 2.5 \mathrm{FF} \end{array}$ | $\begin{aligned} & \mathrm{IM} \\ & \mathbf{I M} \\ & \mathrm{IM} \\ & \mathrm{IM} \end{aligned}$ |
| UCAOI UCA10 venzo UC703 | $\begin{aligned} & \mathbb{N} \\ & \mathbb{N} \\ & \mathbb{N} \\ & \mathbb{N} \\ & \mathbb{N} \end{aligned}$ | P $\mathbf{p}$ $\mathbf{p}$ $\mathbf{N}$ | J j d |  | 2N3994 2N3330 2N3329 2N5362 | $\begin{aligned} & 30 \\ & 30 \\ & 30 \\ & 40 \end{aligned}$ | $\begin{aligned} & 8 \\ & 2-6 \\ & .5-2.3 \\ & .1 \cdot 10 \end{aligned}$ | $\begin{gathered} \text { 2.25. } \\ \text { 1.5-5.-5 } \end{gathered}$ | $\begin{aligned} & 8 \\ & 8 \\ & 8 \\ & 6 \end{aligned}$ | CRSS Cnss CRSS | $\begin{array}{r} 4 \mathrm{PF} \\ 2.5 \mathrm{PF} \\ 2.5 \mathrm{PF} \end{array}$ | $\begin{aligned} & 1 \mathrm{M} \\ & 1 \mathrm{M} \\ & 1 \mathrm{~m} \end{aligned}$ |
| $\begin{aligned} & \text { UC70A } \\ & \text { UC70s } \\ & \text { UC707 } \\ & \text { UC714 } \end{aligned}$ | $\left\|\begin{array}{c} \mathbf{N} \\ \mathbb{N} \\ \mathbb{N} \\ \mathbb{N} \end{array}\right\|$ | $N$ $N$ $N$ $N$ $N$ | $\begin{aligned} & d \\ & j \\ & j \end{aligned}$ |  | 2N5364 <br> 2N5364 <br> 2N4061 <br> 2N3823 | $\begin{aligned} & 40 \\ & 40 \\ & 20 \\ & 30 \end{aligned}$ | $.2-24$ $.5-50$ $2.5-250$ 2.20 | $\begin{aligned} & 1.10 \\ & 2.20 \\ & 5.50 \\ & 2-6.5 \end{aligned}$ | $\begin{gathered} 1 \\ 12 \\ 30 \\ 8 \end{gathered}$ | CR5S | 4 PF | 1 M |
| $\begin{aligned} & \text { UC714E } \\ & \text { UC734 } \\ & \text { UCC34E } \\ & \text { UC751 } \end{aligned}$ | $\left\|\begin{array}{c} \mathbb{N} \\ \mathbb{N} \\ \mathbb{N} \\ \mathbb{N} \\ \mathbb{N} \end{array}\right\|$ | $N$ $N$ $N$ $N$ $N$ | $\begin{aligned} & j \\ & j \\ & j \end{aligned}$ |  | 2N5950 <br> 2N4416 <br> 2N5245 <br> 2N3458 | $\begin{aligned} & 30 \\ & 30 \\ & 30 \\ & 30 \end{aligned}$ | $2-20$ 4.20 4.20 .1. | $\begin{aligned} & 2-6.5 \\ & 3 . \\ & 3- \\ & .35 . \end{aligned}$ | $\begin{array}{r} 8 \\ 4 \\ 4.5 \\ 10 \end{array}$ | CRSS CRSS CRSS | $\begin{gathered} 4 \mathrm{PF} \\ .8 \mathrm{PF} \\ 1 \mathrm{PF} \end{gathered}$ | $\begin{aligned} & 1 m \\ & 1 m \\ & 1 m \end{aligned}$ |
| $\begin{aligned} & \text { UC752 } \\ & \text { UC753 } \\ & \text { UC754 } \\ & \text { UC755 } \end{aligned}$ | $\begin{aligned} & \mathbb{N} \\ & \mathbb{N} \\ & \text { N } \\ & \mathbb{N} \end{aligned}$ | $N$ $N$ $N$ $N$ $N$ | $\begin{aligned} & \mathbf{J} \\ & \mathbf{j} \\ & \mathbf{j} \end{aligned}$ |  | $\begin{aligned} & \text { 2N3458 } \\ & \text { 2N3458 } \\ & \text { 2N3458 } \\ & \text { 2N3458 } \end{aligned}$ | $\begin{aligned} & 30 \\ & 30 \\ & 30 \\ & 30 \end{aligned}$ | $\begin{aligned} & .3 \\ & .9 \\ & .5 \\ & 4-10 \end{aligned}$ | $\begin{array}{r} 1 . \\ 2.5 \\ 1 . \\ 2 . \end{array}$ | $\begin{array}{r} 17 \\ 25 \\ 6 \\ 6 \end{array}$ | CRSS CRSS | $\begin{aligned} & 3 \text { PF } \\ & 3 \text { PF } \end{aligned}$ | 19 $1 m$ |
| UC756 UC814 UC851 UC853 | $\left\{\begin{array}{l} \mathbf{N} \\ \mathbf{N} \\ \mathbf{N} \\ \mathbf{N} \\ \mathbf{N} \end{array}\right.$ | N $\begin{aligned} & \text { N } \\ & p \\ & p \\ & p\end{aligned}$ | J $j$ $j$ |  | 2N3458 <br> 2N3331 <br> 2N2608 <br> 2N3822 | $\begin{aligned} & 30 \\ & 25 \\ & 20 \\ & 20 \end{aligned}$ | $.5-15$ $.3-15$ $.9-9$ $.065-$ | $\begin{gathered} 1 . \\ .8-5 \\ 1 . \\ .18 . \end{gathered}$ | $\begin{array}{r} 6 \\ 16 \\ 17 \\ 10 \end{array}$ | $\begin{aligned} & \text { CRSS } \\ & \text { CRSS } \end{aligned}$ | $\begin{aligned} & 3 \mathrm{PF} \\ & 8 \mathrm{PF} \end{aligned}$ | $\begin{aligned} & 1 M \\ & 1 M \end{aligned}$ |
| $\begin{aligned} & \text { UC854 } \\ & \text { UC855 } \\ & \text { UC1700 } \\ & \text { UC1764 } \end{aligned}$ | $\begin{array}{\|l\|} \mathbf{N} \\ \mathbb{N} \\ \mathbb{N} \\ \mathbb{N} \\ \mathbb{N} \end{array}$ | P | $\begin{gathered} J \\ J \\ \text { IG } \\ \mathbf{I G} \end{gathered}$ |  | 2N2608 2N2609 3N163 | $\begin{aligned} & 25 \\ & 25 \\ & 40 \\ & 30 \end{aligned}$ | $\begin{aligned} & .2- \\ & .44- \\ & .3-30 \end{aligned}$ | $\begin{gathered} .54 \\ 1.4 \\ 2.4 \end{gathered}$ | $\begin{array}{r} 17 \\ 25 \\ 5 \\ 3 \end{array}$ | $\begin{aligned} & \text { CRSS } \\ & \text { CRSS } \end{aligned}$ | $\begin{array}{r} 1.2 \mathrm{PF} \\ 1 \mathrm{PF} \end{array}$ | $\begin{aligned} & 1 M \\ & 1 M \end{aligned}$ |
| $\begin{aligned} & \text { UC2130 } \\ & \text { UC2132 } \\ & \text { UC2134 } \\ & \text { UC2136 } \end{aligned}$ | $\begin{aligned} & \mathbb{N} \\ & \mathbb{N} \\ & \mathbb{N} \\ & \mathbb{N} \\ & \mathbb{N} \end{aligned}$ | N N N N | $\begin{aligned} & \mathbf{J} \\ & \mathbf{j} \\ & \mathbf{j} \end{aligned}$ |  | $\begin{aligned} & \text { 2N5545 } \\ & \text { 2N5546 } \\ & \text { 2N5547 } \\ & \text { 2N5045 } \end{aligned}$ | $\begin{aligned} & 50 \\ & 50 \\ & 50 \\ & 50 \end{aligned}$ | $\begin{array}{r} .5-4.5 \\ .5-4.5 \\ .5-4.5 \\ .5-4.5 \end{array}$ | 1. |  |  |  |  |
| UC2138 UC2139 <br> UC2147 | $\begin{aligned} & \mathbb{N} \\ & \mathbb{N} \\ & \mathbb{N} \\ & \mathbb{N} \end{aligned}$ | N <br> $\mathbf{N}$ <br> $\mathbf{N}$ <br> $\mathbf{N}$ | $\begin{aligned} & \mathbf{j} \\ & \mathbf{j} \\ & \mathbf{j} \end{aligned}$ |  | $\begin{aligned} & \text { 2N5046 } \\ & \text { 2N5047 } \\ & \text { 2N5047 } \\ & \text { 2N5047 } \end{aligned}$ | 50 30 30 50 | $.5-4.5$ $.2-6$ $.5-$ .2. | $\begin{array}{r} 1 . \\ .75 \\ 1 . \\ 2 . \end{array}$ |  |  |  |  |
| $\begin{array}{\|l} \begin{array}{l} \text { UC2149 } \\ \text { UC1766 } \end{array} \end{array}$ | $\left\lvert\, \begin{aligned} & \mathbb{N} \\ & \mathbb{N} \end{aligned}\right.$ |  | $\begin{aligned} & \text { J } \\ & \text { IG } \end{aligned}$ |  | $\begin{aligned} & \text { 2N5047 } \\ & \text { 2N5047 } \end{aligned}$ | $\begin{aligned} & 30 \\ & 30 \end{aligned}$ | $\begin{array}{\|c} .5-15 \\ 5-30 \end{array}$ | 1. | 3.5 | CRSS | 1 PF | 1 M |
|  |  |  |  |  |  |  |  |  |  |  |  |  |

## TRANSISTOR INTERCHANGEABILITY REGISTERED UNLUUNCTION TRANSISTORS

| TYPE NUMETA |  |  | $T$ REPLACEMENT |  | CHARACTEAISTICS |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  | Po $(m W)$ | (kn) | $\boldsymbol{\eta}$ | IV $(m A)$ | $(\mu \mathrm{A})$ | 1EBEO <br> ( $\mu \mathrm{A})$ |
| $\begin{aligned} & 2 \mathrm{~N} 499 \\ & 2 \mathrm{~N} 49 \% \mathrm{~A} \\ & 2 \mathrm{~N} 49 \% \\ & 2 \mathrm{~N} 490 \end{aligned}$ | $\begin{aligned} & \text { UT } \\ & \text { UT } \\ & \text { UT } \\ & \text { UT } \end{aligned}$ | $\begin{aligned} & P+N \\ & P N \\ & P+N \\ & \mathbf{N} \end{aligned}$ | $\begin{aligned} & \text { 2N4CO } \\ & \text { 2N408A } \\ & \text { 2N4OM } \\ & 2 N 490 \end{aligned}$ | $\begin{aligned} & 600 \\ & 600 \\ & 600 \\ & 600 \end{aligned}$ | $\begin{aligned} & 4.78 .8 \\ & 4.7 .8 .8 \\ & 4.74 .8 \\ & 6.29 .1 \end{aligned}$ | $\begin{aligned} & .51-.62 \\ & .51-.62 \\ & .51 . .62 \\ & .51-.62 \end{aligned}$ | 8 | $\begin{array}{r} 12 \\ 12 \\ 6 \\ 12 \end{array}$ | $\begin{aligned} & 2 \\ & 2 \\ & 2 \\ & 2 \end{aligned}$ |
| $\begin{aligned} & 2 N 4 P O A \\ & 2 N / 990 \\ & 2 N / 91 \\ & 2 N / P 1 A \end{aligned}$ | $\begin{aligned} & U T \\ & U T \\ & U / T \\ & U / T \end{aligned}$ | P+N <br> PN <br> PN <br> P-N | $\begin{aligned} & 2 N 4904 \\ & 2 N 4901 \\ & 2 N 491 \\ & 2 N 4914 \end{aligned}$ | $\begin{aligned} & 600 \\ & 600 \\ & 600 \\ & 600 \end{aligned}$ | $\begin{aligned} & 6.2 \cdot 9.1 \\ & 6.2-9.1 \\ & 4.76 .8 \\ & 4.76 .1 \end{aligned}$ | $\begin{aligned} & .51 .06 \\ & .51 .62 \\ & .56 .60 \\ & .56 .69 \end{aligned}$ | $\begin{aligned} & 1 \\ & 8 \end{aligned}$ | $\begin{array}{r} 12 \\ 6 \\ 12 \\ 12 \end{array}$ | $\begin{aligned} & 2 \\ & 2 \\ & 2 \\ & 2 \end{aligned}$ |
| $\begin{aligned} & \text { 2N491B } \\ & \text { 2N492 } \\ & \text { 2N492A } \\ & \text { 2N4920 } \end{aligned}$ | UT <br> UT <br> ил <br> UTT | PN <br> $P+N$ <br> PN <br> PN | 2 M 4918 <br> $2 \mathrm{M} 4 \mathrm{H}_{2}$ <br> 2M492A <br> 2N402: | 600 <br> 600 <br> 600 <br> 600 | $\begin{aligned} & 4.7-8.8 \\ & 6.2-9.1 \\ & 6.2 \cdot 9.1 \\ & 6.2-9.1 \end{aligned}$ | $\begin{aligned} & .56 .68 \\ & .56-.68 \\ & .56 .68 \\ & .56 .60 \end{aligned}$ | 8 | $\begin{array}{r} 6 \\ 12 \\ 12 \\ 6 \end{array}$ | $\begin{aligned} & 2 \\ & 2 \\ & 2 \\ & 2 \end{aligned}$ |
| 2N493 <br> 2N493A <br> 2N493 <br> 2N494 | $\begin{aligned} & \text { UTT } \\ & \text { UTH } \\ & \text { UTT } \\ & \text { UTT } \end{aligned}$ | PN $P \cdot \mathbf{N}$ P-N P-N | $2 \times 498$ 2N4934 2Naps | 600 600 600 600 | $\begin{aligned} & 4.7-4.8 \\ & 4.7-6.8 \\ & 4.7-6.8 \\ & 6.2-9.1 \end{aligned}$ | $\begin{array}{r} .62 .75 \\ .62 .75 \\ .62 .75 \\ .62 .75 \end{array}$ | 8 | $\begin{gathered} 12 \\ 12 \\ 6 \\ 12 \end{gathered}$ | $\begin{aligned} & 2 \\ & 2 \\ & 2 \\ & 2 \end{aligned}$ |
| $\begin{aligned} & \text { 2N494A } \\ & \text { 2N494 } \\ & \text { 2N494C } \\ & \text { 2N1671 } \end{aligned}$ | $\begin{aligned} & \text { UJ } \\ & \text { UT } \\ & \text { UST } \\ & \text { UT } \end{aligned}$ | PN <br> PN <br> P-N <br> P.N | 2N1671 | 600 <br> 600 <br> 600 <br> 450 | $\begin{aligned} & 6.1 \cdot 9.1 \\ & 6.2-9.1 \\ & 6.2 \cdot 9.1 \\ & 4.7-9.1 \end{aligned}$ | $\begin{aligned} & .62-.75 \\ & .62 . .75 \\ & .62 . .75 \\ & .47-.62 \end{aligned}$ | 8 8 8 8 | 12 6 2 5 | $\begin{gathered} 2 \\ 2 \\ .02 \\ 12 \end{gathered}$ |
| $\begin{aligned} & 2 \mathrm{~N} 1671 \mathrm{~A} \\ & 2 \mathrm{~N} 16718 \\ & 2 \mathrm{~N} 2160 \\ & 2 \mathrm{~N} 2307 \end{aligned}$ | UST <br> ur <br> UT <br> UJ | P-N <br> PAN <br> P-N <br> P-N | 2N1671A <br> 2N16718 <br> 2 N 2160 | $\begin{array}{r} 450 \\ 450 \\ 450 \\ 250 \end{array}$ | $\begin{gathered} 4.7-9.1 \\ 4.7-9.1 \\ 4.12 \\ 4.5-9.1 \end{gathered}$ | $\begin{aligned} & .47-.62 \\ & .47-.62 \\ & .47-.80 \\ & .45-.70 \end{aligned}$ | 8 | 25 6 25 | $\begin{array}{r} 12 \\ .2 \\ 12 \\ 10 \end{array}$ |
| $\begin{aligned} & \text { 2N2417 } \\ & \text { 2N2417A } \\ & \text { 2N2417 } \\ & \text { 2N2418 } \end{aligned}$ | UTI <br> UJT <br> UT <br> UT | $P \cdot N$ <br> PN <br> P-N <br> PN | 2 N 489 <br> zandera <br> 2 N 498 <br> 2NMO | $\begin{aligned} & 350 \\ & 350 \\ & 350 \\ & \mathbf{3 5 0} \end{aligned}$ | $\begin{aligned} & 4.7-6.8 \\ & 4.7 .6 .8 \\ & 4.7 .6 .8 \\ & 6.2-9.1 \end{aligned}$ | $\begin{aligned} & .51-.62 \\ & .51-.62 \\ & .51-.62 \\ & .51-.62 \end{aligned}$ | 5 5 5 | $\begin{array}{r} 20 \\ 20 \\ 6 \\ 20 \end{array}$ | $\begin{aligned} & 12 \\ & 12 \\ & 12 \\ & 12 \end{aligned}$ |
| $\begin{aligned} & \text { 2N2418A } \\ & \text { 2N24186 } \\ & \text { 2N2419 } \\ & \text { 2N2419A } \end{aligned}$ | UT <br> UT <br> UTT <br> UT | P-N <br> P-N <br> P-N <br> P-N | 2nagoa <br> 2N4908 <br> 2N4日1 <br> 2N491A | $\begin{aligned} & 350 \\ & 350 \\ & 350 \\ & 350 \end{aligned}$ | $\begin{aligned} & 6.2-9.1 \\ & 6.2-9.1 \\ & 4.7-6.8 \\ & 4.7-6.8 \end{aligned}$ | $\begin{aligned} & .51 . .62 \\ & .51 . .62 \\ & .56 .68 \\ & .50 .68 \end{aligned}$ | $\begin{aligned} & 5 \\ & 5 \\ & 5 \end{aligned}$ | 20 6 20 20 | $\begin{aligned} & 12 \\ & 12 \\ & 12 \\ & 12 \end{aligned}$ |
| $\begin{aligned} & 2 N 24198 \\ & 2 N 2420 \\ & 2 N 2420 \mathrm{~A} \\ & 2 \mathrm{~N} 24208 \end{aligned}$ | UTT <br> UT <br> UT <br> UT | P+N <br> PN <br> P-N <br> PAN | $2 \times 4918$ 2 N 922 2 N 492 A 2N492 | $\begin{aligned} & 350 \\ & 350 \\ & 350 \\ & 350 \end{aligned}$ | $\begin{aligned} & 4.7-6.6 \\ & 6.2-9.1 \\ & 6.2-9.1 \\ & 6.2-9.1 \end{aligned}$ | $\begin{aligned} & .50-.68 \\ & .56-68 \\ & .50 .68 \\ & .56 .68 \end{aligned}$ |  | $\begin{array}{r} 6 \\ 20 \\ 20 \\ 6 \end{array}$ | $\begin{aligned} & 12 \\ & 12 \\ & 12 \\ & 12 \end{aligned}$ |
| $\begin{aligned} & \text { 2N2421 } \\ & \text { 2N2421A } \\ & \text { 2N24218 } \\ & \text { 2N2422 } \end{aligned}$ | $\begin{aligned} & \text { UJT } \\ & \text { UTT } \\ & \text { UJT } \\ & \text { UST } \end{aligned}$ | $\begin{aligned} & \text { P-N } \\ & \text { P-N } \\ & \text { P-N } \\ & \text { P-N } \end{aligned}$ | 2 N 493 2 N 493 A 2N493s | $\begin{aligned} & 350 \\ & 350 \\ & 350 \\ & 350 \end{aligned}$ | $\begin{aligned} & 4.7-6.8 \\ & 4.7-6.8 \\ & 4.7-6.8 \\ & 6.2-9.1 \end{aligned}$ | $\begin{aligned} & .62-.75 \\ & .62-.75 \\ & .62-.75 \\ & .62 . .75 \end{aligned}$ | $\begin{aligned} & 5 \\ & 5 \\ & 8 \\ & 5 \end{aligned}$ | $\begin{array}{r} 20 \\ 20 \\ 6 \\ 20 \end{array}$ | $\begin{aligned} & 12 \\ & 12 \\ & 12 \\ & 12 \end{aligned}$ |
| $\begin{aligned} & \text { 2N2422A } \\ & \text { 2N2422S } \end{aligned}$ | $\begin{aligned} & \text { UTT } \\ & \text { UJT } \end{aligned}$ | $\begin{aligned} & P-\mathbf{N} \\ & P-N \end{aligned}$ |  | $\begin{aligned} & 350 \\ & 350 \end{aligned}$ | $\begin{array}{r} 6.2-9.1 \\ 6.2-9.1 \end{array}$ | $\begin{aligned} & .62 .75 \\ & .62 .75 \end{aligned}$ | 5 | 20 6 | $\begin{aligned} & 12 \\ & 12 \end{aligned}$ |

## TRANSISTOR INTERCHANGEABILITY

REGISTERED UNLUUNCTION TRANSISTORS

|  |  |  |  |  | CHARACTERISTICS |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| TYPE NUMBER |  | $\begin{aligned} & \frac{2}{c} \\ & \frac{1}{c} \\ & 0 \\ & 0 \end{aligned}$ | H <br> REPLACEMENT | $\mathbf{P D}_{\mathbf{D}}$ $(\mathrm{mW})$ | rBB <br> ( $\mathbf{k} \Omega$ ) | $\eta$ | IV <br> (mA) | Ip <br> $(\mu \mathrm{A})$ | IEB20 <br> (1 A ) |
| $\begin{aligned} & \text { 2N2646 } \\ & \text { 2N2647 } \\ & \text { 2N2840 } \\ & \text { 2N3406 } \end{aligned}$ | UJT <br> Uת <br> UJI <br> Uת | $\begin{aligned} & \text { P-N } \\ & \text { P-N } \\ & \text { P-N } \\ & \text { P-N } \end{aligned}$ | $\begin{aligned} & \text { 2N2646 } \\ & \text { 2N2647 } \\ & \text { 2N3980 } \end{aligned}$ | $\begin{aligned} & 300 \\ & 300 \\ & 300 \\ & 450 \end{aligned}$ | $\begin{aligned} & 4.7-9.1 \\ & 4.7-9.1 \\ & 4.7-9.1 \\ & 6.2-9.1 \end{aligned}$ | $\begin{aligned} & .56-.75 \\ & .60-.82 \\ & .40-.85 \\ & .53-.59 \end{aligned}$ | 4 8 .8 8 | 5 2 10 20 | $\begin{array}{r} 12 \\ .2 \\ 1 \\ 12 \end{array}$ |
| $\begin{aligned} & \text { 2N3479 } \\ & \text { 2N3480 } \\ & \text { 2N3481 } \\ & \text { 2N3482 } \end{aligned}$ | UJT <br> UJT <br> UTT <br> UTT | $\begin{aligned} & P-N \\ & P-N \\ & P-N \\ & P-N \end{aligned}$ | 2N1671A 2N2646 2N4853 | $\begin{aligned} & 400 \\ & 400 \\ & 400 \\ & 400 \end{aligned}$ | $\begin{aligned} & 4.7-9.1 \\ & 4.7-9.1 \\ & 4.7 \cdot 9.1 \\ & 4.7-8.8 \end{aligned}$ | $\begin{aligned} & .47-.62 \\ & .56-.75 \\ & .70 . .85 \\ & .51-.62 \end{aligned}$ | $\begin{aligned} & 6 \\ & 4 \\ & 6 \end{aligned}$ | $\begin{aligned} & 20 \\ & 20 \\ & 20 \\ & 2 \end{aligned}$ | $\begin{aligned} & 12 \\ & 12 \\ & 12 \\ & .02 \end{aligned}$ |
| $\begin{aligned} & \text { 2N3483 } \\ & \text { 2N3484 } \\ & \text { 2N3679 } \\ & \text { 2N3980 } \end{aligned}$ | UJT <br> UJT <br> UTT <br> UJT | $\begin{aligned} & \text { P-N } \\ & \text { P-N } \\ & \text { P-N } \\ & \text { P-N } \end{aligned}$ | 2N3980 | $\begin{aligned} & 400 \\ & 400 \\ & 250 \\ & 360 \end{aligned}$ | $\begin{gathered} 4.7-9.1 \\ 6.2-9.1 \\ 4.7-9.1 \\ 48 \end{gathered}$ | $\begin{aligned} & .60 .72 \\ & .70 .85 \\ & .60-.00 \\ & .66-.82 \end{aligned}$ | $\begin{array}{r} 8 \\ 8 \\ 4.2 \\ 1 \end{array}$ | $\begin{aligned} & 5 \\ & 5 \\ & 2 \end{aligned}$ | $\begin{array}{r} 1 \\ .2 \\ 12 \\ .01 \end{array}$ |
| $\begin{aligned} & \text { 2N4851 } \\ & \text { 2N4852 } \\ & \text { 2N4853 } \\ & \text { 2N4870 } \end{aligned}$ | UTT <br> UJT <br> UST <br> UJT | $\begin{aligned} & \text { P-N } \\ & \text { P-N } \\ & \text { P-N } \\ & \text { P-N } \end{aligned}$ | $\begin{aligned} & \text { 2N4851 } \\ & \text { 2N4852 } \\ & \text { 2N4853 } \\ & \text { 2N4891 } \end{aligned}$ | $\begin{aligned} & 300 \\ & 300 \\ & 300 \\ & 300 \end{aligned}$ | $\begin{array}{r} 4.7 \cdot 9.1 \\ 4.7-9.1 \\ 4.7-9.1 \\ 4-9.1 \end{array}$ | $\begin{aligned} & .56-75 \\ & .70 .85 \\ & .70-.85 \\ & .56-.75 \end{aligned}$ | $\begin{aligned} & 2 \\ & 4 \\ & 6 \\ & 2 \end{aligned}$ | 2 2 4 5 | $\begin{array}{r} 5 \\ .1 \\ .05 \\ 1 \end{array}$ |
| 2N4871 <br> 2N4891 <br> $2 N 4892$ <br> 2N4893 | UTT <br> UJT <br> UTT <br> UTT | $\begin{aligned} & \text { P-N } \\ & \text { P-N } \\ & \text { P-N } \\ & \text { P-N } \end{aligned}$ | 2 N 4891 <br> 2N4891 <br> 2N4891 <br> 2N4893 | $\begin{aligned} & 300 \\ & 360 \\ & 360 \\ & 360 \end{aligned}$ | $\begin{aligned} & 4-9.1 \\ & 4-9.1 \\ & 4-9.1 \\ & 4-12 \end{aligned}$ | $\begin{aligned} & .70-.85 \\ & .55-.82 \\ & .51-.69 \\ & .55 .82 \end{aligned}$ | $\begin{aligned} & 4 \\ & 2 \\ & 4 \\ & 2 \end{aligned}$ | $\begin{aligned} & 5 \\ & 5 \\ & 2 \\ & 2 \end{aligned}$ | $\begin{gathered} 1 \\ .01 \\ .01 \\ .01 \end{gathered}$ |
| $\begin{aligned} & \text { 2N4694 } \\ & \text { 2N4947 } \\ & \text { 2N4948 } \\ & \text { 2N4949 } \end{aligned}$ | UT <br> UJT <br> UJT <br> UJT | P-N <br> P-N <br> P-N <br> P-N | 2 N 4893 <br> 2N4947 <br> 2 N 4948 | $\begin{aligned} & 360 \\ & 360 \\ & 360 \\ & 360 \end{aligned}$ | $\begin{aligned} & 4-12 \\ & 4-9.1 \\ & 4-12 \\ & 4-12 \end{aligned}$ | $\begin{aligned} & .74-.86 \\ & .51-.69 \\ & .55-.82 \\ & .74-.86 \end{aligned}$ | 2 4 2 2 | 1 2 2 1 | .01 <br> .01 <br> .01 <br> .01 |
| $\begin{aligned} & \text { 2NS431 } \\ & \text { 2N6027 } \\ & \text { 2N6028 } \\ & \text { 2N6114 } \end{aligned}$ | UT <br> PUT <br> PUT <br> UTT | $\begin{array}{r} \text { P-N } \\ \text { PNPN } \\ \text { PNPN } \\ \text { P-N } \end{array}$ | $\begin{aligned} & \text { ATr6027 } \\ & \text { ATT6028 } \end{aligned}$ | $\begin{aligned} & 300 \\ & S e e D c \\ & \text { See Dc } \\ & 300 \end{aligned}$ | $\begin{array}{r} 6-8.5 \\ \text { Sheet On } \\ \text { Sheet On A } \\ 5.5-8.2 \end{array}$ | $\begin{aligned} & .72-.00 \\ & .58-.62 \end{aligned}$ | $2$ <br> 1 | 4 <br> 5 | .01 <br> .01 |
| 2N6115 <br> 2N6116 <br> 2N6117 <br> 2N6118 | UJT <br> PUT <br> PUT <br> PUT | P-N <br> PNPN <br> PNPN <br> PNPN | $\begin{aligned} & \text { 2N6116 } \\ & \text { 2N6117 } \\ & \text { 2N6118 } \end{aligned}$ | $\begin{aligned} & 300 \\ & S_{e e} \\ & S_{e e} \\ & S_{e e} \end{aligned}$ |  | .58-. 62 | 1 | 15 | . 1 |
| 2N6119 <br> 2N6120 <br> 2N6137 <br> 2N6138 | PUT <br> PUT <br> PUT <br> PUT | PNPN PNPN PNPN PNPN |  |  |  |  |  |  |  |

## TRANSISTOR INTERCHANGEABILITY NONREGISTERED UNLUUNCTION TRANSISTORS

|  |  |  |  |  | CHARACTERISTICS |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| TYPE NUMBER |  |  | $\frac{2}{6}$ $\frac{1}{6}$ $\frac{1}{2}$ | $\begin{gathered} \text { TI } \\ \text { REPLACEMENT } \end{gathered}$ | $(\mathrm{mW})$ | rBB <br> (k) | $\eta$ | Iv $(m A)$ | Ip <br> ( $\mu \mathrm{A})$ | IEB2O <br> ( $\mu \mathrm{A})$ |
| A5T61 16 <br> A5T6117 <br> A5T6118 <br> ATS6027 | $\begin{aligned} & \pi \\ & \pi \\ & \pi \\ & \pi \\ & \pi \end{aligned}$ | $\left\lvert\, \begin{aligned} & \text { PUT } \\ & \text { PUT } \\ & \text { PUT } \\ & \text { PUT } \end{aligned}\right.$ | PNPN <br> PNPN <br> PNPN <br> PNPN | A.5T6116 <br> A5T6117 <br> A5T6118 <br> AT6027 | See D <br> Seo D <br> See D <br> See D |  |  |  |  |  |
| A7T6028 MU4891 MU4892 MU4893 | $\begin{aligned} & 7 \\ & M \\ & M \\ & M \end{aligned}$ | $\left\lvert\, \begin{aligned} & \text { PUT } \\ & \text { UTT } \\ & \text { UTT } \\ & \text { UTT } \end{aligned}\right.$ | PNPN | $\begin{aligned} & \text { ATr6028 } \\ & \text { 2N4891 } \\ & \text { 2N4892 } \\ & \text { 2N4893 } \end{aligned}$ | $\begin{aligned} & \text { See Do } \\ & 300 \\ & 300 \\ & 300 \end{aligned}$ | $\begin{aligned} & \text { eet On } \\ & 4-9.1 \\ & 4-9.1 \\ & 4-12 \end{aligned}$ | $\begin{array}{r} .55-.82 \\ .51-.69 \\ .55-.82 \end{array}$ | 2 2 2 | $\begin{aligned} & 5 \\ & 2 \\ & 2 \end{aligned}$ | $\begin{aligned} & .01 \\ & .01 \\ & .01 \end{aligned}$ |
| Mu4894 <br> T1343 <br> THS43 | $\begin{aligned} & M \\ & \mathbf{T} \\ & \mathbf{T} \end{aligned}$ | UJ UTT UTT | $\begin{aligned} & \text { P-N } \\ & \text { P-N } \\ & \text { P-N } \end{aligned}$ | 2N4894 <br> T1S43 2 N 4891 | $\begin{aligned} & 300 \\ & 300 \\ & 300 \end{aligned}$ | $\begin{aligned} & 4-12 \\ & 4.9 .1 \\ & 4-9.1 \end{aligned}$ | $\begin{aligned} & .74-.86 \\ & .55-.82 \\ & .55-.82 \end{aligned}$ | 2 2 2 | 1 5 5 | .01 <br> .01 <br> .01 |

# Transistor Data Sheets 

## TRANSISTOR DATA SHEETS

## CONTENTS

In this section are data sheets for most of the Texas Instruments line of standard, low-power silicon transistors. (For reference to TI's line of silicon power transistors, see either Section 0, Type Number Index, or The Power Semiconductor Data Book.

Excluded from this volume are data sheets for certain obsolescent types listed and so indicated in Section 0, Type Number Index. Loose-leaf data sheets for these devices may be available upon request.

## DERIVED TYPES

Many of the JEDEC-registered types are available in repackaged form. The designations of these repackaged devices are derived from the original JEDEC type numbers by replacing the 2 N or 3 N prefix with a prefix explained in the table below.
"Repackaging" may mean providing a plastic-encapsulated (Silect ${ }^{\dagger}$ ) equivalent for a metal-cased type (for example, the A5T2222 is a Silect $100-\mathrm{mil}$ pin-circle equivalent for the metal-cased 2N2222) or perhaps different basing (lead locations) from the registered type (for example, the A5T3904 is a Silect $100-\mathrm{mil}$ pin-circle equivalent of the plastic-encapsulated, 2N3904 which is registered with the in-line-lead TO-92 package.) In the case of the A4T prefix for unmounted transistor chips, "repackaging" means no package at all.

In any case, the specifications for the prefixed devices are as close to the registered devices as packaging will permit.
PREFIXES FOR REPACKAGED TRANSISTORS



## ORGANIZATION

Data Sheets are organized in alphanumeric order with numbers taking precedence over letters. The exception to this is that derived types are placed immediately after the registered types from which they were derived.

## CHIP-CHARACTERIZATION REFERENCE

Transistor chip families are characterized in Section 5. Reference to the related chip family is made on the lower right-hand corner of each data sheet, if appropriate.

## Excaptions:

- Grown-junction bars are not characterized.
- Bar-type unijunction transistors are not characterized.
- When the observed values of the characteristics of the basic chips are not applicable to specific devices because of highly selective screening or special diffusions, chip-family references are omitted.
- Transistor types containing two darlington-connected chips do have the chip-family reference but it should be noted that while the characterization data does apply to the individual chips, it does not apply directly to the darlington-connected pairs.


## TYPE 2N17 N-P-N GROWN-JUNCTION SILICON TRANSISTOR

# 9 to 20 beta sproad <br> Specificilly dosignod for high gain at high temperatures 

## mechanical data

Welded case with glass-to-metal hermetic seal between case and leads. Approximate weight is 1.7 grams.

absolute maximum refings at $23^{\circ} \mathrm{C}$ amblent (oxcopt where advanced temporatures ane indieatod)
Collector Voltage Referred to Base . . . . . . . . . . . . . 45 V
Emitter Voltage Referred to Base . . . . . . . . . . . . . 1 V
Collector Current . . . . . . . . . . . . . . . . . 25 mA
Emitter Current . . . . . . . . . . . . . . . . . . -25 mA
Collector Dissipation $\}$. . . . . . . . . . . . . . . . 150 mW
at $100^{\circ} \mathrm{C}$
100 mW
ut $\left.150^{\circ} \mathrm{C}\right\}$. . . . . . . . . . . . . . . . 50 mW
|unction temperature
Maximum Range . . . . . . . . . . . . . . . -65º to $+175^{\circ} \mathrm{C}$
common base design characteristics at $\boldsymbol{T}=25^{\circ} \mathrm{C}$ toxcept whore advanced tomperetures are indicatod)

|  |  | test condlimens |  | min. | dasignt center | max. | unlt |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| BV cso | Collector Breakdown Voltage | Ic $=50 \mu \mathrm{~A}$ | $\mathrm{I}_{E}=0$ | 45 |  |  | Volt |
| Icso | Collector Cutoll Current $\}$ | $V_{C B}=30 \mathrm{~V}$ | $I_{E}=0$ |  |  | 2 | $\mu \mathrm{A}$ |
|  | at $100^{\circ} \mathrm{C}$ \} | $V_{C E}=5 V$ | $I_{E}=0$ |  |  | 10 | $\mu \mathrm{A}$ |
|  | at $\left.150^{\circ} \mathrm{C}\right\}$ | $V_{C B}=5 \mathrm{~V}$ | $\mathrm{I}_{\mathrm{E}}=0$ |  |  | 50 | $\mu \mathrm{A}$ |
| his | Input Impedance | $V_{C B}=5 V$ | $I_{E}=-\operatorname{lm} A$ | 30 | 42 | 80 | Ohm |
| $h_{\text {ob }}$ | Output Admitance | $V_{C B}=5 V$ | $I_{E}=-\operatorname{lm} A$ | 0 | 0.4 | 1.2 | $\mu \mathrm{mino}$ |
| hris | Feedback Voltage Ratio | $V_{C B}=5 V$ | $I_{E}=-\operatorname{lm} A$ | 25 | 120 | 500 | $\times 10-6$ |
| $h_{\text {fib }}$ | Current Transfer Ratio | $V_{C B}=5 V$ | $I_{E}=-1 m A$ | -0.9 | -0.925 | -0.953 |  |
| $\mathrm{PG}_{\mathrm{E}}$ | Power Gain* $\dagger$ | $V_{C E}=20 \mathrm{~V}$ | $I_{E}=-2 m A$ |  | 35 |  | db |
| NF | Noise Figure* $\ddagger$ | $V_{G E}=5 \mathrm{~V}$ | $I_{E}=-\operatorname{lm} A$ |  | 20 |  | db |
| fab | Frequency Cutoff | $V_{C B}=5 \mathrm{~V}$ | $I_{E}=-\operatorname{lm} A$ |  | 4 |  | mc |
| $\mathrm{C}_{\text {ab }}$ | Output Capacitance (1me) | $V_{C B}=5 \mathrm{~V}$ | $l_{E}=-\operatorname{lm} A$ |  | 7 |  | $\mu \mu{ }^{\text {m }}$ |
| $\mathrm{R}_{\text {cs }}$ | Saturation Resistance* | $\mathrm{I}_{\mathrm{B}}=2.2 \mathrm{~mA}$ | $\mathrm{I}_{\mathrm{c}}=5 \mathrm{~mA}$ |  | 100 | 200 | Ohm |

[^18]
# 18 to 40 beta spread Specifically dosignod for high gain at high tomperatures 

mechanical data
Welded case with glass-to-metal hermetic seal between case and leads. Approximate weight is 1.7 grams.


junction temperature
Maximum Range
$-65^{\circ} \mathrm{C}$ to $+175^{\circ} \mathrm{C}$

|  |  | rest conditions |  | min. | destign center | max. | wnit |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| $\mathrm{BV}_{\mathrm{cso}}$ | Collector Breakdown Voltage | $\mathrm{I}_{C}=50_{\mu} \mathrm{A}$ | $\mathrm{I}_{\mathrm{E}}=0$ | 45 |  |  | Volt |
| $\mathrm{I}_{\text {ceo }}$ | Collector Cutoff Current\} | $\mathrm{V}_{\text {CB }}=30 \mathrm{~V}$ | $\mathrm{I}_{\mathrm{E}}=0$ |  |  | 2 | $\mu \mathrm{A}$ |
|  | at $100^{\circ} \mathrm{C}$ | $V_{C B}=5 \mathrm{~V}$ | $\mathrm{I}_{\mathrm{E}}=0$ |  |  | 10 | ${ }_{\mu A}$ |
|  | at $150^{\circ} \mathrm{C}$ | $V_{C B}=5 \mathrm{~V}$ | $\mathrm{I}_{\mathrm{E}}=0$ |  |  | 50 | $\mu \mathrm{A}$ |
| hib | Input Impedance | $V_{c s}=5 V$ | $\mathrm{I}_{\mathrm{E}}=-1 \mathrm{~mA}$ | 30 | 42 | 80 | Ohm |
| hob | Output Admittance | $V_{C B}=5 \mathrm{~V}$ | $\mathrm{I}_{\mathrm{E}}=-\operatorname{lmA}$ | 0 | 0.4 | 1.2 | $\mu \mathrm{mho}$ |
| $h_{\text {cob }}$ | Feedback Voltage Ratio | $V_{C B}=5 V$ | $\mathrm{I}_{\mathrm{E}}=-1 \mathrm{~mA}$ | 25 | 250 | 1000 | $\times 10^{-6}$ |
| $h_{f b}$ | Current Transter Ratio | $V_{C B}=5 V$ | $1 \mathrm{E}=-1 m \mathrm{~A}$ | -0.948 | -0.96 | -0.976 |  |
| $\mathrm{PG}_{6}$ | Power Gain* $\dagger$ | $V_{\text {ce }}=20 \mathrm{~V}$ | $\mathrm{IE}_{\mathrm{E}}=-2 \mathrm{~mA}$ |  | 39 |  | ${ }^{\text {db }}$ |
| NF | Noise Figure* $\ddagger$ | $V_{\text {ce }}=5 \mathrm{~V}$ | $1 \mathrm{E}=-1 \mathrm{~mA}$ |  | 20 |  | db |
| $\mathrm{f}_{\text {ab }}$ | Frequency Cutoff | $V_{\text {ce }}=5 \mathrm{~V}$ | $\mathrm{I}_{\mathrm{E}}=-1 \mathrm{~mA}$ |  | $5$ |  | mc |
|  | Output Capacitances (Imc) Saturation Resistance** | $\begin{aligned} & \\ & V_{C B}=5 V \\ & V_{B}=2.2 \mathrm{~mA}\end{aligned}$ | $\mathrm{I}_{\mathrm{E}}=-1 \mathrm{~mA}$ $\mathrm{IC}_{\mathrm{C}}=5 \mathrm{~mA}$ |  | $\begin{array}{r} 7 \\ 100 \end{array}$ | 200 | ${ }_{\text {Onmi }}^{\text {mim }}$ |

-Commen Emilter
$t_{L}=1 k ; R_{L}=20 k$


# 18 to 86 beta spread <br> Specifically designed for high gain at high temperatures 

mechanical dara
Welded case with glass-to-metal hermetic seal between case and leads. Approximate weight is 1.7 grams.

absolute maximum ratings at $25^{\circ} \mathrm{C}$ amblent texcept where advanced temperatures are indicoted)
Collector Voltage Referred to Base . . . . . . . . . . . . . 45 V
Emitter Voltage Referred to Base . . . . . . . . . . . . . 1 V
Collector Current . . . . . . . . . . . . . . . . . 25 mA
Emitter Current . . . . . . . . . . . . . . . . . . -25 mA
Collector Dissipation $\}$. . . . . . . . . . . . . . . . 150 mW
at $\left.100^{\circ} \mathrm{C}\right\}$. . . . . . . . . . . . . . . . 100 mW
at $\left.150^{\circ} \mathrm{C}\right\}$. . . . . . . . . . . . . . . . 50 mW
junction temperature
Maximum Range .
$-65^{\circ} \mathrm{C}$ to $+175^{\circ} \mathrm{C}$
common base design characteristics at $\mathrm{T}_{\mathrm{j}}=25^{\circ} \mathrm{C}$ [except where advanced temperatures are indicated]

|  |  | 7est conditions |  | min. | design centor | max. | unit |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| $\mathrm{BV}_{\text {CB0 }}$ | Collector Breakdown Voltage | $\mathrm{I}_{\mathrm{C}}=50 \mu \mathrm{~A}$ | $\mathrm{I}_{\mathrm{E}}=0$ | 45 |  |  | Volt |
| 1 CBO | Collector Cutoff Current\} | $V_{C B}=30 \mathrm{~V}$ | $I_{E}=0$ |  |  | 2 | $\mu \mathrm{A}$ |
|  | at $\left.100^{\circ} \mathrm{C}\right\}$ | $V_{C B}=5 \mathrm{~V}$ | $\mathrm{I}_{\mathrm{E}}=0$ |  |  | 10 | $\mu \mathrm{A}$ |
|  | at $150^{\circ} \mathrm{C}$ \} | $V_{C B}=5 \mathrm{~V}$ | $\mathrm{I}_{\mathrm{E}}=0$ |  |  | 50 | $\mu \mathrm{A}$ |
| $h_{\text {ib }}$ | Input Impedance | $V_{C B}=5 \mathrm{~V}$ | $I_{E}=-1 m A$ | 30 | 42 | 80 | Ohm |
| hob | Output Admittance | $V_{C B}=5 \mathrm{~V}$ | $I_{E}=-1 m A$ | 0 | 0.4 | 1.2 | $\mu \mathrm{mho}$ |
| $h_{\text {rb }}$ | Feedback Voltage Ratio | $V_{C B}=5 \mathrm{~V}$ | $\mathrm{I}_{\mathrm{E}}=-1 \mathrm{~mA}$ | 50 | 400 | 1000 | X10-6 |
| $h_{\text {fb }}$ | Current Transfer Ratio | $V_{C B}=5 \mathrm{~V}$ | $\mathrm{I}_{\mathrm{E}}=-1 \mathrm{~mA}$ | -0.948 | -0.975 | -0.989 |  |
| $\mathrm{PG}_{8}$ | Power Gain* $\dagger$ | $V_{C E}=20 \mathrm{~V}$ | $\mathrm{I}_{\mathrm{E}}=-2 \mathrm{~mA}$ |  | 39 |  | db |
| NF | Noise Figure $\ddagger$ | $V_{C E}=5 \mathrm{~V}$ | $i_{E}=-1 m A$ |  | 20 |  | $d b$ |
| $\mathrm{f}_{\text {ab }}$ | Frequency Cutoff | $V_{C B}=5 \mathrm{~V}$. | $\mathrm{I}_{\mathrm{E}}=-\operatorname{lm} A$ | 8 |  |  | me |
| $\mathrm{Cob}_{\text {b }}$ | Output Capacitance (1mc) | $V_{C B}=5 \mathrm{~V}$ | $I_{E}=-1 m A$ |  | 7 | 20 | m ${ }^{\text {f }}$ |
| $\mathrm{R}_{\text {cs }}$ | Saturation Resistance* | $\mathrm{I}_{\mathrm{B}}=2.2 \mathrm{~mA}$ | $I_{C}=5 \mathrm{~mA}$ |  | 100 | 200 | Ohm |

*Common Emitter $\quad t R_{\mathbf{E}}=\mathbf{1 k} ; \mathrm{R}_{\mathbf{L}}=\mathbf{2 0 k}$
$\mp$ Conventional Noise-Compared to $\mathbf{1 0 0 0}$ ohm resistor, $\mathbf{1 0 0 0} \mathrm{cps}$ and $\mathbf{1}$ cycle band width

# 36 to 86 beta spread <br> Specifically designed for high gain at high temperatures 

mechanical data
Welded case with glass-to-metal hermetic seal between case and leads. Approximate weight is 1.7 grams.

absolute maximum ratings af $25^{\circ} \mathrm{C}$ ambient lexcept where advanced temperatures are indicated)

junction temperature
Maximum Range . . . . . . . . . . . . . . . $-\mathbf{6 5}{ }^{\circ} \mathrm{C}$ to $+\mathbf{1 7 5}{ }^{\circ} \mathrm{C}$
common base design characterisfics at $\mathbf{T} \mathbf{j}=25^{\circ} \mathrm{C}$ texcopt where advanced tomperatures are indicated)

|  |  | test' conditions |  | min. | design center | max. | unit |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| BVc8o | Collector Breakdown Voltage | $\mathrm{IC}_{\mathrm{C}}=50 \mu \mathrm{~A}$ | $I_{E}=0$ | 45 |  |  | Volt |
| Icao | Collector Cutoff Current\} | $V_{C B}=30 \mathrm{~V}$ | $\mathrm{I}_{\mathrm{E}}=0$ |  |  | 2 | $\mu \mathrm{A}$ |
|  | at $\left.100^{\circ} \mathrm{C}\right\}$ | $V_{C B}=5 \mathrm{~V}$ | $\mathrm{I}_{\mathrm{E}}=0$ |  |  | 10 | $\mu \mathrm{A}$ |
|  | at $\left.150^{\circ} \mathrm{C}\right\}$ | $V_{C B}=5 \mathrm{~V}$ | $I_{E}=0$ |  |  | 50 | $\mu \mathrm{A}$ |
| $h_{\text {ib }}$ | Input Impedance | $V_{C B}=5 \mathrm{~V}$ | $I_{E}=-1 m A$ | 30 | 42 | 80 | Ohm |
| $h_{\text {ab }}$ | Output Admittance | $V_{C B}=5 V$ | $I_{E}=-1 m A$ | 0 | 0.4 | 1.2 | $\mu \mathrm{mho}$ |
| $h_{\text {rb }}$ | Feedback Voltage Ratio | $V_{C B}=5 \mathrm{~V}$ | $\mathrm{I}_{\mathrm{E}}=-1 \mathrm{~mA}$ | 50 | 400 | 1000 | X10-6 |
| $h_{\text {fb }}$ | Current Transfer Ratio | $V_{C B}=5 \mathrm{~V}$ | $I_{E}=-1 m A$ | -0.9735 | $-0.98$ | -0.989 |  |
| $P{ }^{\text {P }}$ | Power Gain* $\dagger$ | $V_{C E}=20 \mathrm{~V}$ | $I_{E}=-2 m A$ |  | 42 |  | db |
| NF | Noise Figure $\ddagger \ddagger$ | $V_{C E}=5 \mathrm{~V}$ | $I_{E}=-1 m A$ |  | 20 |  | $d b$ |
| $\mathrm{f}_{\text {cb }}$ | Frequency Cutoff | $V_{C B}=5 \mathrm{~V}$ | $I_{E}=-1 m A$ |  | 6 |  | mc |
| $\mathrm{C}_{\text {ob }}$ | Output Capacitance (1mc) Saturation Resistance** | $\begin{aligned} V_{C B} & =5 \mathrm{~V} \\ \mathrm{I}_{\mathrm{B}} & =2.2 \mathrm{~mA}\end{aligned}$ | $\begin{aligned} & I_{E}=-\operatorname{lm} A \\ & I_{C}=5 m A \end{aligned}$ |  | 7 100 |  | $\mu \mu \mathrm{f}$ Ohm |
| $\mathrm{R}_{\mathbf{c t}}$ | Saturation Resistance** | $\mathrm{I}_{\mathrm{B}}=2.2 \mathrm{~mA}$ | $\mathrm{I}_{\mathrm{C}}=5 \mathrm{~mA}$ |  | 100 | 200 | Onm |

[^19]
# 76 to 333 beta spread Specifically designed for high gain at high temperatures 

## mechanical data

Welded case with glass-to-metal hermetic seal between case and leads. Approximate weight is 1.7 grams.

absolute maximum ratings af $25^{\circ} \mathrm{C}$ ambient lexcept where advanced temperatures are indicated]
Collector Voltage Referred to Base . . . . . . . . . . . . . 45 V
Emitter Voltage Referred to Base . . . . . . . . . . . . . 1 V
Collector Current . . . . . . . . . . . . . . . . . 25 mA
Emitter Current . . . . . . . . . . . . . . . . . . -25 mA
Collector Dissipation $\}$. . . . . . . . . . . . . . . . 150 mW
at $\left.100^{\circ} \mathrm{C}\right\}$. . . . . . . . . . . . . . . . 100 mW
at $\left.150^{\circ} \mathrm{C}\right\}$. . . . . . . . . . . . . . . . 50 mW
junction temperature
Maximum Range . . . . . . . . . . . . . . . $-65^{\circ} \mathrm{C}$ to $+175^{\circ} \mathrm{C}$

|  | characterioks at | tost conditions |  | min. | design center | max. | unit |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| $\mathrm{BV}_{C B O}$ | Collector Breakdown Voitage | Ic $=50 \mu \mathrm{~A}$ | $\mathrm{I}_{\mathrm{E}}=0$ | 45 |  |  | Volt |
| $l_{\text {cbo }}$ | Collector Cutoff Current ${ }^{\text {a }}$ | $V_{C B}=30 \mathrm{~V}$ | $\mathrm{I}_{\mathrm{E}}=0$ |  |  | 2 | ${ }_{\mu} \mathrm{A}$ |
|  | at $100^{\circ} \mathrm{C}$ \} | $V_{C B}=5 \mathrm{~V}$ | $\mathrm{I}_{\mathrm{E}}=0$ |  |  | 10 | $\mu \mathrm{A}$ |
|  | at $150^{\circ} \mathrm{C}$ \} | $V_{C B}=5 V$ | $\mathrm{I}_{\mathrm{E}}=0$ |  |  | 50 | $\mu \mathrm{A}$ |
| ${ }^{\text {ib }}$ | Input Impedance | $V_{C B}=5 \mathrm{~V}$ | $\mathrm{I}_{\mathrm{E}}=-1 \mathrm{~mA}$ | 30 | 42 | 80 | Ohm |
| $h_{0 b}$ | Output Admittance | $V_{C B}=5 V$ | $\mathrm{I}_{\mathrm{E}}=-1 \mathrm{~mA}$ | 0 | 0.4 | 1.2 | $\mu \mathrm{mho}$ |
| $h_{\text {rb }}$ | Feedback Voltage Ratio | $V_{C B}=5 V$ | $\mathrm{I}_{\mathrm{E}}=-\mathrm{lmA}$ | 50 | 400 | 1000 | X10-6 |
| ${ }^{\text {hib }}$ | Current Transfer Ratio | $V_{C B}=5 \mathrm{~V}$ | $\mathrm{I}_{\mathrm{E}}=-\operatorname{lmA}$ | $-0.987$ | $-0.99$ | -0.997 |  |
| $\mathrm{PG}^{\text {e }}$ | Power Gain* $\dagger$ | $V_{\text {Ce }}=20 \mathrm{~V}$ | $\mathrm{I}_{\mathrm{E}}=-2 \mathrm{~mA}$ |  | 42.5 |  | db |
| NF | Noise Figure*t | $V_{\text {CE }}=5 \mathrm{~V}$ | $\mathrm{I}_{\mathrm{E}}=-\operatorname{ImA}$ |  | 20 |  | db |
| ${ }_{\text {fab }}$ | Frequency Cutoff | $V_{C B}=5 V$ | $I_{E}=-1 m A$ |  | 7 |  | mc |
| $\mathrm{C}_{\text {ob }}$ | Output Capacitance (1mc) | $V_{C B}=5 V$ | $\mathrm{I}_{\mathrm{E}}=-1 \mathrm{~mA}$ |  | ${ }^{7}$ |  | $\mu \mu{ }^{\text {f }}$ |
| Res | Saturation Resistance* | $1 \mathrm{~B}=2.2 \mathrm{~mA}$ | $\mathrm{I}_{\mathrm{C}}=5 \mathrm{~mA}$ |  | 100 | 200 | Ohm |

$$
\text { *Common Emittor } \quad t R_{E}=\mathbf{1 k} ; \mathbf{R}_{\mathrm{L}}=20 \mathrm{k} \quad \ddagger \text { Conventional Noise-Compared to } 1000 \text { ohm Iesislor, } 1000 \mathrm{cps} \text { and } \mathrm{I} \text { cycle band width }
$$

# TYPES 2N243, 2N244 <br> N-P-N GROWN-JUNCTION SILICON TRANSISTORS 

Oval Welded Package

## mechanical data

The transistor is in an oval welded package with glass-to-metal hermetic seal between case and leads. Unit weight is approximately 1 gram. The mounting clip is hardware supplied with the transistor.


[^20]WOIE: 1. Derute linearly to $150^{\circ} \mathrm{C}$ case temperature at the rate of $6 \mathrm{mw} /{ }^{\circ} \mathrm{C}$.
*JEDEC registered data
electrical charmcteristics of $25^{\circ} \mathrm{C}$ case fomperature (unless otherwise noted)

| paremeter |  | Hest conditions |  | types | min* | typ | max* | unit |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| $\mathrm{l}_{60}$ | Collector Cutoff Cursent | $V_{c t}=30 \mathrm{v}$, | $\mathrm{I}_{\mathrm{E}}=0$ | All |  |  | 1 | $\mu 0$ |
| Icro | Collector Cutofí Current | $\begin{aligned} & Y_{\mathrm{cs}}=30 \mathrm{y} \\ & \mathrm{~T}_{\mathrm{C}}=150^{\circ} \mathrm{C} \end{aligned}$ | $\mathrm{t}_{\mathrm{E}}=0$ | All |  | 15 |  | $\mu \mathrm{a}$ |
| $\mathrm{BV}_{\text {cio }}$ | Colledor-Base Ereokdown Yoltage | $\mathrm{l}_{\mathrm{c}}=50 \mu \mathrm{a}$, | $\mathrm{IE}_{\mathrm{E}}=0$ | A A | 60 |  |  | $v$ |
| $\mathrm{BV}_{\text {ceo }}$ | Collector-Emitter Braakdown Voltage | $\mathrm{l}_{\mathrm{c}}=100 \mu \mathrm{a}$, | $\mathrm{I}_{1}=0$ | All |  | 60 |  | $v$ |
| $V_{\text {be }}$ | Iaso-Emither Voltage | $L_{8}=3 \mathrm{ma}$, | $\mathrm{l}_{\mathrm{c}}=20 \mathrm{ma}$ | All |  |  | 1 | $v$ |
|  | DC Colloctor-Emifter Soturation Resistanca | $\mathrm{I}_{\mathrm{s}}=3 \mathrm{ma}$ | $\mathrm{Ic}_{\mathrm{c}}=20 \mathrm{ma}$ | All |  |  | 350 | ohm |
| $h_{\text {H }}$ | AC Common-bose Forward Current Transfor Ratio | $\begin{aligned} & V_{C B}=10 \mathrm{v}, \\ & \mathrm{f}=1 \mathrm{kt} \end{aligned}$ | $\mathrm{I}_{\mathrm{E}}=-5 \mathrm{ma}$ | $\begin{aligned} & 2 N 243 \\ & 2 N 244 \end{aligned}$ | $\begin{array}{\|r\|} \hline-0.9 \\ -0.961 \\ \hline \end{array}$ | $\begin{array}{\|l\|} \hline-0.94 \\ -0.97 \\ \hline \end{array}$ | $\begin{array}{r} -0.968 \\ -0.989 \end{array}$ |  |
| hib | AC Common-base Input Impedonce | $\begin{aligned} & V_{\mathrm{ct}}=10 \mathrm{v}, \\ & \mathrm{i}=1 \mathrm{kc} \\ & \hline \end{aligned}$ | $\mathrm{I}_{\mathrm{E}}=-5 \mathrm{ma}$ | All |  | 12 | 30 | obm |
| $h_{\text {rb }}$ | AC Common-Base Reverse Voltage Iranster Notio | $\begin{aligned} & v_{c ı}=10 v_{0} \\ & f=1 \mathrm{kc} \end{aligned}$ | $I_{\mathrm{E}}=-5 \mathrm{ma}$ | Ald |  | $60 \times 10^{-4}$ | $300 \times 10^{-6}$ |  |

## functional tests at $25^{\circ} \mathrm{C}$ case temperature




[^21]
# Bota From 9 to 20 <br> Specifically designed for high gain at high tomperatures 

## meshenicell dete

Welded case with glass-to-metal hermetic seal between case and leads. Unit weight is approximately 1 gram. All JEDEC TO-5 dimensions and notes are applicable.

abselufe maximum raflags at $25^{\circ} \mathrm{C}$ amblemf [oxcept where advanced tomperatures are indicatod]

junction remperature
Maximum Range . . . . . . . . . . . . . . . $-65^{\circ} \mathrm{C}$ to $+175^{\circ} \mathrm{C}$
cemmen besse design characteristles of $\mathbf{T j}=25^{\circ} \mathrm{C}$ [except where advanced temperatures are indicetod]

|  |  | test condillous |  | min. | design | mex. | mah |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| $8 \mathrm{~V}_{\text {coo }}$ | Collector Breakdown Voltage | lc $=50 \mu \mathrm{~A}$ | If $=0$ | 45 |  |  | Volt |
| leno | Collector Cutoff Current\} | $V_{\text {ct }}=30 \mathrm{~V}$ | $1:=0$ |  |  | 2 | $\mu \mathrm{A}$ |
|  | at $100^{\circ} \mathrm{C}$ \} | $V_{\text {ct }}=5 \mathrm{~V}$ | $t=0$ |  |  | 10 | $\mu \mathrm{A}$ |
|  | - $150^{\circ} \mathrm{C}$ | $V_{c ı}=5 V$ | $1:=0$ |  |  | 50 | $\mu \mathrm{A}$ |
|  | Input Impedance | $V_{\text {ct }}=5 \mathrm{~V}$ | $1:=-1 m A$ | 30 | 55 | 80 | Ohm |
| hob ! | Output Admitiance | $V_{c ı}=\mathrm{EV}$ | $i=-1 m A$ | 0 | 0.5 | 1.2 | ${ }^{\mu}$ mho |
| hrbit | Feedback Voltage Ratio | $V_{c a}=5 \mathrm{~V}$ | $L_{E}=-1 \mathrm{~mA}$ | 0 | $195$ | 500 | $\times 10^{-6}$ |
| $h_{n}{ }^{\text {f }}$ | Current Transfor Ratio | $V_{c a}=5 V$ | $h=-\operatorname{lmA}$ | $-0.9$ | -0.925 | -0.963 |  |
| NF | Noise Figure ${ }^{\text {\# }}$ | $V_{\text {ca }}=5 \mathrm{~V}$ | $I_{1}=-1 \mathrm{~mA}$ |  | 20 | 30 | db |
| fab | Frequency Cutolf | $V_{c t}=5 \mathrm{~V}$ | $l_{\text {a }}=-\operatorname{ImA}$ | 1 | 6 |  | me |
| Cob | Output Capacitanee (Ime) | $V_{c t}=5 \mathrm{~V}$ | $\mathrm{LE}=-\mathrm{ImA}$ |  | 10 | 30 | $\mu \mu f$ |
| Res | Saturation Rosistance* | $I_{1}=2.2 \mathrm{~mA}$ | $I_{c}=5 \mathrm{~mA}$ |  | 70 | 200 | Ohm |

-Common Emitter $\quad\{f=1$ ke $\quad$ Conventional Nolse-Compared to 1000 ohm restitor, 1000 eps and 1 cycle band width

# Bota From 18 to 40 Specifically designed for high gain of high femperetures 

## mechanfical date

Welded case with glass-to-metal hermetic seal between case and leads. Unit weight is approximately 1 gram. All JEDEC TO-5 dimensions and notes are applicable.


|unction temperature
Maximum Range

$$
\mathrm{C} \text { to }+175^{\circ} \mathrm{C}
$$

common bese design chareetoristies of $\mathrm{T}_{\mathrm{j}}=25^{\circ} \mathrm{C}$ [oxeept where advanced temperatures are indicated]

|  |  | teet eandiliong |  | minm. | doalone | mem. | unt |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| $\begin{aligned} & \text { BVeco } \\ & \mathrm{l}_{\text {ceo }} \end{aligned}$ | Collector Breakdown Voltage Collector Cutoff Currentt $\left.\begin{array}{l}\left.\begin{array}{l}a+100^{\circ} \mathrm{C} \\ +150^{\circ} \mathrm{C}\end{array}\right\}\end{array}\right\}$ | $\begin{aligned} & l_{c}=50 \mu A \\ & V_{e e}=30 V \\ & V_{c e}=5 V \\ & V_{e x}=5 V \end{aligned}$ | $I_{1}=0$ $l_{1}=0$ $I_{1}=0$ $I_{2}=0$ | 45 |  | 2 10 50 | Volt MA $\boldsymbol{\mu A}$ |
| $h_{16}{ }^{\text {t }}$ | Input Impedance | $V_{c c}=5 V$ | $H_{1}=-1 \mathrm{~mA}$ | 30 | 65 | 80 | ${ }_{\text {Ohm }}$ |
| hatt | Oufput Admittance | $V_{c a}=5 V$ | $1 \mathrm{~A}=-1 \mathrm{~mA}$ | 0 | 0.8 | 1.2 | ${ }^{\mu} \mathrm{mh} /{ }^{\text {a }}$ |
| hat $h_{\text {ht }}$ | Feedbeck Voltage Ratio | $V_{c a}=5 V$ $V_{c a}=5 Y$ | $H_{1}=-1 \mathrm{~mA}$ | 0 | 370 | 1000 | $\times 10^{-6}$ |
| NF | Noise Figurs** | $V_{\text {a }}=5 V$ | $1=-\operatorname{lmA}$ | - | 20.96 | 30 | db |
| fab | Frequency Cutoff | $V_{c a}=5 V$ | $1:=-1 m A$ | 2 | 8 |  | me |
| $\mathrm{C}_{\mathbf{6}}$ | Output Capectionce ( 1 mc ) | $V_{\text {ce }}=5 V$ | $f=-1 \mathrm{~mA}$ |  | 10 | 30 | Mpf |
| Res | Saturation Resistance* | $H_{1}=2.2 \mathrm{~mA}$ | $i_{c}=5 \mathrm{~mA}$ |  | 70 | 200 | Ohm |

[^22]
## Beta From 18 to 90

Specifically designed for high gain at high temperatures
mechanical data
Welded case with glass-to-metal hermetic seal between case and leads. Unit weight is approximately 1 gram. All JEDEC TO-5 dimensions and notes are applicable.

abselute maximum retings at $25^{\circ} \mathrm{C}$ ambient [oxeept where advanced temperatures are indicated]

junction temperature
Maximum Range . . . . . . . . . . . . . . . $-65^{\circ} \mathrm{C}$ to $+175^{\circ} \mathrm{C}$
common base design charaeteristics at $\mathbf{T}_{\mathbf{j}}=25^{\circ} \mathrm{C}$ [oxcopt where advanced tomporatures are indicated]


[^23]
# Beta From 36 to 90 Specifically designed for high gain at high temperatures 

## mechanical dofa

Welded case with glass-to-metal hermetic seal between case and leads. Unit weight is approximately 1 gram. All JEDEC TO- 5 dimensions and notes are applicable.

absolute maximum ratings at $25^{\circ} \mathrm{C}$ ambient lexcept where advanced tomperatures are indicated

junction semperature
Maximum Range . . . . . . . . . . . . . . . $-65^{\circ} \mathrm{C}$ to $+175^{\circ} \mathrm{C}$
common base design eharacteristies at $\mathbf{T}_{\mathbf{i}}=25^{\circ} \mathrm{C}$ lexcept where advanced temperatures are indicated)

|  |  | test condifiows |  | min. | design center | max. | math |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| BVCw | Collector Breakdown Voltage |  | $I_{E}=0$ | 45 |  |  |  |
| Icoo | Collector Cutoff Current | $v_{c:}=30 \mathrm{~V}$ | $\mathrm{I}_{\mathrm{E}}=0$ |  |  | 2 | $\mu \mathbf{A}$ |
|  | at $100^{\circ} \mathrm{C}$ | $v_{c B}=5 v$ | $E_{E}=0$ |  |  | 10 | $\mu \mathrm{A}$ |
|  | $\text { at } \left.150^{\circ} \mathrm{C}\right\}$ | $v_{c}=5 \mathrm{~V}$ | $I_{E}=0$ |  |  | $50$ |  |
| $h_{\text {ib }}{ }^{\dagger}$ | Input Impedance | $V_{\text {cs }}=5 \mathrm{~V}$ | $l_{E}=-1 \mathrm{~mA}$ | 30 | 55 | $80$ | Ohm |
| $h_{06} \dagger$ | Output Admittance | $V_{C u}=5 \mathrm{~V}$ | $I_{E}=-1 \mathrm{~mA}$ | $0$ | 0.3 | 1.2 | $\mu \mathrm{mho}$ |
| $h_{\text {rb }}{ }^{\prime}$ | Feedback Voltage Ratio | $V_{C E}=5 \mathrm{~V}$ | $I_{E}=-1 \mathrm{~mA}$ | $0$ | 600 | $1000$ | $\times 10^{-6}$ |
| $h_{f b}{ }^{\prime}$ | Current Transfor Ratio | $v_{c t}=5 v$ | $I_{\varepsilon}=-1 m A$ | -0.9735 | $-0.98$ | $-0.989$ |  |
| NF | Noiso Figure*: | $V_{C E}=5 V$ | $\mathrm{I}_{\mathrm{E}}=-\operatorname{Im} A$ |  | $20$ | 30 | db |
| $f{ }^{\text {fob }}$ | Frequency Cutoff | $V_{c e}=5 \mathrm{~V}$ | $I_{E}=-\operatorname{Im} A$ | 2 | $11$ |  | me |
| $C_{o b}$ Rcs | Output Capacitance (1me) Saturation Resistance* | $V_{C B}=5 \mathrm{~V}$ | $I_{E}=-I m A$ |  | $10$ | $30$ | $\mu \mu f$ |
| Res | Saturation Resistance* | $\mathrm{I}_{\mathrm{B}}=2.2 \mathrm{~mA}$ | $1 \mathrm{c}=5 \mathrm{~mA}$ |  | 70 | $200$ | Ohm |

[^24]
## Beta From 76 to 333

Specifically designed for high gain at high temperatures
mechanical data
Welded case with glass-to-metal hermetic seal between case and leads. Unit weight is approximately 1 gram. All JEDEC TO-5 dimensions and notes are applicable.

absolute maximum ratings at $25^{\circ} \mathrm{C}$ ambient [oxcept where advancod tomporatures are indicated]

junction temperature
Maximum Range
$-65^{\circ} \mathrm{C}$ to $+175^{\circ} \mathrm{C}$
common base design characteristics of $\mathbf{T}_{\mathbf{i}}=25^{\circ} \mathrm{C}$ [except where advanced temperatures are indicated]

|  |  | test condifions |  | min. | design center | mex. | unit |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| $\mathrm{BV}_{\text {cıo }}$ | Collector Breakdown Voltage | $I_{c}=50 \mu \mathrm{~A}$ | $\mathrm{I}_{\mathrm{E}}=0$ | 45 |  |  | Volt |
| Íco | Collector Cutoff Current | $V_{C l}=30 \mathrm{~V}$ | $l_{E}=0$ |  |  | $2$ | $\mu \mathrm{A}$ |
|  | $\left.a+100^{\circ} \mathrm{C}\right\}$ | $V_{c ı}=5 \mathrm{~V}$ | $\mathrm{I}_{5}=0$ |  |  | $10$ | $\mu \mathrm{A}$ |
|  | $\left.a+150^{\circ} \mathrm{C}\right\}$ | $V_{C B}=5 \mathrm{~V}$ | $\mathrm{l}_{\mathrm{E}}=0$ |  |  | 50 | $\mu \mathrm{A}$ |
| $h_{\text {is }} \dagger$ | Input Impedance | $V_{c i}=5 \mathrm{~V}$ | $\mathrm{I}_{\mathrm{E}}=-1 \mathrm{~mA}$ | 30 | 55 | 80 | Ohm |
| hob ${ }^{\text {a }}$ | Output Admittance | $V_{\text {ct }}=5 \mathrm{~V}$ | $y_{z}=-1 \mathrm{~mA}$ | 0 | 0.25 | 1.2 | Mmho |
| $h_{\text {rb }} \dagger$ | Feedback Voltage Ratio | $V_{c i}=5 \mathrm{~V}$ | $l_{E}=-1 \mathrm{~mA}$ | 0 | 700 | 1000 | $\times 10^{-4}$ |
| hibl | Current Transfer Ratio | $V_{\text {ce }}=5 \mathrm{~V}$ | $\mathrm{I}_{\mathrm{E}}=-1 \mathrm{~mA}$ | $-0.987$ | $-0.99$ | $-0.997$ |  |
| NF | Noise Figure* | $V_{C E}=5 Y$ | $l_{\mathrm{E}}=-\operatorname{lmA}$ |  | 20 | 30 |  |
| $\mathrm{fa}_{\text {b }}$ | Frequeney Cutoff | $V_{\text {ct }}=5 \mathrm{~V}$ | $I_{E}=-1 \mathrm{~mA}$ | 2 | 13 |  |  |
| Cob | Output Capacitance (Ime) | $V_{\text {et }}=5 \mathrm{~V}$ | $l_{E}=-1 \mathrm{~mA}$ |  | 10 70 | 30 200 | $\mu \mu \dagger$ <br> Ohm |
| Rcs | Saturation Resistance* | $I_{1}=2.2 \mathrm{~mA}$ | $l_{c}=5 \mathrm{~mA}$ |  | 70 | 200 | Ohm |

- Commen Emitter $\quad \ddagger f=1 \mathrm{kc} \quad \ddagger$ Conventional Noise-Compared to 1000 ohm resistor, 1000 cps and I eycle band width


# FOR SWITCHING AND GENERAL PURPOSE APPLICATIONS <br> - Guaranteed 20-55 DC Beta <br> - 10 mc min Alpha-Cutoff <br> - Low Collector Capacity <br> - High Gain af Low Levels 

## mechanical data

Welded case with glass-to-metal hermetic seal between case and leads. Unit weight is approximately 1 gram. All JEDEC TO-5 dimensions and notes are applicable.

absalute maximum ratings at $25^{\circ} \mathrm{C}$ ambiont temperature (unless otherwise noted)
Collector-Base Valtage ..... 45 v
Collector-Emitter Voltage ..... 30 v
Colloctor Current ..... 20 ma
Emitter Current ..... 20 ma
Total Device Dissipation (Derate $1 \mathrm{mw} /{ }^{\circ} \mathrm{C}$ for Advanced Temperatures) ..... 125 mw
Storage Temperature Range ..... $-65^{\circ} \mathrm{C}$ to $+150^{\circ} \mathrm{C}$
olectrieal charactaribties at $25^{\circ} \mathrm{C}$ ambiont temperature (unless otherwive noted)

|  | paramefers | test condifions | min | typ | max | unit |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| ${ }^{\prime} \mathrm{CeO}$ | Colicitor Reverse Current | $\mathrm{v}_{\mathrm{CB}}=20 \mathrm{~V} \quad \mathrm{I}_{\mathrm{E}}=0$ |  |  | 1 | $\mu$ |
| ${ }^{\text {coso }}$ | Collictor tiverse Currans | $v_{C B}=20 . \quad y_{E}=0 \mathrm{~T}_{\mathrm{A}}=150^{\circ} \mathrm{C}$ |  |  | 100 | $\mu^{\bullet}$ |
| $\mathrm{VN}_{\text {ceo }}$ | Colfecter-Less troakdown Veltegs | $\mathrm{i}_{\mathrm{c}}=50 \mu \mathrm{l} \mathrm{I}_{\mathrm{E}}=0$ | 45 |  |  | $v$ |
| ${ }^{51} \mathrm{CEO}$ | Colloctor-Emitior ilveckiown Yeliage | $\mathrm{I}_{\mathrm{c}}=100 \mu^{0} \mathrm{I}_{1}=0$ | 30 |  |  | v |
| $\mathrm{EVEO}_{\text {EHO}}$ | Emiltor-Base Ereokdown Volicge | $\mathrm{l}_{\mathrm{E}}=50 \mu \mathrm{l} \mathrm{l}_{\mathrm{C}}=0$ | 1 |  |  | $v$ |
| $\mathrm{h}_{\mathrm{ib}}$ | A-C Comman-lise Iaput Impedence | $\mathrm{v}_{\mathrm{CB}}=20 \mathrm{v} \quad \mathrm{l}_{\mathrm{E}}=-1 \mathrm{mat}=1 \mathrm{kc}$ | 30 | 50 | 80 | ohm |
| $h_{0}$ | A-C Commen-Sase Dutwi Admittence | $\mathrm{V}_{\mathrm{CI}}=20 \mathrm{v} \quad \mathrm{l}_{\mathrm{E}}=-1 \mathrm{ma} 1=1 \mathrm{kc}$ |  | 0.2 | 1 | $\mu \mathrm{mmo}$ |
| ${ }^{\text {rb }}$ | A-C Commen-Base Rowrs-Yoltage Trenster tatio | $\mathrm{v}_{\mathrm{ct}}=20 \mathrm{v} \quad \mathrm{l}_{\mathrm{E}}=-1 \mathrm{ma} 9=1 \mathrm{kc}$ |  | 200 | 2000 | $\times 10^{-6}$ |
| $h_{\text {fb }}$ | A.C Common-lese Ferwerd-Current Trewsior Ratie | $\mathbf{v}_{\mathrm{CI}}=20 \mathrm{v} \quad \mathrm{l}_{\mathrm{E}}=-1 \mathrm{ma} f=1 \mathrm{kc}$ | -0.95 | $\rightarrow 0.985$ |  |  |
| $H_{\text {re* }}{ }^{\text {c }}$ | D-C Forward-Currant Tressfor Rotio | $v_{C E}=5 \mathrm{v} \quad i_{c}=10 \mathrm{ma}$ | 20 |  | 35 |  |
| $\left\|h_{\text {fo }}\right\|$ | A-C Common-Emitler Forward Current Iremsfor Ratio | $\mathbf{v}_{\mathrm{Ct}}=20 \mathrm{v} \quad \mathrm{l}_{\mathrm{E}}=-1 \mathrm{mc} \quad \mathrm{t}=2.5 \mathrm{mc}$ | 14 | 22 |  | db |
| ${ }^{\text {d }}$ b ${ }_{\text {b }}$ | Common-Sase Alphe-Crioff frequency | ${ }^{V_{C B}}=20{ }^{\text {r }}$ V $\quad \mathrm{I}_{E}=-1 \mathrm{ma}$ | 10 | 20 |  | me |
| ${ }_{6}{ }^{6}$ | Commen-lase Outpul Capecitence | $\mathbf{v}_{\mathbf{C B}}=20 \mathrm{r} \quad \mathrm{I}_{\mathrm{E}}=0 \quad 1=1 \mathrm{~mm}$ |  | 2 | 3 | $\mu \mu^{\prime \prime}$ |
|  | O-C Commen-Emither Seturation Resistonce | $\mathrm{I}_{8}=1 \mathrm{me} \mathrm{I}_{\mathrm{C}}=10 \mathrm{ma}$ |  | 80 | 150 | ohm |

## avitehing characteriaties

|  | Turn-en Time [Intludes delay time $\left.\left(\mathrm{f}_{\mathrm{d}}\right)\right]$ Storage Time Fall time | See Test Circuit | $\begin{aligned} & 0.05 \\ & 0.02 \\ & 0.08 \end{aligned}$ |  |
| :---: | :---: | :---: | :---: | :---: |

- These paramoters must be moesured using pulse tochniques. $\mathrm{PW}=\mathbf{3 0 0} \mu \mathrm{sec}$, Duty $\mathrm{Cyclo} \leq \mathbf{7 \%}$.
teet eireuit


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or represent that they are free from patent infringement.

# for switching and general purpose applications <br> - Guaranteed 45-150 DC Beta <br> - Low Collector Capacity <br> - 20 mc min Alpha-Cutoff <br> - High Gain af Low Levels 

## mechanical data

Welded case with glass-to-metal hermetic seal between case and leads. Unit weight is approximately 1 gram. All JEDEC TO-5 dimensions and notes are applicable.

absolute maximum ratings at $25^{\circ} \mathrm{C}$ ambient temperature (unless otherwise noted)

electrical characteristics at $25^{\circ} \mathrm{C}$ ambient temperature (unless otherwise noted)

\begin{tabular}{|c|c|c|c|c|c|c|}
\hline \& permmoters \& test cenditions \& min \& typ \& max \& unit \\
\hline \begin{tabular}{l}
\({ }^{\prime} \mathrm{CoO}\) \\
\({ }^{\prime} \mathrm{ceo}\) \\
\({ }^{\mathbf{V Y}_{\text {CeO }}}\) \\
\({ }^{B_{V}} \mathbf{C E O}\) \\
\({ }^{51} V_{\text {EGO }}\) \\
\(H_{i b}\) \\
\({ }^{6}\) ob \\
\({ }^{6}\) \\
\(H_{16}\) \\
\({ }^{H_{F E}}{ }^{*}\) \\
|nt \\
\({ }^{f_{\boldsymbol{\alpha}}} \mathbf{b}\) \\
Cob \\
\({ }^{\text {P }}\) CEISNA"
\end{tabular} \& \begin{tabular}{l}
Collector Reverse Currtint \\
Cellecter, lioverse Curreal \\
Colisctor-Iase Breakdown Voltage \\
Collocter-Emitter Iteokdown Voltoge \\
Emilter-Ease Breakdown Voltage \\
A-C Common-lose Iapul Impedance \\
A-C Comanom-Mose Output Admitjanca \\
A-C Common-Rase Revarse-Yollage Trensfer Ratio \\
A-C Common-Dase Ferward-Curreat Transfer thatio \\
0-C Forward-Current Transtar Ratio \\
A-C Common-Emitter Forward-Current Trensfor Matio \\
Cemmon-Bes: Mlpha-Cutoff Frequeacy \\
Common-Bose Dutput Capacitence \\
O-C Cemmon-Emittor Saturatien Resistance
\end{tabular} \&  \& 45
30
1
30

-0.975
45
20

20 \& | 50 |
| :--- |
| 0.2 |
| 300 |
| -0.99 |
| 80 |
| 24 |
| 30 |
| 2 |
| 80 | \& \[

$$
\begin{array}{r}
1 \\
100 \\
\\
\hline 60 \\
1 \\
2000 \\
150 \\
\hline \\
\hline
\end{array}
$$

\] \& | $\mu$ |
| :--- |
| $\mu^{4}$ |
| $v$ |
| $v$ |
| $v$ |
| ohm |
| $\mu^{\text {mano }}$ |
| $\times 10^{-6}$ |
| db |
| me |
| $\mu \mu^{\dagger}$ |
| ohm | <br>

\hline
\end{tabular}

switching characteristics

| $\begin{aligned} & \mathbf{t o n}^{\prime} \\ & t_{s} \\ & i_{f} \end{aligned}$ | Turn-on Time [Inctudes deloy time (1d)] Slorage Time Fall Time | See Test Circuit | 0.05 0.02 0.08 | $\begin{aligned} & \mu \mathrm{sec} \\ & \mu_{\text {sec }} \\ & \mu^{\text {sec }} \end{aligned}$ |
| :---: | :---: | :---: | :---: | :---: |

- These perematers must be measured using pulse tochniquas. PW $=300 \mu$ sec, Duly cyclo $\leq 2 \%$.
test circuit



## TYPES 2N339 THRU 2N343 <br> N-P-N GROWN-JUNCTION SILICON TRANSISTORS

# 1 Watt at $25^{\circ} \mathrm{C}$ Case Temperature <br> Designed for <br> Audio and Servo Amplifier Applications 

mechanical data


The transistor is in an welded package with glass-to-metal hermetic seal between case and leads. Unit weight is approximately 1.5 grams. *JEDEC TO-11.
A non-insulated mounting clip (TI P/N 10-31-052-006) is provided with each transistor. Material is beryllium copper, cadmium plated-gold iridited.

all leads are insulated from the case

absolute maximum ratings at $25^{\circ} \mathrm{C}$ case temperature (unless otherwise noted)

* Collector Current
*Total Device Dissipation (see note i)
*Total Device Dissipation at $100^{\circ} \mathrm{C}$ Cas . . . . . . . . . . . . . . . 1000 mw
*Total Device Dissipation at $125^{\circ} \mathrm{C}$ Case Temperatur
Total Device Dissipation of $125^{\circ} \mathrm{C}$ Case Temperature (see note 1) . . . . . . . . . . 200 mw
*Storage and Operating Collector Junction Temperature Range . . . . . . . . $-65^{\circ}$ to $+150^{\circ} \mathrm{C}$
Storage and Operating Collector Junction Temperature Range (TI Guarantee) . . . $-65^{\circ}$ to $+175^{\circ} \mathrm{C}$


## *electrical characteristics af $25^{\circ} \mathrm{C}$ cose femperature (unless otherwice meted)

| Paremmeter |  | tent cenditions | 2N339 |  | 2N340 |  | 2N341 |  | 2N392 |  | 2N943 |  | unit |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | min | max | min | mex | min | max | min | max | min | max |  |
| $\mathrm{ICNO}^{\text {cos }}$ | Cellecter Culofl Corrent |  | $V_{\text {cs }}=30 \vee \quad \mathrm{I}_{\mathrm{E}}=0$ |  | 1 |  | 1 |  | 1 |  | 1 |  | 1 | $\mu$ |
| leno | Collecter Cutolf Corront | $\begin{aligned} & y_{c s}=30 v \quad I_{5}=0 \\ & T_{c}=+15 e^{\circ} \mathrm{C} \end{aligned}$ |  | 250 |  | 250 |  | 250 |  | 254 |  | 250 | $\mu$ |
| ${ }^{\mathbf{V}} \mathbf{C + 0}$ | Coflector-tese Iroskdown Voltage | ${ }^{1} \mathrm{c}=50 \mu \mathrm{cos} \mathrm{I}_{5}=0$ | 55 |  | 85 |  | 125 |  | 00 |  | 4 |  | V |
| ${ }^{\text {Pex }}$ | Cellecter-Eminter Prestiown Voltape | $\mathrm{I}_{\mathrm{c}}=100 \mu \mathrm{l}=0$ | 55 |  | 85 |  | 85 |  | 6 |  | 40 |  | V |
| $\mathrm{HEO}_{6}$ | Emittor-ieso Irockitowin Volteg* | $\mathrm{I}_{\mathrm{E}}=100 \mu \mathrm{l} \quad \mathrm{I}_{\mathbf{C}}=0$ | 1 |  | 1 |  | 1 |  | 1 |  | 1 |  | V |
| Pcraset) | $\begin{aligned} & \text { OC Colforfer-Emitter } \\ & \text { Seburation Resistance } \end{aligned}$ | $\mathrm{t}_{\mathrm{s}}=3 \mathrm{~mm} \quad \mathrm{t}_{\mathrm{c}}=20 \mathrm{~mm}$ |  | 300 |  | 350 |  | 400 |  | 354 |  | 350 | $\cdots$ |
| $\mathrm{m}_{\text {fb }}$ | AC Commen-lese Ferwerd Corrent Trensier tavio | $\begin{aligned} & y_{c s}=10 \mathrm{v} \quad \mathrm{l}_{\mathrm{E}}=-5 \mathrm{me} \\ & \mathrm{f}=1 \mathrm{kc} \end{aligned}$ | -0.9 | -0.94\% | -0.9 | -4.769 | -4.9 | -0.949 | $-1.9$ | -0.97 | -0.96 | -0.9\% |  |
| $\mathrm{H}_{\text {ib }}$ | AC Cemancon-Eiess laput Impedeme | $\begin{aligned} & Y_{c s}=10 v \quad l_{t}=-5 \text { ma } \\ & f=1 \mathrm{kc} \end{aligned}$ |  | 30 |  | 39 |  | 0 |  | 30 |  | $\boldsymbol{x}$ | cmm |
| ${ }^{\text {b }}$ | $\begin{aligned} & \text { AC Comen-tere } \\ & \text { Output Adeniftemes } \end{aligned}$ | $\begin{aligned} & y_{c e}=10 . \quad I_{E}=-5 \mathrm{ma} \\ & \mathrm{i} 1 \mathrm{kc} \end{aligned}$ |  | 2 |  | 2 |  | 2 |  | 2 |  | 2 | mane |
| $W_{\text {rb }}$ | $\begin{aligned} & \text { AC Comem-liase teverse } \\ & \text { Vollege Irensfer tatio } \end{aligned}$ | $\begin{aligned} & Y_{C B}=10 \mathrm{y} \quad \mathrm{I}_{\mathrm{E}}=-5 \mathrm{mo} \\ & \mathrm{f}=1 \mathrm{ke} \end{aligned}$ |  | $\begin{array}{r} 300 \\ \times 10-6 \\ \hline \end{array}$ |  | [ $\begin{array}{r}300 \\ \times 10^{-6}\end{array}$ |  | (3009 |  | 300 $\times 10^{-6}$ |  | 300 $\times 10-4$ |  |



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## TYPES 2N339 THRU 2N343 N-P-N GROWN-JUNCTION SILICON TRANSISTORS

*functional teste at $25^{\circ} \mathrm{C}$ case temperature

|  | perametor | tost conditions | type | mln | typ | max | unit |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | Common-Emifter Powar Gain | $\begin{aligned} & \hline V_{c a}=26 \mathrm{v} ; I_{c}=20 \mathrm{ma} \\ & \Omega_{4}=1 \mathrm{k} \Omega_{;} f=1 \mathrm{kc} \\ & V_{g}=0.2 \mathrm{v} \end{aligned}$ | $\begin{aligned} & \hline 201339 \\ & 2 N 342 \\ & 2 N 343 \\ & \hline \end{aligned}$ | 30 |  |  | db |
|  |  | $\begin{aligned} & V_{e r}=45 \mathrm{v} ; \mathrm{l}_{\mathrm{c}}=15 \mathrm{ma;} \\ & a_{1}=2 \mathrm{k} \Omega ; f=1 \mathrm{kc} \\ & v_{0}=0.2 \mathrm{v} \end{aligned}$ | 2N340 | 30 |  |  | ¢ |
|  |  | $\begin{aligned} & Y_{c t}=67.5 v_{i} I_{c}=10 \mathrm{ma} \\ & R_{4}=4 \mathrm{k} \Omega ; f=1 \mathrm{kc} \\ & V_{g}=0.2 \mathrm{v} \end{aligned}$ | 2N341 | 30 |  |  | b |

POWER GAIN TEST CIRCUIT


- Inilicetes JEDEC ruglatered data

THERMAL CHARACTERISTICS

DISSIPATION DERATING CURVE


# TYPES A5T404, A5T404A, ABT404, ABT404A P-N-P SILICON TRANSISTORS 

BULLETIN NO. DL-8 7311979 , MARCH 1873

## SILECT ${ }^{\dagger}$ TRANSISTORS $\ddagger$ <br> FOR LOW-COST REPLACEMENT OF GERMANIUM 2N404, 2N404A <br> - A5T404, A5T404A Have Standard TO.18 100-mil Pin-Circle Configuration <br> - A8T404, A8T404A Have Same Outline and Basing as Motorola MPS404, MPS404A

## mechanical data

These transistors are encapsulated in a plastic compound specifically designed for this purpose, using a highly mechanized process developed by Texas Instruments. The case will withstand soldering temperatures without deformation. These devices exhibit stable characteristics under highthumidity conditions and are capable of meeting MIL-STD-202C, Method 106B. The transistors are Insensitive to light.

absolute maximum ratings at $\mathbf{2 5}{ }^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)


## TYPES A5T404, A5T404A, A8T404, ABT404A P-N-P SILICON TRANSISTORS

electrical characteristics at $25^{\circ} \mathrm{C}$ free-air temperature

| PARAMETER | TEST CONDITIONS |  | AET404 A8T404 | A5T404A A8T404A | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  | MIN MAX | MIN MAX |  |
| $V_{(B R) C B O}$ Collector-Base Breakdown Voitage | ${ }^{1} C=-10 \mu A, \quad I_{E}=0$ |  | -25 | -40 | V |
| $\mathrm{V}_{\text {(BR) CEO }}$ Collector-Emitter Braakdown Voltage | $I_{C}=-10 \mathrm{~mA}, \mathrm{I}_{B}=0$, | See Note 4 | -24 | -35 | V |
| $\mathrm{V}_{\text {(BR)EBO }}$ Emitter-Base Breakdown Voltage | $I_{E}=-10 \mu A, \quad I_{C}=0$ |  | -12 | -25 | V |
| ICBO Collector Cutoff Current | $\mathrm{V}_{C B}=-12 \mathrm{~V}, \mathrm{I}_{\mathrm{E}}=0$ |  | -100 | -100 | nA |
| IEBO Emitter Cutoff Current | $\mathrm{VEB}=-10 \mathrm{~V}, \mathrm{I}^{\prime}=0$ |  | -100 | -100 | nA |
| hFE Static Forward Current Transfer Ratio | $V_{C E}=-0.15 \mathrm{~V}, \mathrm{IC}=-12 \mathrm{~mA}$ |  | $30 \quad 400$ | $30 \quad 400$ |  |
|  | $V_{C E}=-0.2 \mathrm{~V}, \mathrm{I}^{\prime}=-24 \mathrm{~mA}$ |  | 24 | 24 |  |
| Vbe Base-Emitter Voltage (See Note 5) | $\mathrm{I}_{\mathrm{B}}=-0.4 \mathrm{~mA}, \mathrm{I}^{\prime}=-12 \mathrm{~mA}$ | See Note 4 | -0.85 | -0.85 | V |
|  | $I_{B}=-1 \mathrm{~mA}, \quad I_{C}=-24 \mathrm{~mA}$ |  | -1 | -1 |  |
| $V_{\text {ceisat }}$ Col | $\mathrm{I}_{\mathrm{B}}=-0.4 \mathrm{~mA}, \mathrm{I}^{\prime} \mathrm{C}=-12 \mathrm{~mA}$ | See Note 4 | -0.15 | -0.15 | V |
|  | $I_{B}=-1 \mathrm{~mA}, \quad \mathrm{IC}^{=}=-24 \mathrm{~mA}$ |  | $-0.2$ | -0.2 |  |
| Cobo Common-Base Open-Circuit <br> Output Capacitance | $V_{C B}=-6 \mathrm{~V}, \quad \mathrm{I}_{\mathrm{E}}=0$, | $\mathrm{f}=1 \mathrm{MHz}$ | 20 | 20 | pF |
| thfb Small-Signal Common-Base <br>  Forwerd Current Transfer Ratio <br>  Cutoff Frequency | $V_{C B}=-6 \mathrm{~V}, \quad \mathrm{lE}=1 \mathrm{~mA}$ |  | 4 | 4 | $\mathbf{M H z}$ |

NOTES: 4. These parameters must be measured using pulse techniquas. $t_{w}=\mathbf{3 0 0} \mu \mathrm{s}$, duty cycle $<\mathbf{2 \%}$.
5. The base-amitter voltage is the principal characteristic difference between these devices and their germanium counterparts. The $\mathrm{V}_{\mathrm{BE}}$ maximum limits for the 2 N 404 and 2 N 404 A are -0.36 V at $\mathrm{IC}=-12 \mathrm{~mA}$, and -0.4 V at $\mathrm{IC}=-24 \mathrm{~mA}$.
switching characteristics at $\mathbf{2 5}{ }^{\circ} \mathrm{C}$ free-air temperature

| PARAMETER |  | TEST CONDITIONS ${ }^{\text { }}$ | A.5T404 A8T404 |  |  | A5T404A A8T404A |  |  | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | MIN | TYP | MAX | MIN | TYP | MAX |  |
| $t_{d}$ | Delay Time |  | $\begin{aligned} & V_{C C}=-10 \mathrm{~V}, \\ & I_{B}=-10 \mathrm{~mA}, \\ & \mathrm{I}_{\mathrm{B}(1)}=-1 \mathrm{~mA}, \\ & \mathrm{~S}_{\mathrm{BE}} \text { Figure } 1 \end{aligned}$ |  | 65 |  |  | 80 |  | ns |
| $t_{5}$ | Rise Time |  |  | 55 |  |  | 100 |  | ns |
| $\mathrm{t}_{8}$ | Storage Time | $\begin{aligned} & V_{C C}=-10 V, \\ & I_{B}(1)=-1 \mathrm{~mA}, \\ & I_{B}=-10 \mathrm{~mA}, \\ & S_{B e} \text { Figure } 1 \end{aligned}$ |  | 400 |  |  | 400 |  | ns |
| $t_{f}$ | Fall Time |  |  | 70 |  |  | 100 |  | ns |
| $\mathrm{O}_{\mathbf{T}}$ | Total Control Charge | See Figure 2 |  |  | 1.8 |  |  | 1.8 | nc |

†Voltage and current values shown are nominal; exact values vary silightly with translstor parameters.

## TYPES A5T404, A5T404A, ABT404, ABT404A P-N-P SILICON TRANSISTORS

## PARAMETER MEASUREMENT INFORMATION



FIGURE 1-SWITCHING TIMES


TEST CIRCUIT


VOLTAGE WAVEFORMS

FIGURE 2-TOTAL CONTROL CHARGE

NOTES: a. The input waveform has the following characteristics: $\mathrm{t}_{\mathbf{r}} \leqslant 1 \mathrm{~ns}, \mathrm{t}_{\mathrm{f}} \leqslant 1 \mathrm{~ns}, \mathrm{t}_{\mathbf{w}} \geqslant 5 \mu \mathrm{~s}$, duty cycle $\leqslant 2 \%$.
b. Waveforms are monitored on an oscilloscope with the following characteristics: $\mathrm{t}_{\mathrm{r}} \leqslant 4 \mathrm{~ns}, \mathrm{R}_{\text {in }} \geqslant 100 \mathrm{k} \Omega, \mathrm{C}_{\text {in }} \leqslant 12 \mathrm{pF}$.
c. $\mathrm{Q}_{\mathrm{T}} \leqslant \mathbf{i . 8} \mathbf{n C}$ when the transistor turns off monotonically as shown by the solid line.

# TYPES 2N489 THRU 2N493, 2N489A THRU 2N493A, 2N489B THRU 2N493B P-N BAR-TYPE SILICON UNIJUNCTION TRANSISTORS 

Designed for Medium-Power Switching, Oscillator and Pulse Timing Circuits<br>- Highly Stable Negative Resistance and Firing Voltage<br>- Low firing Current<br>- High Pulse Current Capabilities<br>- Simplified Circuit Design

## *mechanical data

Package outline is similar to JEDEC TO-5 except for lead position. Approximate weight is one gram.

*absolute maximum ratings at $\mathbf{2 5}{ }^{\circ} \mathbf{C}$ free-air temperature (uniess otherwise noted)


MOTES 1. For maximum interbass voltoge see Figure
2. Derate linearly to $140^{\circ} \mathrm{C}$ free-air temperature ot the rate of $3.9 \mathrm{mw} /{ }^{\circ} \mathrm{C}$.
3. Derate linearly to $175^{\circ} \mathrm{C}$ hee-air temperature of the rale of $4.0 \mathrm{mw} /{ }^{\circ} \mathrm{C}$
4. Total interbase power dissipation must be limited by external circuit.

[^25]
## TYPES 2N489 THRU 2N493, 2N489A THRU 2N493A, 2N489B THRU 2N493B P-N BAR-TYPE SILICON UNIJUNCTION TRANSISTORS

*electrical characteristics at $25^{\circ} \mathrm{C}$ free-air femperature (unless otherwise noted)

| PARAMETER |  | TEST CONDITIONS | TYPE | PARENT SERIES |  | A SERES |  | B Smins |  | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | MIN |  | MAX | MIN | MAX | MIN | MAX |  |
| ${ }^{\text {P }}$ | Static Interbest Resistence |  | $\mathbf{v}_{\mathbf{m b l}}=3 \mathrm{v}, \mathrm{J}_{\mathrm{E}}=0$ | 2N489, 2N491, 2m43 | 4.1 | 6.4 | 4.7 | 6.8 | 4.7 | 6.8 | k |
|  |  | 2N490, 2N492 |  | 6.2 | 9.1 | 6.2 | 9.1 | 6.2 | 9.1 | kn |
| $\boldsymbol{\eta}$ | Intrinsic Standofi Ratio | $\begin{aligned} & y_{\text {Eiti }}=10 v \\ & \text { Seo Figore } 5 \end{aligned}$ | 2N469, 21490 | 0.51 | 0.62 | 0.51 | 0.62 | 0.51 | 0.62 |  |
|  |  |  | 2M491, 2N492 | 0.56 | 0.60 | 0.56 | 0.68 | 0.56 | 0.48 |  |
|  |  |  | 24193 | 0.62 | 0.75 | 0.62 | 0.75 | 0.62 | 0.75 |  |
| Itaben | Modulatod Intorbese Currnot | $\mathrm{v}_{\mathbf{2 2 H 1}}=10 \mathrm{v}_{1} \mathrm{I}_{\mathrm{E}}=50 \mathrm{ma}$ | All Types | 6.8 | 22 | 6.8 | 22 | 6.8 | 22 | ma |
| $\mathrm{I}_{\text {elzo }}$ | Emitior Remorse Curreat | $\mathrm{V}_{12 \mathrm{E}}=60 \mathrm{v}_{\text {, }} \quad \mathrm{I}_{\mathrm{Bl} 1}=0$ | All Types |  | -2 |  | -2 |  | -2 | $\mu$ |
|  |  | $\mathrm{V}_{\mathrm{BE}}=30 \mathrm{v}_{\mathrm{r}} \quad \mathrm{I}_{\mathrm{Bl}}=0$ | All Typos |  |  |  |  |  | -0.2 | $\mu$ |
|  |  | $\begin{aligned} & \mathbf{v}_{\mathrm{B} 2 \mathrm{E}}=10 \mathrm{v}, \mathrm{I}_{\mathrm{B} 1}=0 \\ & \mathrm{~T}_{\mathrm{J}}=150^{\circ} \mathrm{C} \end{aligned}$ | All Types |  | -20 |  | -20 |  | -20 | $\mu \mathrm{A}$ |
| 1 p | Powk-Paint Emither Corrent | $\mathrm{V}_{8201}=25 \mathrm{r}$ | All Types |  | 12 |  | 12 |  | 6 | $\mu$ |
| $\mathbf{v}_{\text {EBH\|sa+ }}$ | Enitter less-0ne Safuration Veltage | $\mathrm{V}_{\mathrm{Bza}}=10 \mathrm{v}, \mathrm{I}_{\mathrm{E}}=50 \mathrm{md}$ | 2M409, 2M4\% |  | 5.0 |  | 4.0 |  | 4.0 | $v$ |
|  |  |  | 2N491, 2N492 |  | 5.0 |  | 4.3 |  | 4.3 | $v$ |
|  |  |  | $2 \mathrm{N493}$ |  | 5.0 |  | 4.4 |  | 4.6 | $v$ |
| IV | Valloy-Point Emither Current | $\mathrm{V}_{\text {B2 }}=20 \mathrm{v}_{1} \mathrm{R}_{\text {B2 }}=100 \Omega$ | All Types | 8 |  | 8 |  | 1 |  | me |
| $V_{\text {OBI }}$ | Cose-Ono Prok Puiso Voltage | $\begin{aligned} & V_{1}=200 \\ & R_{10}=20 \Omega \\ & \text { Soe Figure } 4 \end{aligned}$ | All Types |  |  | 3.0 |  | 3.0 |  | $\checkmark$ |

FIGURE I-INTERBASE VOLTAGE RATING CURVE
$r_{\text {s }}$ - STATIC INTERBASE RESISTANCE $-\mathrm{k} \Omega$



EXAMPLE:
FOR $r_{m}$ OF $6 \mathrm{k} \Omega$
AND $\mathrm{T}_{\mathrm{A}}$ OF $50^{\circ} \mathrm{C}$, MAX. ALLOWABLE V ${ }^{\circ}$ WOULD BE 58 VOLTS
-Inelleates JEDEC megistorvd data

## TYPES 2N489 THRU 2N493, 2N489A THRU 2N493A, 2N489B THRU 2N493B P-N BAR-TYPE SILICON UNIJUNCTION TRANSISTORS

PARAMETER MEASUREMENT INFORMATION


FIGURE 2 -UNIJUNCTION TRANSISTOR NOMENCLATURE


FIGURE 3-GENERAL STATIC EMITTER CHARACTERISTIC CURVE


FIGURE 4 - $V_{\text {OBI }}$ TEST CIRCUIT

$\boldsymbol{\eta}$ - Intrinsic Standoff Ratio - This parameter is defined in terms of the peak-point voltage, $V_{p}$, by means of the equation: $V_{p}=\boldsymbol{\eta}$ $V_{\text {E2n }}+V_{F}$, where $V_{F}$ is obout 0.56 volt at $25^{\circ} \mathrm{C}$ and decreases with temperature of about 2 millivolts/deg.

The circuit used to measure $\eta$ is shown in the figure. In this circuit, $R_{1}, C_{1}$ and the unijunction transistor form a relaxation oscillator, and the remainder of the circuit serves os a peak-voltage defector with the diode $D_{1}$ aufomatically subtracting the voltage $V_{F}$. To use the circuit, the "cal" button is pushed, and $R_{3}$ is adjusted to make the current meter $M_{1}$ read full scale. The "cal" button then is released and the value of $\eta$ is read directly from the meter, with $\eta=1$ corresponding to full:scale deflection of $100 \mu \mathrm{~h}$.
$D_{1}$; IW457, or equivelent, with the followiag charactoristics:
$V_{F}=0.565$ V at $I_{F}=50 \mu \mathrm{~A}$,
$\mathrm{I}_{\mathrm{R}} \leq 2 \mu \mathrm{~A}$ at $\mathrm{V}_{\mathrm{R}}=20 \mathrm{~V}$

FIGURE 5 - TEST CIRCUIT FOR INTRINSIC STANDOFF RATIO ( $\boldsymbol{n}$ )

# Highly Roliable, Vorsatile Devices Designod for Amplificr, Switching and Osdilator Applications from $<0.1 \mathrm{ma}$ to $>150 \mathrm{ma}$ de to 30 mc 

\author{

- High Voltage - Low Leakage <br> - Useful hre Over Wide Current Range
}
*mechanical deta
Device types 2N717, 2N718, 2N718A, 2N730, 2N731, and 2N956 are in JEDEC TO-18 packages. Device types 2N696, 2N697, 2N1420, 2N1507, 2N1613, and 2N1711 are in JEDEC TO-5 packages.

*absolute maximum rafings at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

|  | $\begin{aligned} & \text { 2N696 } \\ & \text { 2N697 } \\ & \hline \end{aligned}$ | $\begin{aligned} & 2 \mathrm{2N717} \\ & 2 \mathrm{~N} 718 \\ & \hline \end{aligned}$ | 2N718A | $\begin{aligned} & 2 \mathrm{~N} 730 \\ & 2 \mathrm{NT31} \end{aligned}$ | 2N956 | $\begin{aligned} & 2 \mathrm{~N} 1420 \\ & 2 \mathrm{~N} 1507 \end{aligned}$ | 2N1613 | 2N1711 | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Collactor-Lase Voltage | 60 | 60 | 75 | 60 | 75 | 60 | 75 | 75 | V |
| Collictor-Emittor Voltage (Sen Moto I) | 40 | 40 | 50 | 40 | 50 | 30 | 50 | 50 | $v$ |
| Colisctor-Emitter Voltage (Soe Note 2) |  |  | 32 |  |  |  |  |  | $v$ |
| Emither-Lose Voltaje | 5 | 5 | 7 | 5 | 7 | 5 | 7 | 7 | V |
| Collictor Current |  |  |  | 1.0 |  | 1.0 |  | 1.0 | 0 |
| Total Dovica Dissipotion at (or bolow) $25^{\circ} \mathrm{C}$ Freo-Alr Tempereture (Seo Mote Indicated In Porenthesos) $\rightarrow$ | $\begin{aligned} & \hline 0.6 \\ & \dagger \\ & (3) \\ & \hline \end{aligned}$ | $\begin{aligned} & 0.4 \\ & t \dagger \\ & (5) \\ & \hline \end{aligned}$ | 0.5 <br> (7) | $\begin{aligned} & 0.5 \\ & \dagger \dagger \\ & 19 \\ & \hline \end{aligned}$ | $0.5$ <br> (7) | $\begin{gathered} 0.6 \\ \dagger \\ \text { (3) } \end{gathered}$ | $\begin{aligned} & 0.8 \\ & (10) \\ & \hline \end{aligned}$ | 0.8 <br> (10) | w |
| Totad Dovico Dissipation at (or below) $25^{\circ} \mathrm{C}$ Case Tempercture (See Noto Indicated in Paranthoses) $\rightarrow$ | $\begin{gathered} 20 \\ \dagger \\ (4) \\ \hline \end{gathered}$ | $\begin{aligned} & 1.5 \\ & \dagger \dagger \\ & 16 \\ & (6) \\ & \hline \end{aligned}$ | 1.8 <br> (8) | $\begin{aligned} & 1.5 \\ & \dagger \\ & 1 \\ & (6) \end{aligned}$ | 1.8 <br> (8) | $\begin{gathered} 2.0 \\ \dagger \\ \text { (4) } \\ \hline \end{gathered}$ | 3.0 <br> (11) | 3.0 <br> (11) | W |
| Totol Dovice Dissipation of $100^{\circ} \mathrm{C}$ Case Tomperature | $\begin{aligned} & 1.0 \\ & i \end{aligned}$ | $\begin{aligned} & 0.75 \\ & +1 \end{aligned}$ | 1.0 | $0.75$ | 1.0 | $\begin{aligned} & 1.0 \\ & + \end{aligned}$ | 1.7 | 1.7 | * |
| Operating Collictor Junction Tamperatere | 175 $\dagger$ | 175 $\dagger \dagger$ | 200 | 175†t | 200 | 175† | 200 | 200 | ${ }^{\circ} \mathrm{C}$ |
| Storage Tomporaturi Range | $-65^{\circ} \mathrm{C}$ 10 $200^{\circ} \mathrm{C}$ |  |  |  |  |  |  |  |  |

 10 -mms.
2. This velue epplios when the treso-minitior aliote is emen-circuliod.
3. Devale lineorly to $175^{\circ} \mathrm{C}$ troe-air temperstive at the rete of $4.0 \mathrm{~mm} / \mathrm{C}^{\circ}$.
4. Berate lineerty to $175^{\circ} \mathrm{C}$ ense remperatione of the rate of $13.3 \mathrm{mw} / \mathrm{C}^{\circ}$.

6. Tonate limerly to $175^{\circ} \mathrm{C}$ come temperetive of the rethe of $10.0 \mathrm{~mm} / \mathrm{C}^{\circ}$.
7. Everule limerriy to $2000^{\circ} \mathrm{C}$ heo-air temperative of the reth of $2.06 \mathrm{~mm} / \mathrm{c}^{\circ}$.
8. Derate liamerly to $200^{\circ} \mathrm{C}$ cues tramperature of the rete of $10.3 \mathrm{~mm} / \mathrm{C}^{\circ}$.
9. Doraln limenty to $175^{\circ} \mathrm{C}$ frow-air memperature at in rute of $3.33 \mathrm{~mm} / \mathrm{C}^{\circ}$
18. Berale lineerly to $200^{\circ} \mathrm{C}$ freo-elr temperation of the rate of $4.56 \mathrm{~mm} / \mathrm{C}^{\circ}$.
11. Bevale Heserily te $200^{\circ} \mathrm{C}$ cose tempentiore of the rate of $17.2 \mathrm{mw} / \mathrm{C}^{\circ}$.
†Toxes Imstruments guarontces its types $\mathbf{2 M 6 9 6}$, 2N697, 2N1420, and 2N1507 to be capatle of the same dioctpation as reglotered and shown for types $2 N 1613$ cad 201711 with epprepriate cration focters shown in Motes 10 and 11.
$\dagger$ †Toxes Instruments suarmatees its typer 2w717, 2N718, $2 N 730$, and 20431 to to capphle of the some ditsclpation as registoriod and shown for types 2N718A and 2M956 with oppropitete derwiling fectors shown in Notes 7 and 8 .
*Imikents JEDEC rogistercd dete.
*electricel characteristics at $25^{\circ} \mathrm{C}$ free-alr tomperature (unioss otherwise noted)

| PARAMITMA |  |  |  |  | $\begin{aligned} & \text { aN717 } \\ & \text { 2N780 } \\ & \hline \end{aligned}$ | $\begin{array}{\|l\|l\|} \hline \text { 2N7IB } \\ \text { 2N7SI } \\ \hline \end{array}$ | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | 2NGS | 2N697 |  |  |  |
|  |  | MIN MAX | MIN MAX | MIN MAX | MIN Max |  |
|  |  |  | $\mathrm{I}_{\mathrm{c}}=100 \mu \mathrm{a}_{1} \mathrm{I}_{1}=0$ | 6 | 0 | 6 | 0 | $v$ |
| Vinucio | Colcector-Emittor Insekdown Voltage |  | $\mathrm{I}_{\mathrm{c}}=20 \mathrm{me} \mathrm{I}_{\mathrm{s}}=0$, gen Mote It |  |  |  |  | $y$ |
| $V_{\text {V }}^{\text {mjecun }}$ | Collocior-Emilior Irandewn Veltage | $\mathrm{I}_{\mathrm{c}}=100 \mathrm{ma}_{\text {, }} \mathrm{m}_{\mathrm{m}}=10 \mathrm{n}^{\text {, }}$ Se0 Molo 12 | 40 | 40 | 40 | 4 | V |
| Viminio | Emititer-lost Irackdown Valtage | $I_{\mathrm{I}}=100 \mu \mathrm{a}, \mathrm{I}_{\mathrm{c}}=0$ <br> Exuept 2N17,2NTIG $\mathbf{I}_{1}=1 \mathrm{mu}$ | 5 | 5 | 5 | 5 | $\checkmark$ |
| ${ }^{\text {cto }}$ | Collectior Cutoft Current | $V_{C s}=50 v_{i} I_{1}=0$ | 1.0 | 1.0 | 1.0 | 1.0 | $\mu$ |
|  |  | $V_{c s}=30 y_{1} I_{1}=0, \quad T_{A}=150^{\circ} \mathrm{C}$ | 100 | 100 | 100 | 100 | $\mu \mathrm{s}$ |
|  |  | $V_{C B}=60 v_{1} 1_{1}=0$ |  |  |  |  | $\mu$ |
|  |  | $V_{C A}=60 v_{1} T_{1}=0, \quad T_{A}=150^{\circ} \mathrm{C}$ |  |  |  |  | $\mu$ |
| $\mathrm{I}_{\text {cas }}$ | Collector Cutoff Curromi |  |  |  |  |  | $\mu$ |
| Itio | Emitor Cutofl Curroal | $v_{\text {If }}=5 v_{0} \quad l_{C}=0$ |  |  |  |  | $\mu$ |
| $h_{\text {Hf }}$ | Stattc Forward Curront Transier Ratle | $V_{c E}=10 \mathrm{v}, \mathrm{l}_{\mathrm{c}}=10 \mu$ |  |  |  |  |  |
|  |  | $V_{C!}=10 \mathrm{v}, \mathrm{l}_{\mathrm{C}}=100 \mu$ |  |  |  |  |  |
|  |  | $V_{C!}=10 \mathrm{v}, \mathrm{c}_{\mathrm{C}}=10 \mathrm{ma}, \mathrm{Sos}^{\text {Nota } 12}$ |  |  |  |  |  |
|  |  | $\begin{aligned} & \mathrm{v}_{\mathrm{ca}}=10 v_{1} \mathrm{I}_{\mathrm{C}}=10 \mathrm{mo}, \mathrm{I}_{\mathrm{A}}=-35^{5} \mathrm{C} \\ & \text { Sot Hole } 12 \end{aligned}$ |  |  |  |  |  |
|  |  | $V_{C I}=10 v_{\text {c }} I_{C}=150 \mathrm{~mm}, 500$ Mole 12 | 20.60 | 40180 | $20 \quad 60$ | $40 \quad 120$ |  |
|  |  | $v_{C E}=10 v_{0} I_{C}=500$ men, Se0 Moto 12 |  |  |  |  |  |
| $V_{\text {時 }}$ | Dan-Emitar Voltage | $\mathrm{I}_{1}=15 \mathrm{~ms}, \mathrm{I}_{\mathrm{C}}=150 \mathrm{~mm}$, Soe Mote 12 | 1.3 | 1.3 | 1.3 | 1.3 | $\eta$ |
| $V_{\text {Cla }}(\underline{W}+1$ | Collictar-Emilitr Soturation Voltage | $\mathrm{I}_{\mathrm{s}}=15 \mathrm{ma}, \mathrm{I}_{\mathrm{c}}=150 \mathrm{~mm}, \mathrm{Sm}$ Nots 12 | 1.5 | 1.5 | 1.5 | 1.5 | $v$ |
| $h_{\text {lb }}$ | Small-Signal Commen-Rast Input Impedence | $V_{C a}=1 v_{1} I_{c}=1 \mathrm{mo}, \quad 1=1 \mathrm{kc}$ |  |  |  |  | anm |
|  |  | $V_{C B}=10 \mathrm{v}, \mathrm{l}_{\mathrm{C}}=5 \mathrm{mot}, \quad t=1 \mathrm{kc}$ |  |  |  |  | thm |
| $\mathrm{hrb}^{\text {rb }}$ | Smell.Signal Commen-Dase Reverse Voltage Iramior Retio | $\mathbf{v}_{\mathbf{c s}}=5 \mathrm{v}_{\mathrm{c}} \quad \mathrm{l}_{\mathbf{c}}=1 \mathrm{~ms}, \quad 1=1 \mathrm{kc}$ |  |  |  |  |  |
|  |  | $\boldsymbol{v}_{\mathbf{C a}}=10 \mathrm{v}, \mathrm{l}_{\mathbf{C}}=5 \mathrm{ma}, \quad 1=1 \mathrm{kc}$ |  |  |  |  |  |
| $h_{\text {ob }}$ | Small-Signal Commen-Lost Output Admiftante | $\mathrm{V}_{\mathrm{Cs}}=5 \mathrm{r}, \mathrm{I}_{\mathrm{c}}=1 \mathrm{ma}, \quad 1=1 \mathrm{kc}$ |  |  |  |  | $\mu$ meo |
|  |  | $\mathrm{V}_{\mathrm{CB}}=10 \mathrm{v}_{1} \mathrm{l}_{\mathrm{C}}=5 \mathrm{ma}, 1=1 \mathrm{kc}$ |  |  |  |  | $\mu \mathrm{mhe}$ |
| $h_{6}$ | Small-Signal Common-Emittor Ferward Curront Trassfor Ratio | $V_{C E}=5 \mathrm{v}_{1} \mathrm{l}_{\mathrm{C}}=1 \mathrm{ma}, \quad 1=1 \mathrm{kc}$ |  |  |  |  |  |
|  |  | $\mathrm{v}_{\text {CE }}=10 \mathrm{r}, \mathrm{I}_{\mathrm{C}}=5 \mathrm{mo}, 1=1 \mathrm{kc}$ |  |  |  |  |  |
| $\left\|h_{\text {fol }}\right\|$ | Small-Signal Commen-Emititer Forward Current Tramsfor Ratio | $v_{\text {ce }}=10 \mathrm{v}, \mathrm{l}_{\mathrm{c}}=50 \mathrm{~mm}, \quad f=20 \mathrm{mc}$ | 2.0 | 2.5 | 2.0 | 2.5 |  |
| $c_{\text {ab }}$ | Common-Bass Open-Ciruit Outpyl Capocitance | $v_{\mathrm{ct}}=10 \mathrm{v}, \mathrm{l}_{\mathrm{E}}=0 . \quad i=1 \mathrm{mk}$ | 35 | 35 | 35 | 35 | pf |
| $c_{i b}$ | Commen-less Open-Ciccult Input Capacitans: | $v_{\mathrm{EB}}=0.5 \mathrm{v}, \mathrm{l}_{\mathrm{c}}=0, \quad \mathrm{f}=1 \mathrm{mc}$ |  |  | ¢ | 80 | pf |

[^26]
## *Indicalos JEDEC registored data

# Highly Rollable, Vorsatlle Dovices Designed for Amplifior, Switshing and Oselliator Applications from $<0.1 \mathrm{ma}$ to $>150 \mathrm{ma}$ de to 30 me 

\author{

- High Voltago - Low Loakago <br> - Usotul $h_{\text {fe }}$ Over Wido Current Rango
}
mechanical dafa
Device types 2N719, 2N719A, 2N720, 2N720A, 2N870 and 2N871 are in JEDEC TO-18 packages".
Device types 2N698, 2N699, 2N1889, 2N1890, and 2N1893 are in JEDEC TO-39 packages*.

*absolute maximum ratings at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

|  | 2N698 | 2N699 | $\begin{aligned} & \text { 2N719 } \\ & \text { 2N720 } \end{aligned}$ | 2N719A | 2N720A | $\begin{array}{\|l\|l\|} \hline 2 N 870 \\ 2 N 871 \end{array}$ | $\left.\begin{array}{\|l\|} \hline 2 N 1889 \\ 2 N 1890 \end{array} \right\rvert\,$ | 2N1893 | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Collector-Base Volliage | 120 | 120 | 120 | 120 | 120 | 100 | 100 | 120 | $V$ |
| Coilector-Emilter Voltoge (Seo Note 1) | 80 | 80 | 80 | 80 | 100 | 80 | 80 | 100 | $v$ |
| Colloctor-Emitter Voltage (See Note 2) | 60 |  |  | 60 | 80 | 60 | 60 | 80 | $v$ |
| Emitter-Base Voltage | 7 | 5 | 5 | 7 | 7 | 7 | 7 | 7 | $v$ |
| Collector Current |  |  |  | 1.0 |  |  |  | 0.5 | 0 |
| Total Device Dissipation of (or below) $25^{\circ} \mathrm{C}$ Fres-Air Temperature (See Note Indicated in Parentheses) $\longrightarrow$ | $\begin{aligned} & 0.8 \\ & (3) \\ & \hline \end{aligned}$ | $\begin{gathered} \hline 0.6 \\ t \\ (5) \\ \hline \end{gathered}$ | $\begin{array}{r} \hline 0.4 \\ \ddagger \\ (7) \\ \hline \end{array}$ | $\begin{aligned} & 0.5 \\ & (9) \end{aligned}$ | $\begin{aligned} & 0.5 \\ & \text { (9) } \end{aligned}$ | $\begin{aligned} & 0.5 \\ & \text { (9) } \\ & \hline \end{aligned}$ | $0.8$ <br> (3) | (3) | W |
| Total Device Dissipation of (or below) <br> $25^{\circ} \mathrm{C}$ Case Temperature <br> (See Note Indicated in Parentheses) $\longrightarrow$ | $\begin{array}{r} 3.0 \\ + \\ (4) \\ \hline \end{array}$ | $\begin{array}{r} 2.0 \\ t \\ (6) \\ \hline \end{array}$ | $\begin{array}{r} 1.5 \\ \ddagger \\ (8) \\ \hline \end{array}$ | $\begin{array}{r} 1.8 \\ (10) \\ \hline \end{array}$ | $\begin{aligned} & 1.8 \\ & (10) \\ & \hline \end{aligned}$ | $\begin{aligned} & 1.8 \\ & (10) \\ & \hline \end{aligned}$ | $\begin{gathered} 3.0 \\ t \\ 1 \\ \hline \end{gathered}$ | $\begin{array}{r} 3.0 \\ t \\ (4) \\ \hline \end{array}$ | W |
| Slorage Temperature Ronge | $-65^{\circ} \mathrm{C}$ to $200^{\circ} \mathrm{C}$ |  |  |  |  |  |  |  |  |

MOTES: 1. This values epplios whan the bese-mitter resistence ( $\mathrm{n}_{\mathrm{me}}$ ) is equel to or less than 10 ahms.
2. This values applios when the base-emifiter didede is epmen-circuited.
3. Devale linearly to $200^{\circ} \mathrm{C}$ froe-air temperature at the rate of $4.57 \mathrm{~mm} /{ }^{\circ} \mathrm{C}$.
4. Derate lineserly $10200^{\circ} \mathrm{C}$ cesse temperature at the rete of $17.2 \mathrm{~mm} /{ }^{\circ} \mathrm{C}$.
5. Derate limewrly to $175^{\circ} \mathrm{C}$ froo-air temperature at the rate of $4.0 \mathrm{~mm} /{ }^{\circ} \mathrm{C}$.
6. Derale linearly to $175^{\circ} \mathrm{C}$ case temperature at the rate of $13.3 \mathrm{~mm} /{ }^{\circ} \mathrm{C}$.
J. Derale linearily to $175^{\circ} \mathrm{C}$ fres-air thempenature at the rats of $2.07 \mathrm{~mm} /{ }^{\circ} \mathrm{C}$.
8. Bercole linverly to $175^{\circ} \mathrm{C}$ cose temperature at the rate of $10.0 \mathrm{mw} /{ }^{\circ} \mathrm{C}$.
9. Derale linearty to $760^{\circ} \mathrm{C}$ free-sir temperature at the rate of $2.86 \mathrm{~mm} /{ }^{\circ} \mathrm{C}$.
10. Derate Iinearly te $200^{\circ} \mathrm{C}$ cose temperature at the rete of $10.3 \mathrm{~mm} /{ }^{\circ} \mathrm{C}$.

## -JEDEC reghatered data.

*The JEDEC regintered outlime for these devices is TO-5.
TO-39 falls within TO-5 with the exception of lead langth.
${ }^{\dagger}$ Texas Instruments guarantses these devices in TO-39 packages dato-coded 7328 or hisher to be capable of incrocesed distipetion ms follows: 0.8 w at $\mathrm{T}_{A}<25^{\circ} \mathrm{C}$ dernted linearly to $\mathrm{T}_{A}=200^{\circ} \mathrm{C}$ at at $\mathrm{T}_{A}<25^{\circ} \mathrm{C}$ derated linetrly to $\mathrm{T}_{A}=200^{\circ} \mathrm{C}$ at
the rate of $4.57 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$, or 10 W at $\mathrm{T}_{\mathrm{C}}<25^{\circ} \mathrm{C}$ ( 5.71 W at $\mathrm{T}_{C}=100^{\circ} \mathrm{C}$ ) derated linearly to $\mathrm{T}_{\mathrm{C}}=200^{\circ} \mathrm{C}$ at the rate of $57.1 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$.
$\ddagger$ Toxas Instruments quarantese its types 2N719 and 2N720 to be cepable of the same diveipation at registered end shown for types 2N719A, 2N720A, 2N870, and 2N871 with sppropriate derating factors dhown in Notes 9 and 10.

## TYPES 2N698, 2N699, 2N719, 2N719A N-P-N SILICON TRANSISTORS

*eloctrical charactoristics at $25^{\circ} \mathrm{C}$ free-air temperature (unless othorwise notod)


MOTE 11 Those peramelors must be mensurad usime pulse techalques. Tw $\leq 300$ $\mu s o c$., Duty cycle $\leq 2 \%$. Pulse width must be such that hoiving or doobling doen net cowse a chenge grester them the roquirad accuracy of the moosuremont.
*Iadicatos JEDEC rogistwed dete.

# TYPES 2N696, 2N697, 2N77, 2N718, 2N718A, 2N730, 2N731, 2N956, $2 N 1420,2 N 1507,2 N 1613,2 N 711$ N-P-N SILICON TRANSISTORS <br> BULLETIN NO. DL-S 693471. MAY 1963-REVISED AUGUST 1969 

## Highly Reliable, Versatile Devices Designed for <br> Amplifier, Switching and Osdilator Applications <br> from $<0.1 \mathrm{ma}$ to $>150 \mathrm{ma}$, dk to 30 mc

- High Voltage - Low Leakage
*mechanical defa
Device types 2N717, 2N718, 2N718A, 2N730, 2N731, and 2N956 are in JEDEC TO-18 packages. Device types 2N696, 2N697, 2N1420, 2N1507, 2N1613, and 2N1711 are in JEDEC TO-5 packages.

*absolute maximum ratings at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

|  | $\begin{array}{\|l\|} \hline \text { 2N696 } \\ \text { 2N697 } \\ \hline \end{array}$ | $\begin{array}{\|l\|} \hline 2 \mathrm{NF} 17 \\ 2 \mathrm{NT18} \\ \hline \end{array}$ | 2N718A | $\begin{array}{r} 2 N 730 \\ 2 N 731 \\ \hline \end{array}$ | 2N956 | $\begin{array}{\|l\|} 2 \mathrm{~N} 142 \mathrm{O} \\ 2 \mathrm{~N} 1507 \\ \hline \end{array}$ | 2N1613 | 2N1711 | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Collector-Base Voltoge | 60 | 60 | 75 | 60 | 75 | 60 | 75 | 75 | $v$ |
| Collector-Emitter Yolitage (See Note 1) | 40 | 40 | 50 | 40 | 50 | 30 | 50 | 50 | $v$ |
| Collector-Emitter Voltage (See Note 2) |  |  | 32 |  |  |  |  |  | $v$ |
| Emitar-Aase Voltage | 5 | 5 | 7 | 5 | 7 | 5 | 7 | 7 | $v$ |
| Collector Current |  |  |  | 1.0 |  | 1.0 |  | 1.0 | a |
| Total Device Dissipation of (or below) $25^{\circ} \mathrm{C}$ Free-Air Temperature (See Note Indicated in Parentheses) $\rightarrow$ | $\begin{aligned} & \hline 0.6 \\ & \vdots \\ & (3) \\ & \hline \end{aligned}$ | $\begin{aligned} & \hline 0.4 \\ & \dagger \dagger \\ & 1 \\ & \hline \end{aligned}$ | (7) | $\begin{aligned} & \hline 0.5 \\ & \dagger \\ & 1 \dagger \\ & \text { (9) } \end{aligned}$ | (7) | $\begin{aligned} & \hline 0.6 \\ & \vdots \\ & \text { (3) } \\ & \hline \end{aligned}$ | 0.8 <br> (10) | 0.8 <br> (10) | w |
| Total Device Dissipation of (or below) $25^{\circ} \mathrm{C}$ Case Temperature (See Note Indicoted in Parenthesas) $\rightarrow$ | $\begin{gathered} 2.0 \\ \vdots \\ (4) \\ \hline \end{gathered}$ | $\begin{aligned} & 1.5 \\ & \dagger \dagger \\ & 1 \\ & (6) \\ & \hline \end{aligned}$ | $1.8$ <br> (8) | $\begin{aligned} & 1.5 \\ & 1 \dagger \\ & 1 . \\ & \hline \end{aligned}$ | 1.8 <br> (8) | $\begin{gathered} 2.0 \\ \dagger \\ (4) \\ \hline \end{gathered}$ | 3.0 <br> (11) | $3.0$ <br> (11) | W |
| Total Device Dissipotion af $100^{\circ} \mathrm{C}$ Case Temperatura | $\begin{aligned} & 1.0 \\ & i \\ & \hline \end{aligned}$ | $\begin{aligned} & 0.75 \\ & \dagger \dagger \\ & \hline \end{aligned}$ | 1.0 | $\begin{aligned} & 0.75 \\ & i t \\ & \hline \end{aligned}$ | 1.0 | $\begin{aligned} & 1.0 \\ & + \\ & \hline \end{aligned}$ | 1.7 | 1.7 | w |
| Operating Collector Junction Temperature | 175 $\dagger$ | 175¢† | 200 | 175†t | 200 | 175 $\dagger$ | 200 | 200 | ${ }^{\circ} \mathrm{C}$ |
| Storuge Temperature Runge | $-65^{\circ} \mathrm{C}$ to $200^{\circ} \mathrm{C}$ |  |  |  |  |  |  |  |  |

NOTES: 1. This value applies when the base-emittor resistence (Rye) is equal to or less then 10 ohms.
2. This value applios whon the base-militer diode is epen-circuited.
3. Derate linearly to $175^{\circ} \mathrm{C}$ tree-alr tomporature af the rate of $4.0 \mathrm{~mm} / \mathrm{c}^{\circ}$.
4. Derate linearly to $175^{\circ} \mathrm{C}$ cose tamperature at the rate of $13.3 \mathrm{nmw} / \mathrm{C}^{\circ}$.
5. Derati liseasty to $175^{\circ} \mathrm{C}$ free-alt temperature at the rate of $2.67 \mathrm{mw} / \mathrm{c}^{\circ}$.
6. Derate linearly to $175^{\circ} \mathrm{C}$ case tomperatore af the rate of $10.0 \mathrm{mw} / \mathrm{c}^{\circ}$.
7. Derats linearly to $200^{\circ} \mathrm{C}$ fros-oir temperature of the rate of $2.06 \mathrm{mw} / \mathrm{C}^{\circ}$.
3. Derefe linserly to $200^{\circ} \mathrm{C}$ cass temporature at the rete of $10.3 \mathrm{mw} / \mathrm{c}^{\circ}$.
9. Derete linearly to $175^{\circ} \mathrm{C}$ free-air temperalure of the rate of $3.33 \mathrm{mw} / \mathrm{c}^{\circ}$.
10. Derate linearly to $200^{\circ} \mathrm{C}$ freo-sir tamperature of the rete of $4.56 \mathrm{~mm} / \mathrm{c}^{\circ}$.
II. Derate linearly to $200^{\circ} \mathrm{C}$ case temperature of the rate of $17.2 \mathrm{~mm} / \mathrm{C}^{\circ}$.
†Toxis Instruments guarantees its types 2N696, 2N697, 2N1420, and 2 M1 507 to be capmble of the same disslpation as registered and shown for types 2 Ni 613 and 2 N 1711 with appropiote derating factors shown in Moles 10 and 11.
$\dagger$ †toxas Instruments guarantees its types 2N717, 2N718, 2N730, and 2M731 to be capable of the same dissipation as rogistored and ahown for types 2N718A and 2N956 with appropriate derating facfors shown in Notes 7 and 8.

[^27]
## TYPES 2N696, 2N697, 2N717, 2N718, 2N718A, 2N730, 2N731 N-P-N SILICON TRANSISTORS

*electrical characteristics at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

| PARAMETER |  | TEST CONDITIONS $\quad$ TO. $5 \rightarrow$ |  |  | $\begin{aligned} & \text { 2N717 } \\ & 2 N 730 \end{aligned}$ | $\begin{array}{\|l\|l\|} \hline \text { 2N718 } \\ \hline \end{array}$ | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | 2N696 | 2N697 |  |  |  |
|  |  | MIN Max | MIN MAX | MIN max | MIN max |  |
| $V_{\text {Ifereo }}$ | Collector-Base Braokdown Veltage |  | $\mathrm{I}_{\mathbf{C}}=100 \mu \mathrm{c}, \mathrm{I}_{\mathrm{E}} \neq 0$ | 40 | 40 | 60 | 60 | V |
| $V_{\text {(u) }}$ | Collcator-Emittor krakdown Voltage |  | ${ }^{1} \mathrm{C}=30 \mathrm{ma}, \mathrm{I}_{\mathrm{B}}=0, \quad$ See Note 12 |  |  |  |  | $V$ |
| $V_{\text {(ma) }{ }^{\text {ceer }}}$ | Cellecter-Emittor Ireakdown Voltage | $\mathrm{I}_{\mathrm{C}}=100 \mathrm{ma}, \mathrm{R}_{\text {de }}=10 \mathrm{n}$. Sees Mote 12 | 40 | 40 | 40 | 40 | V |
|  | Emilter-loss Irenkdown Veltaga | $I_{E}=100 \mu 0, I_{C}=0$ <br> Except 2N717,24718: $\mathrm{I}_{\mathrm{E}}=1 \mathrm{ma}$ | 5 | 5 | 5 | 5 | V |
| ${ }^{\prime} \mathrm{Cso}$ | Colloctor Cutoff Curront | $v_{C B}=30 \mathrm{v}, \mathrm{l}_{\mathrm{E}}=0$ | 1.0 | 1.0 | 1.0 | 1.0 | $\mu$ |
|  |  | $V_{C E}=30 \mathrm{r}, \mathrm{T}_{\mathrm{E}}=0, \quad \mathrm{~T}_{\mathrm{A}}=150^{\circ} \mathrm{C}$ | 100 | 100 | 100 | 100 | $\mu$ |
|  |  | $\mathrm{V}_{\mathrm{CB}}=\mathbf{\omega} \mathrm{r}, \mathrm{I}_{\mathrm{E}}=0$ |  |  |  |  | $\mu$ |
|  |  | $v_{C B}=00 v_{1} \mathrm{I}_{\mathrm{E}}=0, \quad \mathrm{~T}_{\mathrm{A}}=150^{\circ} \mathrm{C}$ |  |  |  |  | $\mu$ |
| ${ }^{\text {ceer }}$ | Colloctor Cuteff Current | $\mathrm{v}_{\text {CE }}=20 \mathrm{v}, \mathrm{n}_{\text {EE }}=100 \mathrm{k} \mathrm{\Omega}$ |  |  |  |  | $\mu$ |
| $\mathrm{I}_{\text {EWO }}$ | Emitter Cutoff Current |  |  |  |  |  | $\mu$ |
| $h_{\text {FE }}$ | Static Forword Curreat <br> Transfer Ratio | $v_{C E}=10 r_{\text {c }} \mathrm{I}_{C}=10 \mu$ |  |  |  |  |  |
|  |  | $V_{C E}=10 \mathrm{v}, \mathrm{I}_{\mathrm{C}}=100 \mu \mathrm{~m}$ |  |  |  |  |  |
|  |  | $V_{C E}=10 \mathrm{v},{ }^{\prime}{ }_{C}=10 \mathrm{~ms}$, Soe Mote 12 |  |  |  |  |  |
|  |  | $\begin{aligned} & \mathrm{V}_{\mathrm{CE}}=10 \mathrm{v}, \mathrm{I}_{\mathrm{C}}=10 \mathrm{ma}, \mathrm{~T}_{\mathrm{A}}=-55^{\circ} \mathrm{C} \\ & \mathrm{Sot} \text { Note } 12 \end{aligned}$ |  |  |  |  |  |
|  |  | $V_{C E}=10 \mathrm{v}, \mathrm{t}_{\mathbf{C}}=150 \mathrm{mo}$, S00 Mote 12 | $20 \quad 6$ | 40.120 | $20 \quad 60$ | $40 \quad 120$ |  |
|  |  | $V_{C E}=10 \mathrm{v}, \mathrm{I}_{C}=500 \mathrm{~mm}$, Se0 Mote 12 |  |  |  |  |  |
| $V_{\text {EE }}$ | Caso-Emittor Voltage | $\mathrm{I}_{\mathrm{s}}=15 \mathrm{ma}, \mathrm{I}_{C}=150 \mathrm{ma}$, See Mote 12 | 1.3 | 1.3 | 1.3 | 1.3 | $v$ |
| $\mathbf{V}_{\text {CEs sath }}$ | Collecter-Emittor Saluration Yoliage | $\mathrm{I}_{\mathrm{B}}=15 \mathrm{ma}, \mathrm{I}_{\mathrm{C}}=150 \mathrm{ma}$, Soet Wote 12 | 1.5 | 1.5 | 1.5 | 1.5 | V |
| $h_{i b}$ | Small-Signal Cemmen-lase Input Impedence | $\mathbf{v}_{\mathbf{c s}}=5 \mathrm{v}, \mathrm{l}_{\mathbf{c}}=1 \mathrm{ma}, \quad \mathrm{f}=1 \mathrm{kc}$ |  |  |  |  | dmm |
|  |  |  |  |  |  |  | anm |
| $h_{\text {rb }}$ | Small-Signol Common-Sase Reversa Voltage Transfer Ratio | $\mathbf{v}_{\mathrm{CB}}=5 \mathrm{v}, \quad \mathbf{l}_{\mathrm{c}}=1 \mathrm{ma}, \quad \mathrm{l}=1 \mathrm{kc}$ |  |  |  |  |  |
|  |  | $\mathbf{v}_{\mathbf{C s}}=10 \mathrm{v}, \mathrm{I}_{\mathbf{c}}=5 \mathrm{~mm}, \quad 1=1 \mathrm{kc}$ |  |  |  |  |  |
| $h_{\text {ob }}$ | Small-Signal Commen-Lase Output Admittance | $v_{\mathrm{ct}}=5 \mathrm{v}, \mathrm{l}_{\mathrm{c}}=1 \mathrm{ma}, \quad f=1 \mathrm{kt}$ |  |  |  |  | $\mu \mathrm{mme}$ |
|  |  | $\mathrm{V}_{\mathrm{CB}}=10 \mathrm{v}, \mathrm{I}_{\mathrm{C}}=5 \mathrm{me}, \quad f=1 \mathrm{kt}$ |  |  |  |  | $\mu \mathrm{mmp}$ |
| $h_{60}$ | Small-Signal Commen-Emifter formard Current Trensfer Ratio | $V_{C E}=5 \mathrm{v}_{1} \quad \mathrm{I}_{\mathrm{C}}=1 \mathrm{ma}, \quad \mathrm{f}=1 \mathrm{kc}$ |  |  |  |  |  |
|  |  | $V_{C E}=10 \mathrm{v}, \mathrm{l}_{\mathrm{C}}=5 \mathrm{ma}, \quad 1=1 \mathrm{kc}$ |  |  |  |  |  |
| $\left\|h_{\text {fo }}\right\|$ | Small-Signal Commen-Emitter Forward Curreml Transfor Ratie | $\mathbf{v}_{\mathbf{C E}}=10 \mathrm{v}, \mathrm{l}_{\mathbf{C}}=50 \mathrm{ma}, \quad \mathrm{f}=20 \mathrm{mc}$ | 2.0 | 2.5 | 2.0 | 2.5 |  |
| $C_{\text {ab }}$ | Common-Less Open-Circuit Output Capadtance | $\mathbf{v}_{\mathbf{C E}}=10 \mathrm{v}, \mathrm{l}_{\mathbf{E}}=0, \quad 1=1 \mathrm{mc}$ | 35 | 35 | 35 | 35 | * |
| $c_{i b}$ | Common-base Open-Circuit Input Capecitance | $v_{\mathrm{E}}=0.5 \mathrm{v}, \mathrm{l}_{\mathrm{c}}=0, \quad t=1 \mathrm{mc}$ |  |  | 0 | 0 | f |

 a charge greeter then the repuirut ucturacy of the measurummat.

[^28]
## TYPES 2N77, 2N718, 2N718A, 2N956, 2N1420, 2N1507, 2N1613, 2N1711 N-P-N SILICON TRANSISTORS

*electrical characteristics at $25^{\circ} \mathrm{C}$ froe-air tomperature (unless otherwise noted)


[^29][^30]TYPES 2N77, 2N718, 2N718A, 2N956, 2N1613, 2N711 N-P-N SILICON TRANSISTORS
*operating characteristics at $\mathbf{2 5}{ }^{\circ} \mathrm{C}$ free-air temperafure

| PARAMETER | TEST CONDITIONS | TO-18 $\rightarrow$ | $\frac{2 N 956}{2 N 1711}$ |  | $\begin{aligned} & \frac{2 N 718 A}{2 N 1613} \end{aligned}$ |  | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | TO-5 $\longrightarrow$ |  |  |  |  |  |
|  |  |  | TYP | MAX | TYP | MaX |  |
| NF Spot Moise Figure | $\begin{aligned} & V_{C E}=10 \mathrm{v}, \mathrm{Ic}_{\mathrm{c}}=300 \mu \mathrm{a} \\ & R_{G}=510 \Omega, f=1 \mathrm{kc} \end{aligned}$ |  | 5 | 8 | 6 | 12 | db |

* switching characteristics at $25^{\circ} \mathrm{C}$ free-air temperature

| PARAMETER | TEST CONDITIONS | $\xrightarrow{\text { TO-18 }} \rightarrow$ | $\begin{aligned} & \hline \text { 2N718A } \\ & \hline 2 N 1613 \\ & \hline \end{aligned}$ |  | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  | TYP | MAX |  |
| $\dagger_{T}$ Total Switching Time | See Figure 1 |  | 20 | 30 | nsec |

*PARAMETER MEASUREMENT INFORMATION


FIGURE 1 - SWITCHING TIME MEASUREMENT CIRCUIT FOR 2N7IBA AND 2NI613
WOTES: 13. The input wovolorm is suppliod by a mercury rolay pulse generetor with the following choracteristics: $\mathrm{t}_{\mathrm{r}} \leq 1$ nsec, $\mathrm{t}_{\mathrm{i}} \leq 1$ nsec, $\mathrm{PW}=15$ nsec. Adjust $\mathbf{R}_{1}$ and the input pulse amplitede to ebtain the specifiod voltage lovels at Point $A$.
14. Wevaforms are monitered on a sompliag oscilloscope ( $\mathrm{i}_{\mathrm{r}} \leq 0.4$ nssc) using a $2000 \Omega$ probo.
*Indicates JEDEC regislered data ( Iypical deta excloded)

# TYPES 2N698, 2N699, 2N718, 2N718A, 2N720, 2N720A, 2N87O, 2N871, 2N1889, 2N1890, 2N1893 N-P-N SILICON TRAMSISTORS 

Highly Reliable, Versatile Devicess Designod for Amplifior, Switching and Oscillator Applications from $<0.1 \mathrm{ma}$ to $>150 \mathrm{ma}$, de to 30 mc<br>- High Voltage - Low Leakage<br>- Useful $h_{f l}$ Over Wide Current Range

mochonical defa
Device types 2N719, 2N719A, 2N720, 2N720A, 2N870 and 2N871 are in JEDEC TO-18 packages*.
Device types $2 \mathrm{~N} 698,2 \mathrm{~N} 699,2 \mathrm{~N} 1889,2 \mathrm{~N} 1890$, and 2 N 1893 are in JEDEC TO-39 packages*.

*absolute maximum ratings at $25^{\circ} \mathrm{C}$ free-air temperature (unless ofherwise noted)

|  | 2N698 | 2N699 | $\begin{array}{\|l\|} \hline 2 N 719 \\ \text { 2N720 } \end{array}$ | 2N719A | 2N720A | $\begin{array}{\|l\|l\|} \hline 2 N A 70 \\ 2 N 871 \end{array}$ | $\begin{array}{\|l\|} \hline 2 N 1889 \\ 2 N 1890 \end{array}$ | 2N1893 | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Collector-Ease Vollage | 120 | 120 | 120 | 120 | 120 | 100 | 100 | 120 | $v$ |
| Colliector-Emitter Voltuge (Seo Nofe 1) | 80 | 80 | 80 | 80 | 100 | 80 | 80 | 100 | $v$ |
| Collector-Emitter Volhoge (See Note 2) | 60 |  |  | 60 | 80 | 60 | 60 | 80 | $v$ |
| Emither-Lase Vollage | 7 | 5 | 5 | 7 | 7 | 7 | 7 | 7 | $v$ |
| Collector Current |  |  |  | 1.0 |  |  |  | 0.5 | a |
| Total Device Dissipation of (or telow) $25^{\circ} \mathrm{C}$ Froe-Air Tomperature (See Mote Indicaled in Porentheses) $\longrightarrow$ | $\begin{aligned} & 0.8 \\ & \text { (3) } \\ & \hline \end{aligned}$ | $\begin{gathered} 0.6 \\ t \\ (5) \\ \hline \end{gathered}$ | $\begin{array}{r} 0.4 \\ \ddagger \\ (7) \\ \hline \end{array}$ | $\begin{aligned} & 0.5 \\ & \text { (9) } \end{aligned}$ | $\begin{aligned} & 0.5 \\ & \text { (9) } \end{aligned}$ | $\begin{aligned} & 0.5 \\ & (9) \\ & \hline \end{aligned}$ | $\begin{aligned} & \hline 0.8 \\ & \text { (3) } \\ & \hline \end{aligned}$ | $0.8$ <br> (3) | w |
| Total Device Dissipation at (or below) <br> $25^{\circ} \mathrm{C}$ Cose Temperoture <br> (Seo Note Indictoted in Porentheses) $\longrightarrow$ | $\begin{gathered} 3.0 \\ + \\ (4) \end{gathered}$ | $\begin{gathered} 2.0 \\ t \\ (6) \end{gathered}$ | $\begin{gathered} 1.5 \\ \ddagger \\ \ddagger \\ (8) \end{gathered}$ | $\begin{aligned} & 1.8 \\ & (10) \end{aligned}$ | 1.8 <br> (10) | $\begin{aligned} & 1.8 \\ & (10) \end{aligned}$ | $\begin{gathered} 3.0 \\ + \\ (4) \end{gathered}$ | $\begin{gathered} 3.1 \\ \hline .0 \\ \dagger \\ \text { (4) } \end{gathered}$ | w |
| Slorage Pemperature Range | $-65^{\circ} \mathrm{C}$ to $200^{\circ} \mathrm{C}$ |  |  |  |  |  |  |  |  |

MOTES: 1. This values epplies whan the bese-mititer mesistence (Res) is equal to er less then 10 chms.

3. Gorate linevily to $200^{\circ} \mathrm{C}$ frot-air temperature at the rate of $4.57 \mathrm{mw} /{ }^{\circ} \mathrm{C}$.
4. Borcte lineorly to $200^{\circ} \mathrm{C}$ case temparatere at the rate of $17.2 \mathrm{mw} /{ }^{\circ} \mathrm{C}$.

6. Borcte linearly to $175^{\circ} \mathrm{C}$ cese tomperature of the refe of $13.3_{\mathrm{mm}}{ }^{\circ} \mathrm{C}$.

D. Devale liacerly $\mathrm{to} 175^{\circ} \mathrm{C}$ cese temperatura at the rate of $10.0 \mathrm{~mm} /{ }^{\circ} \mathrm{C}$.
9. Derate lineerly io $280^{\circ} \mathrm{C}$ fres-alt temperatere at the rate of $2.25 \mathrm{~mm} /{ }^{\circ} \mathrm{C}$.
10. Derente Inenerly to $200^{\circ} \mathrm{C}$ eane temperation ot the rate of $10.3 \mathrm{~mm} /{ }^{\circ} \mathrm{C}$.

## JEDEC regintered data.

The JEDEC registered ourline for theme devices is TO-5.
TO. 39 fells within TO-5 with the excepption of lead length.
†Texas Instruments quarantees these devices in TO-39 packages deto-coded 7328 or higher to be capebte of incromed dispipation as followe: 0.8 W at $T_{A}<25^{\circ} \mathrm{C}$ derated tineerly to $\mathrm{T}_{A}=200^{\prime \prime} \mathrm{C}$ at the rate of $4.57 \mathrm{~mW} / \mathrm{C}^{\circ} \mathrm{C}$, or 10 W at $\mathrm{T}_{\mathrm{C}}<25^{\circ} \mathrm{C}$ ( 5.71 W at $\mathrm{T}_{\mathrm{C}}=100^{\circ} \mathrm{C}$ ) derated linearly to

$\ddagger$ Texes Inctruments gumentees its types 2N719 and 2 N 720 to be capable of the same diseipation at registered and shown for typee 2N719A, 2N720A, 2N870, and 2N871 with mppropriate derating factors shown in Notes 9 and 10.

## TYPES 2N698, 2N699, 2N719, 2N719A, 2N720, 2N720A N-P-N SILICON TRAMSISTORS

*electrical charactoristics at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)


NOTE 11 These parometers muss bo masurad using pulst lachniques. PW $\leq 300 \mu$ sec., Duty cycle $\leq \mathbf{2 \%}$.
Pulse width must be swh that halving or doubling does nol cevse a change proster then the
required accuracy of the measurament.
-Indicalos JEDEC registored data.

TYPES 2N719, 2N718A, 2N720, 2N720A, 2N870, 2N871, 2N1889, 2N1890, 2N1893 M-P-N SILICON TRANSISTORS
*olectricel charceforlstics of $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

|  | PARAMETER | TEST CONDITIONS | 70-12- | 2N720 |  | 2N720A |  | 2N370 |  | 2N871 |  | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  | 10-39 |  |  | 2N1893 |  | 2N1099 |  | 2N1890 |  |  |
|  |  |  |  | MIN | max | MIN | MAX | MIN | MAX | MiN | max |  |
| $V_{\text {Imaceo }}$ | Collectiv-lese <br> Dreekdiven Vellige | $I_{c}=100 \mu, I_{1}=0$ |  | 120 |  | 121 |  | 100 |  | 100 |  | V |
| $V_{\text {Imjero }}$ | Colicotw-Emitior Broakdown Voliepe | $\mathrm{I}_{\mathrm{c}}=30 \mathrm{mb}, \quad \mathrm{I}_{\mathrm{s}}=0 . \quad \mathrm{Sen}$ | 111 |  |  | 0 |  | 60 |  | 60 |  | $\checkmark$ |
| Y (micas | Colloctor-Enitter Brockdown Veltepe | $\mathrm{Ic}_{\mathrm{c}}=100 \mathrm{~m}, \mathrm{I}_{\mathrm{m}}=10 \mathrm{n}, \mathrm{sen}$ | 11 | 0 |  | 100 |  | 0 |  | 80 |  | V |
| Y/emineo | Emither-ilese <br> Brackdown Vofiage | $\mathrm{I}_{1}=100 \mu \mathrm{~L}, 1_{c}=0$ |  |  |  | 7 |  | 1 |  | 1 |  | V |
|  |  | $\mathrm{l}_{5}=1 \mathrm{~mm}, \quad \mathrm{l}_{c}=0$ |  | 5 |  |  |  |  |  |  |  | $v$ |
| ICos | Colloctar coleth Curront | $v_{C B}=0 v_{1} \quad I_{E}=0$ |  |  | 2 |  |  |  |  |  |  | $\mu$ |
|  |  | $V_{C S}=60 v_{1} \quad 1 \begin{aligned} & \text { a }\end{aligned}$ | $150^{\circ} \mathrm{C}$ |  | 290 |  |  |  |  |  |  | $\mu \mathrm{m}$ |
|  |  | $v_{c a}=75 v_{1} \quad 18=0$ |  |  |  |  |  |  | 0.010 |  | 0.010 | $\mu \mathrm{m}$ |
|  |  | $V_{C E}=75 v_{1} \quad I_{E}=0_{1} \quad I_{A}$ | $180^{\circ} \mathrm{C}$ |  |  |  |  |  | 15 |  | 15 | $\mu \mathrm{m}$ |
|  |  | $v_{c_{0}}=N_{0} v_{1} \quad I_{5}=0$ |  |  |  |  | 0.010 |  |  |  |  | $\mu$ |
|  |  | $\mathrm{V}_{\mathrm{Cl}}=\mathrm{v}_{1} \mathrm{v}_{1} \quad \mathrm{I}_{\mathrm{E}}=0, \quad \mathrm{~T}_{\mathrm{A}}$ | $150^{\circ} \mathrm{C}$ |  |  |  | 15 |  |  |  |  | $\mu$ |
| 140 | Emititer Cuteff Cerromi | $r_{11}=2 v_{1}, \quad l_{C}=0$ |  |  |  |  |  |  |  |  |  | $\mu \mathrm{m}$ |
|  |  |  |  |  |  |  | 0.010 |  | 0.010 |  | 0.010 | $\mu$ |
| Hre | Statk Fownond Current Trension Ratio | $v_{\text {cti }}=10 v_{0}, I_{C}=100 \mu$ |  |  |  | 24 |  | 20 |  |  |  |  |
|  |  | $v_{\text {cte }}=10 v_{1} v_{c}=10 \mathrm{ma}$ Sot | N11 |  |  | 35 |  | 35 |  |  |  |  |
|  |  | $\begin{aligned} & Y_{c i}=10 \mathrm{v}, \quad I_{\mathrm{C}}=10 \mathrm{~mm}, I_{\mathrm{A}} \\ & \text { sot mote } 11 \end{aligned}$ | $-55^{\circ} \mathrm{C}$ |  |  | 20 |  | 8 |  |  |  |  |
|  |  |  | te 11 | 4 | 120 |  | 120 | 41 | 140 |  | 300 |  |
|  | lese-Emitter Volicye | $\mathrm{I}_{1}=5 \mathrm{~mm}, \quad \mathrm{I}_{\mathrm{c}}=50 \mathrm{ma}$ Sem | te 11 |  |  |  | 0.9 |  | 0.9 |  | 0.1 | $v$ |
|  |  | $\mathrm{I}_{1}=15 \mathrm{~mm}, \mathrm{I}_{\mathrm{c}}=150 \mathrm{~mm}, \mathrm{sen}$ | W 11 |  | 1.8 |  | 1.3 |  | 1.3 |  | 1.8 | $v$ |
| $V_{\text {cutan }}$ | Colloctor-Emitior Scturation Velepo | $\mathrm{I}_{1}=5 \mathrm{~ms}, \mathrm{I}_{\mathrm{C}}=50 \mathrm{~mm}, \mathrm{sm}$ | te 11 |  |  |  | 1.2 |  | 1.2 |  | 1.2 | $v$ |
|  |  | $\mathrm{l}_{1}=15 \mathrm{~mm}, \mathrm{l}_{c}=150 \mathrm{ma}, \mathrm{sen}$ | to 11 |  | 5 |  | 5 |  | 5 |  | 5 | $\checkmark$ |
| $H_{10}$ | Small-SigalComan-lenelaput Imperanco | $\mathbf{v}_{\mathrm{Cs}}=5 \mathrm{v}, \quad \mathrm{I}_{\mathrm{c}}=1$ ma, 1 |  | 20 | 31 |  | 30 | 20 | 30 |  | 80 | anm |
|  |  | $v_{C s}=10 v_{1}, \mathrm{l}_{C}=5 \mathrm{~mm}, 1=$ |  |  | 10 | 4 | $t$ | 4 | 1 | 4 | 8 | atm |
| ${ }^{\text {rb }}$ | small.Signel <br> Commen-lese <br> Rewasu Yeltage <br> Treator Rictio | $v_{c a}=5 v_{0} \quad I_{c}=1 \mathrm{~mm}, 1=$ |  |  | $\begin{array}{r} 2.5 x \\ 10^{-4} \\ \hline \end{array}$ |  | $\begin{array}{r} 1.25 \mathrm{x} \\ 10-4 \\ \hline \end{array}$ |  | $\begin{gathered} 1.25 \times \\ 10^{-4} \\ \hline \end{gathered}$ |  | $\begin{gathered} 1.5 x \\ 10^{-4} \\ \hline \end{gathered}$ |  |
|  |  | $\mathrm{V}_{\mathbf{C s}}=10 \mathrm{v}, \quad \mathrm{I}_{\mathbf{c}}=3$ me, $1=$ |  |  | $\begin{gathered} 3 x \\ 10^{-4} \end{gathered}$ |  | $\begin{gathered} 1.52 \\ 10^{-4} \end{gathered}$ |  | $\begin{array}{c\|} \hline 1.5 x \\ 10^{-4} \end{array}$ |  | $\begin{aligned} & 1.5 x \\ & 10-4 \end{aligned}$ |  |
| ${ }^{*}{ }_{\text {b }}$ | Smallisignal Commen-Iote Outpel Adentience | $v_{c t}=5 v_{0} \quad t_{c}=1 \mathrm{mo}, 1=$ |  | 0.1 | 0.5 |  | 0.5 |  | 0.5 |  | 0.3 | $\mu \mathrm{mlve}$ |
|  |  | $v_{c i}=10 \mathrm{v}, \quad \mathrm{I}_{\mathbf{C}}=5 \mathrm{~mm}, \quad 1=$ |  |  | 1.0 |  | 0.5 |  | 0.5 |  | 0.3 | $\mu \mathrm{mme}$ |
| $h_{\text {f }}$ | Smell-Sigmal <br> Commen-Emither <br> Forward Cursual <br> Treaster Ratio | $v_{\text {cis }}=5 \mathrm{v}_{\mathrm{t}} \quad \mathrm{Ic}_{\mathrm{c}}=1 \mathrm{ma}, \quad 1=$ |  | 35 | 100 | 30 | 100 |  | 100 |  | 200 |  |
|  |  | $v_{\text {ct }}=10 \mathrm{v}^{\prime}, \mathrm{I}_{\mathrm{c}}=5 \mathrm{~mm}, 1=$ |  | 45 |  | 45 |  | 45 | 150 |  | 380 |  |
| $\left\|h_{\text {mo }}\right\|$ | Smell-Signel <br> Commen-Emifter <br> Ferwerd Curteal <br> Trunstor Ratle | $v_{c i n}=10 v_{1}, l_{c}=90 \mathrm{ma}, 1=20 \mathrm{mc}$ |  | 2.5 |  | 2.5 |  | 2.5 |  | 2.0 |  |  |
| Cob | Comman-ision Open-Cirall Oulpul Cepactitente |  | $\begin{aligned} & 1 \mathrm{me} \\ & 140 \mathrm{kt} \end{aligned}$ |  | 28 |  | 15 |  | 15 |  | 15 | M |
| $c_{\text {c }}$ | Common-lese Opma-Clecult Input Copactianes |  | $\begin{aligned} & 1 \mathrm{me} \\ & 140 \mathrm{ke} \end{aligned}$ |  | 55 |  | 15 |  | 15 |  | ${ }^{5}$ | \% |



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-Imeliceter JEDEC mikitord deta.

BULLETIN NO. DL-S 7311976 , JUNE 1973

## FOR MEDIUM-SPEED, MEDIUM-POWER, GENERAL PURPOSE AMPLIFIER APPLICATIONS

- fT . . . $60 \mathrm{MHz} \min (2 N 722)$
*mechanical data

*absolute maximum ratings at $\mathbf{2 5}{ }^{\circ} \mathbf{C}$ free-air temperature (unless otherwise noted)

| Collector-Base Voltaga |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Collector-Emitter Voltage (See Note 1) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Collector-Emitter Voltage (See Note 2) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Emitter-Base Voltage |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Continuous Device Dissipation at (or below) $\mathbf{2 5}{ }^{\circ} \mathrm{C}$ Free-Air Temperature (See Note 3) . . . . . . . . . . 0.4 W |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Continuous Device Dissipation at (or below) $25^{\circ} \mathrm{C}$ Case Temperature (See Note 4) . . . . . . . . . . . 1.5 W |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Storage Temperature Range . . . . . . . . . . . . . . . . . . . . . . . . . $-65^{\circ} \mathrm{C}$ to $\mathbf{2 0 0}{ }^{\circ} \mathrm{C}$ |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |

NOTES: 1. This value applies when the base-amitter diode is open-circuited.
2. This value applies when the base-amitter rasistanca $R_{\mathrm{BE}}<10 \Omega$.
3. Derate linesily to $175^{\circ} \mathrm{C}$ free-air tempersture at the rate of $2.87 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$.
4. Derate linearly to $175^{\circ} \mathrm{C}$ cese temperature at the rate of $10 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$.

[^31]
# TYPES 2N721, 2N722 P-N-P SILICON TRANSISTORS 

*electrical characteristics at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)


NOTE 5. These parameters must be measured using puise techniques. $t_{w}=300 \mu s$, duty cycle $\leqslant 1 \%$. *JEDEC registered data

## THERMAL INFORMATION

FREE-AIR TEMPERATURE


CASE TEMPERATURE DISSIPATION DERATING CURVE


# TYPES 2N696, 2N697, 2N717, 2N718, 2N718A, 2N730, 2N731, 2N956, 2N1420, 2N1507, 2N1613, 2N7H1 N-P-N SILICON TRANSISTORS 

# Highly Roliable, Versatile Devices Designed for Amplifier, Switching and Oscillator Applications from $<0.1 \mathrm{ma}$ to $>150 \mathrm{ma}$, de to 30 mc 

\author{

- High Voltage - Low Leakage <br> - Usoful $\mathrm{h}_{\mathrm{fE}}$ Over Wide Current Range
}


## *mechanical data

Device types 2N717, 2N718, 2N718A, 2N730, 2N731, and 2N956 are in JEDEC TO-18 packages.
Device types 2N696, 2N697, 2N1420, 2N1507, 2N1613, and 2N1711 are in JEDEC TO-5 packages.

*absolute maximum ratings at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

|  | $\begin{array}{\|l\|} \hline 2 \mathrm{~N} 696 \\ 2 \mathrm{~N} 697 \\ \hline \end{array}$ | $\begin{array}{r} 2 \mathrm{~N} 717 \\ 2 \mathrm{~N} 718 \\ \hline \end{array}$ | 2N718A | $\begin{array}{r} 2 N 730 \\ 2 N 731 \\ \hline \end{array}$ | 2N956 | $\begin{array}{\|l\|} \hline 2 N 1420 \\ \text { 2Nis07 } \\ \hline \end{array}$ | 2N1613 | 2N1711 | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Collector-Cose Voltage | 60 | 60 | 75 | 60 | 75 | 60 | 75 | 75 | $v$ |
| Colloctor-Emittor Voltage (See Note 1) | 40 | 40 | 50 | 40 | 50 | 30 | 50 | 50 | $v$ |
| Collector-Emitter Voltage (See Note 2) |  |  | 32 |  |  |  |  |  | $v$ |
| Emitter-Base Voltage | 5 | 5 | 7 | 5 | 7 | 5 | 7 | 7 | $v$ |
| Collector Current |  |  |  | 1.0 |  | 1.0 |  | 1.0 | 0 |
| Total Devica Dissipation at (or below) $25^{\circ} \mathrm{C}$ Froe-Air Temperature (See Note Indicuted in Parentheses) $\rightarrow$ | $\begin{gathered} 0.6 \\ \vdots \\ \vdots \\ \hline \end{gathered}$ | $\begin{aligned} & 0.4 \\ & \dagger \dagger \\ & 1 \dagger \\ & \hline \end{aligned}$ | $\begin{aligned} & 0.5 \\ & (7) \\ & \hline \end{aligned}$ | $\begin{aligned} & 0.5 \\ & 1 \dagger \\ & (9) \\ & \hline \end{aligned}$ | $\begin{aligned} & 0.5 \\ & (7) \\ & \hline \end{aligned}$ | $\begin{aligned} & \hline 0.6 \\ & \dagger \\ & \vdots \\ & \hline \end{aligned}$ | $\begin{aligned} & 0.8 \\ & (10) \\ & \hline \end{aligned}$ | $\begin{aligned} & 0.8 \\ & (10) \end{aligned}$ | W |
| Total Device Dissipation at (or below) $25^{\circ} \mathrm{C}$ Case Temperature (See Mote Indicated in Parentheses) $\rightarrow$ | $\begin{aligned} & 2.0 \\ & \vdots \\ & 1 \\ & (4) \end{aligned}$ | $\begin{aligned} & 1.5 \\ & t \\ & 16 \\ & \hline \end{aligned}$ | 1.8 <br> (8) | $\begin{aligned} & 1.5 \\ & t \\ & 1 . \\ & \hline(6) \end{aligned}$ | 1.8 <br> (8) | $\begin{aligned} & 2.0 \\ & i \\ & \text { (4) } \\ & \hline \end{aligned}$ | $\begin{aligned} & 3.0 \\ & \text { (11) } \\ & \hline \end{aligned}$ | 3.0 <br> (11) | W |
| Total Dovice Dissipation at $100^{\circ} \mathrm{C}$ Case Tomperoture | $\begin{aligned} & 1.0 \\ & \dagger \\ & \hline \end{aligned}$ | $\begin{aligned} & 0.75 \\ & i+ \\ & \hline \end{aligned}$ | 1.0 | $\begin{aligned} & 0.75 \\ & \text { t } \\ & \hline \end{aligned}$ | 1.0 | $\begin{aligned} & 1.0 \\ & + \\ & \hline \end{aligned}$ | 1.7 | 1.7 | W |
| Operating Collector Junction Temperature | 175† | 175it | 200 | 175t† | 200 | 175† | 200 | 200 | ${ }^{\circ} \mathrm{C}$ |
| Storage Temperature Ronge |  |  |  | -6 | ${ }^{\circ} \mathrm{C}$ to 20 | $0^{\circ} \mathrm{C}$ |  |  |  |

NOTES: 1. This value applies when the beso-amitior resistence (fice) is oqual to or less than 10 chmm.
2. This value applies when the base-omilter diode is opon-circuited.
3. Derate lineerly to $175^{\circ} \mathrm{C}$ tree-ale tomperature at the rate of $4.0 \mathrm{~mm} / \mathrm{c}^{\circ}$. 4. Derats Iinearly to $175^{\circ} \mathrm{C}$ cass tomperature at the rate of $13.3 \mathrm{mw} / \mathrm{c}^{\circ}$.
5. Derate limearly to $175^{\circ} \mathrm{C}$ fres-alr temperature at the rale of $2.07 \mathrm{~mm} / \mathrm{C}^{\circ}$.
4. Derats limenty te $175^{\circ} \mathrm{C}$ cose temperature of the rate of $10.0 \mathrm{~mm} / \mathrm{C}^{\circ}$.
7. Devals linearly to $200^{\circ} \mathrm{C}$ hot-air temperature at the rate of $2.06 \mathrm{~mm} / \mathrm{C}^{\circ}$
8. Borcte linearly to $200^{\circ} \mathrm{C}$ cese temperature af the rate of $10.3 \mathrm{~mm} / \mathrm{C}^{\circ}$.
9. Derels limourly to $175^{\circ} \mathrm{C}$ fros-air temporature at the rate of $3.33 \mathrm{mw} / \mathrm{C}^{\circ}$
10. Derste linesily to $200^{\circ} \mathrm{C}$ frem-air temperature at the rate of $4.56 \mathrm{mw} / \mathrm{c}^{\circ}$.
11. Derate linearly to $290^{\circ} \mathrm{C}$ esee tomperature of the rate of $17.2 \mathrm{~mm} / \mathrm{C}^{\circ}$.
fToxas Instruments guarentes: ins types 2N646 2N697, 2 N1420, and 2 N1507 to be capathe of the same ditaipation as regloterod and shown fer types 2N1613 and 2N1711 with approprlate derationg factors shown in Metes 10 and 11.
$\dagger \dagger$ Toxas Instruments guarantees its types 210717, 2N71s, 2N730, and 2N781 to we cappote of the same dilislpation as reglatored and shown for types 2N718A and 2N956 with eppropplate derating fortors shown In Metes 7 and e.
-Indkatos JEDEC regisiorad deta.

## *electrical characteristics af $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

| PARAMETER |  |  |  |  | $\begin{aligned} & 2 N 717 \\ & 2 N 730 \end{aligned}$ | $\begin{array}{\|l\|} \hline \text { 2N718 } \\ \text { 2N731 } \\ \hline \end{array}$ | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | 2N696 | 2N697 |  |  |  |
|  |  | MIN Max | MIN MAX | Min max | MIN max |  |
|  |  |  | $\mathrm{I}_{\mathrm{C}}=100 \mu \mathrm{~m}, \mathrm{I}_{\mathrm{E}}=0$ | $\omega$ | $\omega$ | 60 | 10 | $v$ |
| Vinuceo | Colicater-Emititer Broekdown Vollege |  | $\mathrm{I}_{\mathrm{c}}=30 \mathrm{mo}, \mathrm{I}_{1}=0, \quad$ Soe Note 12 |  |  |  |  |  |
| $V_{\text {(m) }}$ | Collocter-Emittor Brackdem Yoliteg | $\mathrm{I}_{\mathrm{c}}=100 \mathrm{mos}, \mathrm{I}_{\text {E }}=10 \mathrm{\Omega}$, Seo Nota 12 | 40 | 40 | 10 | 40 | v |
| VIEREDO | Emitter-bose Prackivw Voliage | $I_{E}=100 \mu_{0}, I_{c}=0$ <br> Except 20V17,21V1): $\mathrm{I}_{\mathrm{E}}=1 \mathrm{ma}$ | 5 | 5 | 5 | 5 | $\checkmark$ |
| ${ }^{1} \mathbf{C D O}$ | Callecter Cutoff Cerreat | $v_{C!}=30 v, I_{E}=0$ | 1.0 | 1.0 | 1.0 | 1.0 | $\mu \mathrm{a}$ |
|  |  | $V_{C E}=30 \mathrm{v}, \mathrm{I}_{\mathrm{E}}=0, \quad \mathrm{~T}_{\mathrm{A}}=150^{\circ} \mathrm{C}$ | 100 | 100 | 100 | 100 | $\mu \mathrm{c}$ |
|  |  | $\mathrm{v}_{\mathrm{CE}}=60 \mathrm{v}_{\mathrm{t}} \mathrm{I}_{\mathrm{E}}=0$ |  |  |  |  | $\mu$ |
|  |  | $V_{C A}=60 v_{,} \mathrm{I}_{\mathrm{E}}=0, \quad \mathrm{I}_{\mathrm{A}}=150^{\circ} \mathrm{C}$ |  |  |  |  | $\mu 0$ |
| ${ }^{\text {CeER }}$ | Collocitor Cutofl Cwrrat | $\mathbf{v}_{\text {CE }}=22 \mathrm{v}, \mathrm{R}_{\text {PE }}=100 \mathrm{k} \mathrm{\Omega}$ |  |  |  |  | $\mu 0$ |
| Ceor | Emitier Cuteff Curront | $v_{\text {E }}=5 \mathrm{v}, \mathrm{l}_{\mathbf{c}}=0$ |  |  |  |  | $\mu$ |
| ${ }^{4} \mathbf{f z}$ | Static Fonwed Carmat Trensfor latte | $v_{C E}=10 v, l_{C}=10 \mu \mathrm{~m}$ |  |  |  |  |  |
|  |  | $v_{C E}=10 y_{r} 1_{C}=100 \mu_{0}$ |  |  |  |  |  |
|  |  | $V_{C E}=10 r_{1} I_{C}=10 \mathrm{mo}$, See Motic 12 |  |  |  |  |  |
|  |  | $Y_{C E}=10 v_{1} I_{C}=10 \mathrm{ma}, \quad \mathrm{~T}_{\mathrm{A}}=-55^{\circ} \mathrm{C}$ <br> Sen Note 12 |  |  |  |  |  |
|  |  | $V_{C E}=10 v_{i} I_{C}=150 \mathrm{ma}$, Stot Mote 12 | 20.60 | $40 \quad 120$ | $20 \quad 60$ | $40 \quad 120$ |  |
|  |  | $Y_{C E}=10 \mathrm{r}, \mathrm{I}_{C}=500 \mathrm{ma}$, See Mote 12 |  |  |  |  |  |
| $V_{\text {me }}$ | Bess-Emittor Yoltage | $\mathrm{l}_{\mathrm{B}}=15 \mathrm{ma}, \mathrm{I}_{\mathrm{c}}=150 \mathrm{ma}$, Sen Mott 12 | 1.3 | 1.3 | 1.3 | 1.3 | * |
| $\mathrm{V}_{\text {CEsati }}$ | Colfecter-Emititer Soturation Velteyo | $\mathrm{I}_{\mathrm{B}}=15 \mathrm{mo}, \mathrm{I}_{\mathrm{c}}=150 \mathrm{ma}$, See Mola 12 | 1.5 | 1.5 | 1.5 | 1.5 | V |
| $h_{i b}$ | Smail-Signal Commm-lose Inpul Iapedence | $\mathrm{V}_{\mathrm{c},}=5 \mathrm{y}, \mathrm{l}_{\mathrm{c}}=1 \mathrm{ma}, 1=1 \mathrm{kc}$ |  |  |  |  | chem |
|  |  | $v_{C I}=10 \mathrm{v}, \mathrm{I}_{\mathrm{C}}=5 \mathrm{ma}, \quad f=1 \mathrm{kc}$ |  |  |  |  | cmm |
| ${ }^{\text {brb }}$ | Small-Signed Commen-Vase Rowws Voltage Itcmster Retio | $\mathbf{v}_{\mathbf{C s}}=5 \mathrm{v}, \mathrm{I}_{\mathbf{c}}=1 \mathrm{~mm}, \quad \mathrm{f}=1 \mathrm{kc}$ |  |  |  |  |  |
|  |  | $v_{\text {ces }}=10 \mathrm{r}, \mathrm{l}_{\mathrm{c}}=5 \mathrm{ma}, \quad f=1 \mathrm{kc}$ |  |  |  |  |  |
| $b_{0}$ | Smali-Signal (cmama-Sent Outpot Admittence | $v_{\mathrm{cs}}=5 \mathrm{v}, \mathrm{I}_{\mathrm{c}}=1 \mathrm{mb}, \quad 1=1 \mathrm{k}$ |  |  |  |  | $\mu$ mine |
|  |  |  |  |  |  |  | $\mu \mathrm{mmb}$ |
| $h_{6}$ | Smell-Signal Commen-Emilter Forward Curroat Trunsfor Ratio | $\mathbf{Y}_{\mathbf{C E}}=5 \mathrm{v}, \mathrm{l}_{\mathbf{C}}=1 \mathrm{me}, f=1 \mathrm{kc}$ |  |  |  |  |  |
|  |  | $v_{C E}=10 v_{0} \mathrm{l}_{\mathrm{C}}=5 \mathrm{ma}, \quad i=1 \mathrm{kc}$ |  |  |  |  |  |
| $\left\|h_{\text {fol }}\right\|$ | Smell-Signal Connmon-Emittor Forward Curronal Trenstor Ratio | $\mathbf{v}_{\mathbf{C E}}=10 \mathrm{v}, \mathrm{l}_{\mathbf{C}}=50 \mathrm{ma}, f=20 \mathrm{mc}$ | 2.0 | 2.5 | 2.0 | 2.5 |  |
| ${ }_{\text {c }}{ }^{\text {b }}$ | Commen-Lase Open-Circuit Outpul Capacitonce | $\mathbf{v}_{\mathbf{C s}}=10 \mathrm{v}, \mathrm{l}_{\mathbf{E}}=0, \quad i=1 \mathrm{mc}$ | 35 | 35 | 35 | 35 | Pf |
| $c_{i b}$ | Cammen-lose Open-Gircult Input Capacitancs | $\mathrm{v}_{\mathrm{ft}}=0.5 \mathrm{v}, \mathrm{l}_{\mathrm{c}}=0, \quad i=1 \mathrm{mc}$ |  |  | 80 | 80 | pf |

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*Indicetes JEBEC misistorad data

## TYPES 2N849, 2N850 <br> N-P-N SILICON TRANSISTORS

## DESIGNED FOR HIGH-SPEED SWITCHING APPLICATIONS

mechanical data
The transistors are in a hermetically sealed welded package meeting the JEDEC TO-50 outline.

*absolute maximum ratings at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)
Collector-Base Voltage
Collector-Emitter Voltage (see note 1). . . . . . . . . . . . . . . . . . . . . 25 v

Collector-Emitter Voltage (see note 1) . . . . . . . . . . . . . . . . . . . . . 15 r
Emitter-Bose Voltage . . . . . . . . . . . . . . . . . . . . . . . . . . 5 v
Collector Current . . . . . . . . . . . . . . . . . . . . . . . . . . 50 ma
Total Device Dissipation at $25^{\circ} \mathrm{C}$ Free-Air Temperature (see note 2) . . . . . . . . . . . 0.3 w
Total Device Dissipation at $25^{\circ} \mathrm{C}$ Case Temperature (see note 3) . . . . . . . . . . . . 1.2 w
Collector Junction Operating Temperature . . . . . . . . . . . . . . . . . . $175^{\circ} \mathrm{C}$
Storage Temperature Range . . . . . . . . . . . . . . . . . . . $-65^{\circ} \mathrm{C}$ to $+200^{\circ} \mathrm{C}$
*electrical characteristics at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

| PARAMETER |  | TEST CONDITONS |  | MIN | MAX | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| $\mathrm{I}_{\text {cıo }}$ | Collector Cutofl Current | $V_{C B}=15 v_{\text {c }} \mathrm{t}_{\mathrm{E}}=0$, |  |  | 0.5 | $\mu 0$ |
| Icso | Collector Cutoff Current | $V_{C B}=15 v, \mathrm{I}_{\mathrm{E}}=0 \quad \mathrm{~T}_{\mathrm{A}}=150^{\circ} \mathrm{C}$ |  |  | 30 | $\mu \mathrm{O}$ |
| $\mathrm{I}_{\mathbf{c} 80}$ | Collector Cutoff Current | $V_{C E}=25 v, I_{E}=0$ |  |  | 10 | $\mu \mathrm{a}$ |
| $l_{\text {CER }}$ | Collector Cutoff Current | $V_{C E}=20 \mathrm{v}, \mathrm{R}_{\text {BE }}=100 \mathrm{k} \Omega$ |  |  | 10 | $\mu \mathrm{a}$ |
| $\mathrm{l}_{\text {EBO }}$ | Emitter Cutoff Current | $V_{E B}=5 \mathrm{v}_{2} \quad \mathrm{I}_{\mathbf{C}}=0$ |  |  | 10 | $\mu \mathrm{a}$ |
| +V $V_{\text {far)ceo }}$ | Collector-Emitter Breakdown Voltage | $\mathrm{l}_{\mathrm{c}}=10 \mathrm{ma}, \mathrm{I}_{\mathrm{B}}=0$ |  | 15 |  | $\mu$ |
|  | Collector-Emitter Breakdown Voltoge | $\mathrm{I}_{\mathrm{C}}=10 \mathrm{mo}, \mathrm{R}_{\text {bE }}=10 \Omega$ |  | 20 |  | V |
| $Y_{\text {(Ea) }}$ | Collector-Base Breakdown Voltage | $l_{c}=10 \mu \mathrm{a}, \mathrm{l}_{\mathrm{E}}=0$ |  | 25 |  | $\checkmark$ |
| $\mathbf{V}_{\text {(m) }}$ | Emitter-Base Breakdown Voltage | $\mathrm{I}_{\mathrm{E}}=10 \mu \mathrm{a}, \mathrm{I}_{C}=0$ |  | 5 |  | V |
| $\dagger^{\text {fre }}$ | Static Forward Current Transler Ratio | $V_{C E}=1 \mathrm{v}, \quad \mathrm{I}_{\mathrm{C}}=10 \mathrm{ma}$ | 2N849 | 20 | 60 |  |
|  |  |  | 2N850 | 40 | 120 |  |
| $\dagger_{\text {f }} \mathrm{V}_{\text {PE }}$ | Base-Emilter Voltage | $\mathrm{I}_{\mathrm{s}}=1 \mathrm{ma}, \quad \mathrm{I}_{\mathrm{c}}=10 \mathrm{ma}$ |  | 0.7 | 0.9 | $y$ |
| ${ }^{+V_{\text {celsat }}}$ | Collector-Emitter Saturation Voltage | $I_{B}=1 \mathrm{ma}, I_{c}=10 \mathrm{ma}$ |  |  | 0.6 | $v$ |
| $\left\|h_{\text {ral }}\right\|$ | Small-Signal Common-Emitter Forward Current Transfer Ratio | $V_{C E}=10 \mathrm{v}, \mathrm{I}_{\mathrm{E}}=-10 \mathrm{mo}, f=100 \mathrm{mc}$ |  | 6 |  | db |
| $C_{\text {cb }}$ | Common-Base Oufput Capacitance | $V_{C S}=5 v_{,} \mathrm{I}_{\mathrm{E}}=0, \quad f=1 \mathrm{mc}$ |  |  | 5 | pf |

*switching characteristics at $25^{\circ} \mathrm{C}$ free-air temperature

|  | PARAME | TEST CONDITIONS |  | MAX | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: |
| $t_{\text {on }}$ | Tum-On Time | $\begin{aligned} & I_{\mathbb{A}(1)}=3 \mathrm{mo}, I_{\mathrm{a}(2)}=-1 \mathrm{mo} \\ & V_{\mathrm{CC}}=3 \mathrm{v}, \quad \mathbf{R}_{\mathrm{L}}=270 \Omega \text {, (see Circuit A) } \end{aligned}$ |  | 40 | nsec |
| $t$ dff | Turn-Off Time |  |  | 75 | nsec |
| $t_{5}$ | Storage Time |  | 21.849 | 25 | nsec |
|  |  |  | 21850 | 35 | nsec |

†These porameters must be measurad with a pulse duration of 300 microseconds and a duty cycle of 2 percent.
NOTES: 1. This volue applies when the base-amitter diode is opan-circuited.
2. Derate linearly to $775^{\circ} \mathrm{C}$ free-air temperature at the rate of $2 \mathrm{~mm} /{ }^{\circ} \mathrm{C}$.
3. Derate linearly to $175^{\circ} \mathrm{C}$ case temparature at the rate of $8 \mathrm{mw} /{ }^{\circ} \mathrm{C}$.
*Indicates JEDEC registered data.

## TYPES 2N849, 2N850 N-P-N SILICON TRANSISTORS

## "circuit A



input and output pulse wavefonms

## circuit a


input and output pulse wayirorms

NOTES: ©) All eapeaituncen in $\mu \boldsymbol{\mu}$.
b) All renintors $\pm 1 \%, 0.1 \mathrm{~m}$, HRR.
c) Decoupling capaciton ( $\mathbf{2 5} \mu \mathrm{f}$ ) are ploced across the power supply terminals to $\mathrm{V}_{\mathrm{Cc}}$ and $\mathrm{V}_{\text {es }}$.
d) The input to each circuit is supplied by a Model 303 Lumatron Mercury-Relay Pulse Generator ( $z_{\text {eut }}=50$ @) or equivalent. Pulse rise time $\leq 1$ nsec. PW $\geq 400$ nasc, Duty Cycle $\leq 2 \%$.
-) Output waveforma are menitored by a Model 12.AB Lumatron Sampling Oceiloscope ( $Z_{\text {in }}=50 \mathrm{a}$, rise time $\leq 1$ nsck) or equivalent.


# TYPES 2N851, 2N852 <br> N-P-N SILICON TRANSISTORS 

## DESIGNED FOR HIGH-SPEED SWITCHING APPLICATIONS


*absolute maximum ratings at $\mathbf{2 5}{ }^{\circ} \mathrm{C}$ froe-alr temporature(unless otherwise noted)
Collector-Base Voltage . . . . . . . . . . . . . . . . . . . . . . . . . 20 r

Collector-Emitter Voltage (see note 1) . . . . . . . . . . . . . . . . . . . . 12 v
Emitter-Base Voltage . . . . . . . . . . . . . . . . . . . . . . . . . . 5 r
Collector Current . . . . . . . . . . . . . . . . . . . . . . . . . . 200 ma
Total Device Dissipation at $25^{\circ} \mathrm{C}$ Free-Air Temperature (see note 2) . . . . . . . . . . . 0.3 w
Total Device Dissipation at $25^{\circ} \mathrm{C}$ Case Temperature (see note 3) . . . . . . . . . . . . 1.2 w
Collector Junction Operating Temperature . . . . . . . . . . . . . . . . . . $175^{\circ} \mathrm{C}$
Storage Temperature Range . . . . . . . . . . . . . . . . . . . $-65^{\circ} \mathrm{C}^{\circ}$ to $+200^{\circ} \mathrm{C}$
*olectrical characteristics at $25^{\circ} \mathrm{C}$ free-air temperature (unless othorwise noted)

| PARAMETER | TEST CONDITIONS |  | MIN | MAX | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: |
| Iens Collactor Culoff Current | $V_{C I}=20 \mathrm{r}, \quad \mathrm{V}_{\mathrm{m}}=0$ |  |  | 1 | $\mu 0$ |
| ICas Colloctor Cutoff Currant | $V_{\text {Cl }}=20 \mathrm{~V}_{1} \quad V_{\mathrm{E}}=0, \quad \mathrm{I}_{\mathrm{A}}=170^{\circ} \mathrm{C}$ |  |  | 100 | $\mu$ |
| Icix Collector Culoff Currant | $\mathrm{V}_{\mathrm{CI}}=.10 \mathrm{~V}, \quad \mathrm{~V}_{\mathrm{B}}=+0.35 \mathrm{~V}, \mathrm{~T}_{\mathrm{A}}=100^{\circ} \mathrm{C}$ |  |  | 30 | $\mu$ |
| leos Emittor Cutoff Current | $V_{1 s}=5 \mathrm{v}, \quad \mathrm{l}_{\mathrm{c}}=0$ |  |  | 10 | $\mu \mathrm{O}$ |
| tV eukceo Colloctor-Emitter Braokdown Voitoge | $\mathrm{I}_{\mathrm{c}}=10 \mathrm{ma}, \mathrm{I}_{\mathrm{B}}=0$ |  | 12 |  | - |
| $V_{\text {carcio }}$ Colloctor-Bose Breakdown Vollage | $L_{c}=10 \mu a_{1} l_{t}=0$ |  | 20 |  | $v$ |
| Y wayuo Emithor-Base Braokdown Voltage | $\mathrm{L}_{1}=10 \mu 0, \mathrm{k}_{\mathrm{c}}=0$ |  | 5 |  | $v$ |
| Static Forword Current Transter Ratio | $V_{c t}=0.25 \mathrm{v}, \mathrm{l}_{\mathrm{c}}=1 \mathrm{ma}$ | $2 \mathrm{2N851}$ | 10 |  |  |
|  |  | 2N852 | 20 |  |  |
| Static Forward Current Iramstor Ratio | $V_{\text {ct }}=0.35 \mathrm{v}, \mathrm{I}_{\mathrm{c}}=10 \mathrm{ma}$ | 24651 | 20 | 60 |  |
|  |  | 214852 | 40 | 120 |  |
| Statik Forword Current Pranster Ratio | $V_{\text {ce }}=1.0 \mathrm{v}, \quad \mathrm{I}_{\mathrm{c}}=100 \mathrm{mo}$ | $2 \mathrm{2N051}$ | 10 |  |  |
|  |  | 24852 | 20 |  |  |
| Stotk Forword Currant Trunster Ratio | $V_{C E}=0.35 \mathrm{v}, \mathrm{I}_{\mathrm{c}}=10 \mathrm{ma}, \quad \mathrm{T}_{\mathrm{A}}=-55^{\circ} \mathrm{C}$ | 24051 | 10 |  |  |
|  |  | 2 W 652 | 20 |  |  |
| $V_{\text {m }}$ Bas-Emittor Yoltage | $\mathrm{l}_{\mathrm{L}}=1 \mathrm{ma}, \quad \mathrm{l}_{\mathrm{c}}=10 \mathrm{ma}$ |  | 0.65 | 0.85 | $V$ |
| tVe Base-Emitter Voltage | $\mathrm{I}_{\mathrm{s}}=10 \mathrm{ma}, \quad \mathrm{l}_{\mathrm{c}}=100 \mathrm{mo}$ |  |  | 1.5 | $v$ |
| Ve Coso-Emither Voltage | $\mathrm{I}_{\mathrm{B}}=1 \mathrm{mo}, \quad \mathrm{I}_{\mathrm{c}}=10 \mathrm{ma}, \quad \mathrm{T}_{\mathrm{A}}=-55^{\circ} \mathrm{C}$ |  |  | 1.1 | $v$ |
| tV $\mathrm{V}_{\text {me }} \quad$ Base-Emither Voltage | $\mathrm{I}_{\mathrm{B}}=10 \mathrm{ma}, \quad \mathrm{I}_{\mathrm{C}}=100 \mathrm{ma}, \quad \mathrm{T}_{\mathrm{A}}=-55^{\circ} \mathrm{C}$ |  |  | 1.6 | $\checkmark$ |
| Veluay Collector-Emilter Saturation Voltoge | $\mathrm{I}_{\mathrm{t}}=1 \mathrm{ma}, \quad \mathrm{I}_{\mathrm{c}}=10 \mathrm{ma}, \quad \mathrm{T}_{\mathrm{A}}=170^{\circ} \mathrm{C}$ |  |  | 0.35 | $v$ |
| $\pm V_{\text {celuet }}$ Collector-Emitter Saturation Voltage | $\mathrm{I}_{1}=10 \mathrm{ma}, \mathrm{I}_{\mathrm{C}}=100 \mathrm{ma}, \mathrm{T}_{\mathrm{A}}=170^{\circ} \mathrm{C}$ |  |  | 1.0 | $v$ |
| $\left\|h_{\text {me }}\right\| \quad \begin{aligned} & \text { Small-Signal Common-Emifthr } \\ & \text { Forwend Current Pranstor Ratio }\end{aligned}$ | $V_{c t}=10 \mathrm{v}_{1} \quad \mathrm{Ic}_{\mathrm{c}}=10 \mathrm{ma}, \quad f=100 \mathrm{mc}$ |  | 9 |  | db |
| Cob Commen-Bose Output Capesitance | $V_{C l}=5 \mathrm{v}, \quad h_{1}=0, \quad t=1 \mathrm{mc}$ |  |  | 5 | M |

*swlithing charactoristics at $23^{\circ} \mathrm{C}$ free-air temperature

|  | PARAMITR | TIST CONDITIONS |  | Max | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: |
| ${ }^{\text {fan }}$ | Tum-On TIme |  |  | 16 | nsch |
|  |  | $\mathrm{Ic}_{\mathrm{c}} \approx 100 \mathrm{me}$ In Crumita |  | 12 | mact |
| $t_{\text {det }}$ | Purnoff IIme | Ic $=10 \mathrm{mo} \mathrm{in} \mathrm{Crailf} \mathrm{A}$ | 2ME51 | 24 | mat |
|  |  |  | 2 M852 | 24 | $\underline{\mathrm{mac}}$ |
|  |  | $\mathrm{Ic}_{\mathrm{c}} \approx 100 \mathrm{ma}$ in Cruil A | 2 N 551 | 40 | mact |
|  |  |  | $2 \mathrm{NeS2}$ | 45 | mact |
| t. Storage Iime |  |  | 2 N051 | 14 | mact |
|  |  | 2 ME52 | 18 | nsec |

thene paremsters must be meosurad with equle duration of 300 microneconds mad a duty eycle of 2 percent.

Wadicatit JEDET mgitiorod date.
3. Berate linearly to $175^{\circ} \mathrm{C}$ case temperature at the rate of $8 \mathrm{~mm} /{ }^{\circ} \mathrm{C}$.

## TYPES 2N851, 2N852 N-P-N SILICON TRANSISTORS

## PARAMETER MEASUREMENT INFORMATION

## CIRCUIT A


nfut and output pulse wavtrome
CIRCUIT CONDITIONS

| $\underset{m a^{*}}{\mathrm{I}_{\mathrm{c}}}$ | $\operatorname{lman}_{\mathrm{ma}}$ | $\begin{aligned} & I_{\text {IM } 21} \\ & m a^{*} \end{aligned}$ |  | $V_{c c}$ | $R_{1}=R_{2}$ | R2 | $\begin{aligned} & \overline{R_{4}} \end{aligned}$ | ${ }_{6}$ | $\mathrm{t}_{0}$ |  | leat |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 10 | 3 | -1.5 | -1.5 | 3.0 | 3.3 K | 50 |  |  | ver | V1m, r | 120, | $\mathrm{V}_{\mathrm{ln}, \mathrm{y}}$ |
| 100 | 40 | -20.0 | -24 | 60 | 330 (b) |  |  | 0 | -3.0 | 15.0 | 12.0 | -15.0 |
|  |  |  |  | 6.0 |  | 56 | 0 | 1 K | -4.5 | 20.0 | $15.3{ }^{(d)}$ | -20.0 |

*Approximofo values.
*Prior baso-mmitter voltoge, "OfF" state.
CIRCUIT:

mput and output puls wayirorms

NOPES, a) All capactanees in $\mu$ f.
b) All resittors $£ 1 \%, 0.1 \mathrm{w}$, HFR except $\mathrm{R2}$ is 0.5 w at 100 ma .
-) Decoupling capacitors ( $\mathbf{2 5} \mu$ ) are placed across the power supply terminals to $V_{C C}$ and $V_{\text {as }}$.
d) $\mathrm{V}_{\mathrm{BL}}$ is pulsed for 1.5 sec at less than $\mathbf{1 0 \%}$ duly cycle for $100 \mathrm{ma} \mathrm{t}_{\mathrm{off}}$ to keop ease temperature below $\mathbf{3 0}{ }^{\circ} \mathrm{C}$.
-) The input to each sircult is supplied by a Model 303 Lumatron Mercury-helay Pule Generator ( $\mathrm{Z}_{\text {eut }}=50$ @) or equivalent. Pulse rise times 1 nsec. PW $\geq 300$ nsec, Duty Cyele $\leq 2 \%$.
f) Output waveforms are monitored by a Model 12-At Lumatron Sampling Ocellioseope ( $\mathrm{Z}_{\mathrm{in}}=50 \Omega$, rist time $\leq$ insec ) or equivalent.

# Highly Relliable, Versatile Devices Designed for Amplifier, Switching and Oscillator Applications from $<0.1 \mathrm{ma}$ to $\boldsymbol{>} \mathbf{1 5 0} \mathrm{ma}$, de to $\mathbf{3 0} \mathrm{me}$ <br> - High Voltage - Low Leakage <br> - Useful $h_{\text {fe }}$ Over Wide Current Range 

mechanical data
Device types 2N719, 2N719A, 2N720, 2N720A, 2N870 and 2N871 are in JEDEC TO-18 packages*.
Device types 2N698, 2N699, 2N1889, 2N1890, and 2N1893 are in JEDEC TO-39 packages*.

*absolute maximum rafings at $25^{\circ} \mathrm{C}$ free-air temperature (unless ofherwise noted)

|  | 2N698 | 2N699 | $\begin{aligned} & 2 N 719 \\ & 2 N 720 \end{aligned}$ | 2N719A | 2N720A | $\left\lvert\, \begin{aligned} & 2 \mathrm{~N} 870 \\ & 2 \mathrm{~N} 871 \end{aligned}\right.$ | $\begin{array}{\|l\|} \hline 2 \mathrm{~N} 1889 \\ 2 \mathrm{~N} 1890 \end{array}$ | 2N1893 | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Collector-Base Voltage | 120 | 120 | 120 | 120 | 120 | 100 | 100 | 120 | $v$ |
| Collector-Emitior Vohage (See Note 1) | 80 | 80 | 80 | 80 | 100 | 80 | 80 | 100 | $v$ |
| Collector-Emitter Voltage (See Note 2) | 60 |  |  | 60 | 80 | 60 | 60 | 80 | $v$ |
| Emittor-Base Voltage | 7 | 5 | 5 | 7 | 7 | 7 | 7 | 7 | $v$ |
| Colloctor Current |  |  |  | 1.0 |  |  |  | 0.5 | 0 |
| Total Device Dissipation at (or below) $25^{\circ} \mathrm{C}$ Free-Air Temperature (See Note Indicated in Parenthessas) $\longrightarrow$ | $0.8$ <br> (3) | $\begin{array}{r} 0.6 \\ t \\ (5) \\ \hline \end{array}$ | $\begin{array}{r} 0.4 \\ \ddagger \\ (7) \\ \hline \end{array}$ | $\begin{aligned} & 0.5 \\ & \text { (9) } \end{aligned}$ | $\begin{aligned} & 0.5 \\ & \text { (9) } \end{aligned}$ | $\begin{aligned} & 0.5 \\ & \text { (9) } \end{aligned}$ | (3) | (3) | w |
| Totol Devise Dissipation of (or below) $25^{\circ} \mathrm{C}$ Case Temperature <br> (See Mote Indicated in Parenthesses) $\longrightarrow$ | $\begin{gathered} 3.0 \\ \uparrow \\ \text { (4) } \end{gathered}$ | $\begin{gathered} 2.0 \\ + \\ \text { (6) } \\ \hline \end{gathered}$ | $\begin{gathered} 1.5 \\ \ddagger \\ \text { (8) } \\ \hline \end{gathered}$ | $\begin{aligned} & 1.8 \\ & (10) \\ & \hline \end{aligned}$ | $\begin{aligned} & 1.8 \\ & (10) \\ & \hline \end{aligned}$ | 1.8 <br> (10) | $\begin{gathered} 3.0 \\ \dagger \\ \text { (4) } \\ \hline \end{gathered}$ | $\begin{gathered} 3.0 \\ t \\ \text { (4) } \\ \hline \end{gathered}$ | W |
| Storage Temperature Range | $-65^{\circ} \mathrm{C}$ to $200^{\circ} \mathrm{C}$ |  |  |  |  |  |  |  |  |

MOTES: 1. This values applies when the baso-omitter rosisteme ( $\mathrm{R}_{\text {efe }}$ ) is equal to or tess than 10 shms.
2. This velues epplies when the hen-emmititer diedo is open-chiculiced.
3. Derste linearly te $200^{\circ} \mathrm{C}$ fret-air temperature of the rate of $4.57 \mathrm{mw} /{ }^{\circ} \mathrm{C}$.
4. Derete lineerly $10200^{\circ} \mathrm{C}$ cese temperature at the rate of $17.2 \mathrm{~mm} /{ }^{\circ} \mathrm{C}$.
5. Derate linoerly to $175^{\circ} \mathrm{C}$ froo-air temparature of the rate of $4.0 \mathrm{~mm} /{ }^{\circ} \mathrm{C}$.
4. Derate linecerly to $175^{\circ} \mathrm{C}$ cose temparature at the rate of $13.3^{\mathrm{mm}} /{ }^{\circ} \mathrm{C}$.
7. Derate Ineorly $10175^{\circ} \mathrm{C}$ free-eis tempenature at the rate of $2.67 \mathrm{~mm} /{ }^{\circ} \mathrm{C}$.
B. Derate linearly to $175^{\circ} \mathrm{C}$ cese temparature at the rate of $10.0 \mathrm{~mm} /{ }^{\circ} \mathrm{C}$.
9. Derate linesily to $200^{\circ} \mathrm{C}$ tree-air temperature at the rate of $2.05 \mathrm{~mm} /{ }^{\circ} \mathrm{C}$.
10. Derols lineerly is $200^{\circ} \mathrm{C}$ case tempmature at the rats of $10.3 \mathrm{~mm} /{ }^{\circ} \mathrm{C}$.
*JEDEC reglstered data.
-The JEDEC repisterred ourline for thoe dovices is TO-5.
TO-39 folls within TO-S with the exeeption of lead length.

TTexes Imbtrumente quarmintes theoe devices in TO-39 packages dote-coded 7328 or higther to be capebile of inereseed dissipetion as follown: 0.8 W at $\mathrm{T}_{A}<25^{\circ} \mathrm{C}$ derated Hinearly to $\mathrm{T}_{A}=200^{\circ} \mathrm{C}$ at the rate of $4.57 \mathrm{~mW} / \mathrm{C}$, or 10 W at $\mathrm{T}_{\mathrm{C}}<25^{\circ} \mathrm{C}$ (B.71 W at $\mathrm{TC}_{\mathrm{C}}=100^{\circ} \mathrm{C}$ ) derated linearly to $T_{C}=200^{\circ} \mathrm{C}$ at the rete of $57.1 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$.
$\ddagger$ Taxes Instruments guerentow its typee 2N718 and 2 N 720 to be cepoble of the seme diseipation and reglaterred and hown for typee 2N719A, 2N720A, 2N870, and 2NS71 with mppropriate derating factors thown in Notess and 10.

## TYPES 2N720. 2N720A, 2N870, 2N871, 2N1889, 2N1890, 2N1893 N-P-N SILICON TRANSISTORS

*electrical characteristics at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

| PARAMETER |  | TEST CONDITIONS | $\begin{array}{c\|} 10-18- \\ \hline 10-39-1 \end{array}$ | 2N720 |  | 2N720A |  | 2N870 |  | $2 \mathrm{Na71}$ |  | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  | MiN | MaX | MIN | max | MIN | max | MIN | MAX |  |
| $V_{\text {(mp)ceo }}$ | Collector-iase Dreakdown Voltoge |  | $\mathrm{I}_{\mathbf{c}}=100 \mu \mathrm{a}, \mathrm{I}_{\mathrm{E}}=0$ |  | 120 |  | 120 |  | 100 |  | 100 |  | $\vee$ |
| $v$ Imalceo | Collector-Emifter Ireakdewn Voltage | $\mathrm{I}_{\mathrm{c}}=30 \mathrm{ma}, \quad \mathrm{I}_{\mathrm{s}}=0 . \quad$ See Mote 11 |  |  |  | 80 |  | 60 |  | 60 |  | v |
| $V_{\text {( }}^{\text {(R) CER }}$ | Collecter-Emifter Breakdown Voltage | ${ }^{I_{c}}=100 \mathrm{ma}, \mathrm{R}_{\text {dee }}=10 \Omega$, Seot Mote 11 |  | 30 |  | 100 |  | 0 |  | 60 |  | $v$ |
| $V_{\text {IURJESO }}$ | Emitter-Dase <br> Braokdown Voltoge | $\mathrm{I}_{\mathbf{E}}=100 \mu \mathrm{a}, \mathrm{I}_{\mathbf{C}}=0$ |  |  |  | 7 |  | 7 |  | 7 |  | V |
|  |  | $\mathrm{I}_{\mathrm{E}}=1 \mathrm{mo}, \quad \mathrm{I}_{C}=0$ |  | 5 |  |  |  |  |  |  |  | $v$ |
| ${ }^{\mathbf{C}} \mathbf{C O}$ | Coltecter Cutoft Current | $v_{C I}=60 v_{1} \quad t_{E}=0$ |  |  | 2 |  |  |  |  |  |  | $\mu$ |
|  |  | $v_{C B}=60 \mathrm{v}, \quad \mathrm{I}_{\mathrm{E}}=0, \quad \mathrm{~T}_{\mathrm{A}}=150^{\circ} \mathrm{C}$ |  |  | 200 |  |  |  |  |  |  | $\mu \mathrm{m}$ |
|  |  | $V_{C s}=75 v_{1}, \quad I_{E}=0$ |  |  |  |  |  |  | 0.010 |  | 0.010 | $\mu \mathrm{L}$ |
|  |  | $\mathrm{V}_{\mathrm{CB}}=75 \mathrm{v}, \quad \mathrm{I}_{\mathrm{E}}=0, \quad \mathrm{~T}_{\mathrm{A}}=150^{\circ} \mathrm{C}$ |  |  |  |  |  |  | 15 |  | 15 | $\mu \mathrm{ma}$ |
|  |  | $\mathrm{V}_{\mathrm{CE}}=90 \mathrm{v}, \mathrm{I}_{\mathrm{E}}=0$ |  |  |  | 0.010 |  |  |  |  |  | $\mu \mathrm{a}$ |
|  |  | $v_{C I}=90 v_{1} \quad I_{E}=0, \quad \mathrm{~T}_{\mathrm{A}}=150^{\circ} \mathrm{C}$ |  |  |  |  | 15 |  |  |  |  | $\mu$ |
| ${ }_{\text {Eta }}$ | Emittor Cutofl Curcent | $v_{E B}=2 v_{1} \quad \mathbf{I}_{\mathbf{c}}=0$ |  |  |  |  |  | 0.010 |  |  |  | $\mu$ |
|  |  |  |  |  |  | 0.010 |  |  |  | 0.010 |  | $\mu$ |
|  |  | $V_{C E}=10 \mathrm{r},{ }^{1} \mathrm{C}=100 \mu \mathrm{e}$ |  |  |  | 20 |  | 20 |  |  |  |  |
|  |  | $v_{C E}=10 \mathrm{r}, \quad \mathrm{l}_{C}=10 \mathrm{ma}, \mathrm{sec}$ | Wete 11 |  |  | 35 |  | 35 |  |  |  |  |
| $h_{\text {fe }}$ | Tronsfor Ratio | $\begin{aligned} & V_{C E}=10 \mathrm{v}, \quad I_{C}=10 \mathrm{ma}, I_{A} \\ & \text { Soe Mote } 11 \end{aligned}$ | $=-55^{\circ} \mathrm{C}_{0}$ |  |  | 20 |  | 20 |  |  |  |  |
|  |  | $\mathbf{v}_{\text {CE }}=10 \mathrm{v}, \quad \mathrm{I}_{\mathrm{C}}=150 \mathrm{ma}$, See | dell 11 | 40 | 120 | 4 | 120 | 40 | 120 | 100 | 300 |  |
|  | East- | $\mathrm{I}_{\mathrm{B}}=5 \mathrm{ma}, \quad t_{C}=50 \mathrm{ma}, \mathrm{see}$ | ate 11 |  |  |  | 0.9 |  | 0.9 |  | 0.9 | $V$ |
| ${ }^{\text {BE }}$ |  | $\mathrm{I}_{\mathrm{B}}=15 \mathrm{ma}, \mathrm{I}^{\mathrm{C}}=150 \mathrm{ma}, \mathrm{sec}$ | Wote 11 |  | 1.3 |  | 1.3 |  | 1.3 |  | 1.3 | V |
| $V_{\text {ceicelt }}$ | Collector-Emitter | $\mathrm{t}_{\mathrm{B}}=5 \mathrm{ma}, \quad \mathrm{I}_{\mathrm{c}}=50 \mathrm{ma}, 500$ | Ote 11 |  |  |  | 1.2 |  | 1.2 |  | 1.2 | $v$ |
| CEIsetI | Saturation Volage | $\mathrm{I}_{1}=15 \mathrm{ma}, \quad \mathrm{I}_{C}=150 \mathrm{ma}, \mathrm{sec}$ | ole 11 |  | 5 |  | 5 |  | 5 |  | 5 | $v$ |
|  | Small-signal Commen-lesa | $\mathbf{v}_{\mathrm{cs}}=5 \mathrm{v}, \quad \mathrm{l}_{\mathbf{c}}=1 \mathrm{ma}, \mathrm{f}=$ |  | 20 | 30 | 20 | 30 | 20 | 30 | 20 | 30 | ctm |
|  | Iaput Impodance | $\mathrm{v}_{\mathrm{CB}}=10 \mathrm{v}, \quad \mathrm{I}_{\mathrm{C}}=5 \mathrm{ma}, 1=$ |  |  | 10 | 4 | 1 | 4 | 1 | 4 | 8 | otm |
|  | Small-Signal Common-lase | $\mathrm{v}_{\mathrm{cs}}=5 \mathrm{v}, \quad \mathrm{l}_{\mathrm{c}}=1 \mathrm{ma}, \quad 1=$ |  |  | $\begin{gathered} 2.5 x \\ 10^{-4} \\ \hline \end{gathered}$ |  | $\begin{array}{r} 1.25 \times \\ 10^{-4} \\ \hline \end{array}$ |  | $\begin{gathered} 1.25 \times \\ 10^{-4} \\ \hline \end{gathered}$ |  | $\begin{gathered} 1.5 x \\ 10^{-4} \end{gathered}$ |  |
| ${ }^{6}$ | Reverse Voltage <br> Transter Ratio | $\mathbf{v}_{\mathbf{C E}}=10 \mathrm{r}, \quad \mathrm{l}_{\mathbf{C}}=5 \mathrm{ma}, \quad \mathbf{t}=$ |  |  | $\begin{gathered} 3 x \\ 10-4 \end{gathered}$ |  | $\begin{gathered} 1.5 x \\ 10^{-4} \end{gathered}$ |  | $\begin{array}{c\|} \hline 1.5 \times \\ 10^{-4} \end{array}$ |  | $\begin{aligned} & 1.5 x \\ & 10^{-4} \end{aligned}$ |  |
| $h_{0}$ | Smoll-Signal <br> Commen-Ease | $\mathbf{v}_{\mathrm{Ca}}=5 \mathrm{v}, \quad \mathrm{I}_{\mathrm{c}}=1 \mathrm{ma}, 1=$ |  | 0.1 | 0.5 |  | 0.5 |  | 0.5 |  | 0.3 | Henle |
|  | Output Admittanse | $\mathbf{v}_{\mathbf{C B}}=10 \mathrm{v}, \quad \mathrm{I}_{\mathrm{C}}=5 \mathrm{ma}, \quad \mathrm{f}=$ | 1 kt |  | 1.0 |  | 0.5 |  | 0.5 |  | 0.3 | $\mu \mathrm{mine}$ |
|  | Smell-Signal Common-Emittier | $\mathbf{v}_{\text {ce }}=5 \mathrm{v}, \quad \mathrm{I}_{\mathbf{c}}=1 \mathrm{ma}, \quad 1=$ |  | 35 | 100 | 30 | 100 | 30 | 100 |  | 200 |  |
| \% 6 | Forward Current Transfer Ratio | $\mathbf{v}_{\mathbf{C E}}=10 \mathrm{r}, \quad \mathrm{l}_{\mathrm{c}}=5 \mathrm{ma}, \quad \mathrm{f}=$ | 1 kt | 45 |  | 45 |  | 45 | 150 |  | 300 |  |
| $\left\|h_{\text {fol }}\right\|$ | Small-Signal Commen-Eminter Ferward Curtent Transfor Ratio | $\mathbf{v}_{\mathbf{C E}}=10 \mathrm{v}, \quad \mathrm{I}_{\mathbf{C}}=50 \mathrm{ma}, \mathrm{f}=$ | 20 mc | 2.5 |  | 2.5 |  | 2.5 |  | 3.6 |  |  |
| $c_{\text {ab }}$ | Common-Rase Open-Circuit Oulput Capacitance | $\mathbf{v}_{\mathbf{C B}}=10 \mathrm{v}, \quad \underset{\text { Except 2N720: }}{\mathrm{I}_{\mathrm{E}}=0,} \quad \mathbf{f =}$ | $\begin{aligned} & 1 \mathrm{mc} \\ & 140 \mathrm{kc} \end{aligned}$ |  | 20 |  | 15 |  | 15 |  | 15 | p |
| $c_{i b}$ | Common-Bose <br> Open-Circuit <br> Input Capacitance | $\mathbf{v}_{\mathrm{Et}}=0.5 \mathrm{v}, \quad \mathrm{I}_{\mathbf{c}}=0, \quad 1=$ | $\begin{aligned} & 1 \mathrm{mc} \\ & 140 \mathrm{kc} \end{aligned}$ |  | 85 |  | 85 |  | 85 |  | 85 | pf |

NOTE 11: These porameters must be measored using pulse techniques. PW $\leq 300 \mu$ sec., Dufy cycle $\leq \mathbf{2 \%}$.
Pulse width must be such that holving or doubling does not couse o chonge greater thon the
required accuracy of the measurement.
${ }^{\bullet}$ Indicates JEDEC regisferod data.

## HIGHLY RELIABLE, VERSATILE DEVICES CHARACTERIZED ESPECIALLY FOR SMALL-SIGNAL APPLICATIONS

\author{

- High Voltage - Low Leakage <br> - Useful hfe Over Wide Current Range <br> - Both Common-Emitter and Common-Base Small-Signal Characterization
}
mechanical data
2N910, 2N911, $2 N 912$
absolute maximum ratings at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)


NOTES: 1. This value applies when the base-mitter resistance $R_{\mathrm{BE}} \mathbf{< 1 0 \Omega} \mathbf{\Omega}$.
2. This value applies when the base-emitter diode is open-circuited.
3. For $2 \mathrm{~N} 910,2 \mathrm{~N} 911$, and 2 N 912 , derate linearly to $200^{\circ} \mathrm{C}$ free-air temperature at the rate of $2.86 \mathrm{mw} / \mathrm{C}$.
4. For $2 \mathrm{~N} 1973,2 \mathrm{~N} 1974$, and 2 N 1975 , derate linearly to $200^{\circ} \mathrm{C}$ free-air temperature at the rate of $4.57 \mathrm{mw} /{ }^{\circ} \mathrm{C}$.
5. For $2 \mathrm{~N} 910,2 \mathrm{~N} 911$, and 2 N 912 , derate linearly to $200^{\circ} \mathrm{C}$ case temperature at the rate of $10.3 \mathrm{mw} /{ }^{\circ} \mathrm{C}$.
6. For $2 \mathrm{~N} 1973,2 \mathrm{~N} 1974$, and 2 N 1975 , derate linearly to $200^{\circ} \mathrm{C}$ case temperature at the rates of $57.1 \mathrm{mw} /{ }^{\circ} \mathrm{C}$ for the 10 -watt rating and $17.2 \mathrm{mw} /{ }^{\circ} \mathrm{C}$ for the 3 -watt (JEDEC reglstered) rating.

- JEDEC registered dats. This data sheet contains all applicable registered deta in effect at the time of publication.
-The JEDEC registered outline for these devices is TO-5. TO-39 falis within TO-5 with the exception of lead length.
$t_{\text {This value is }}$ guaranteed by Texas Instruments in addition to the JEDEC registered value which is aiso shown.
USES CHIP N23


## TYPES 2N910, 2N911, 2N912, 2N1973, 2N1974, 2N1975 N-P-N SILICON TRANSISTORS



## *operating characteristics at $\mathbf{2 5}{ }^{\circ} \mathrm{C}$ free-air temperature

| PARAMETER | TEST CONDITIONS | TO-18 $\rightarrow$ | 2N910 | 2N911 | 2N912 | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | 70-39 $\rightarrow$ | 2N1973 | 2N1974 | 2N1975 |  |
|  |  |  | MAX | MAX | MAX |  |
| MF Spot Moise Flgure | $\begin{aligned} & V_{c \Delta}=10 \mathrm{v}, \mathrm{I}_{\mathrm{c}}=300 \mu \mathrm{\mu}, \mathrm{R}_{\boldsymbol{G}}=510 \Omega \\ & \mathrm{I}=1 \mathrm{kc}, \text { Woise Bondwith }=200 \mathrm{qs} \end{aligned}$ |  | 12 | 15 | 18 | db |

 - dengege greoter then the required eccurecy of the monswremont.
-Indicates JeDEC Registerad Data.

## designed for use in vhf and uhf amplifier AND OSCILLATOR APPICATIONS

- Guaranteed Unneutralized Power Gain - 9 db min at $\mathbf{2 0 0} \mathbf{~ M c}$
- Low Cobo- 1.7 pf max
- Low Noise Figure - 3 db typ at 60 Mc
*mechanical data

t10.12 outline is same as $\mathbf{T 0}-18$ outitine with the addition of a fourih lead.
*absolute maximum ratings at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

*electrical characteristics at $\mathbf{2 5}{ }^{\circ} \mathbf{C}$ free-air temperature (unless otherwise noted)

| PARAMETER | TEST CONDITIONS ${ }^{+}$ | MIN | MAX | UNIT |
| :---: | :---: | :---: | :---: | :---: |
| $\mathrm{V}_{\text {[m]cso }}$ Colledor-Base Breakdown Voltage | $\mathrm{I}_{\mathrm{C}}=1 \mu \mathrm{a}, \quad \mathrm{l}_{\mathrm{E}}=0$ | 30 |  | V |
| $V_{\text {(ra) CEO }}$ Collector-Emitfer Breakdown Voltage | $\mathrm{I}_{\mathrm{c}}=3 \mathrm{ma}, \quad \mathrm{I}_{\mathrm{s}}=0, \quad$ See Note 4 | 15 |  | $v$ |
| $\mathbf{V}_{\text {[R] }}$ Emo Emitler-Base Breakdown Voltage | $\mathrm{I}_{\mathrm{E}}=10 \mu \mathrm{O}, \quad \mathrm{I}_{\mathrm{C}}=0$ | 3 |  | $v$ |
|  | $V_{\text {Cs }}=15 \mathrm{v}, \mathrm{I}_{\mathrm{E}}=0$ |  | 1 | na |
| Icso Colledor Culoff Current | $\mathrm{V}_{C B}=15 \mathrm{v}_{1} \quad \mathrm{I}_{\mathrm{E}}=0, \quad \mathrm{~T}_{\mathrm{A}}=150^{\circ} \mathrm{C}$ |  | 0.1 | $\mu \mathrm{a}$ |
| $\mathrm{h}_{\text {fe }} \quad$ Static Forward Current Yransfer Ratio | $\mathrm{V}_{\mathrm{CE}}=1 \mathrm{v}, \quad \mathrm{I}_{\mathrm{C}}=3 \mathrm{ma}$ | 20 | 200 |  |
| $\mathrm{V}_{\mathrm{DE}} \quad$ Base-Emitter Voltage | $\mathrm{l}_{\mathrm{s}}=0.15 \mathrm{ma}, \mathrm{l}_{\mathrm{C}}=3 \mathrm{ma}$ |  | 0.87 | $v$ |
| $\mathrm{V}_{\text {CEIsat] }}$ Collector-Emitter Soturation Voltage | $\mathrm{I}_{\mathrm{B}}=0.15 \mathrm{ma}, \mathrm{I}_{\mathrm{C}}=3 \mathrm{ma}$ |  | 0.5 | $v$ |
| $\left\|\mathrm{h}_{\mathrm{te}}\right\| \quad$Small-Signal Commen-Emitter <br> Forward Current Transier Ratio | $\mathrm{V}_{\mathrm{CE}}=10 \mathrm{v}, \quad \mathrm{l}_{\mathrm{c}}=4 \mathrm{ma}, \mathrm{f}=100 \mathrm{Mc}$ | 5 |  |  |
| $\begin{array}{\|ll} \hline \text { C }_{\text {obo }} & \begin{array}{l} \text { Common-Base Open-Circuit } \\ \text { Output Copocitance } \end{array} \\ \hline \end{array}$ | $V_{C E}=10 \mathrm{v}, \quad \mathrm{I}_{\mathrm{E}}=0, \quad \mathrm{f}=140 \mathrm{kc}$ |  | 1.7 | pf |
| $\mathrm{C}_{\text {ibo }}$ Common-Base Open-Circuit <br> Inpul Capacitance | $\mathrm{V}_{\mathrm{EB}}=0.5 \mathrm{v}, \mathrm{I}_{\mathrm{C}}=0, \quad \mathrm{f}=140 \mathrm{kc}$ |  | 1.6 | pf |
| $\mathrm{ra}^{\prime} \mathrm{C}_{\mathrm{c}} \quad$ Collector-Base Time Constant | $V_{C B}=10 \mathrm{v}, I_{C}=4 \mathrm{ma}, f=40 \mathrm{mc}$ |  | 75 | psec |

NOTES: 1. This value applies when the base-emitter diade is open-circuited.
2. Derale linearly to $200^{\circ} \mathrm{C}$ free-air temperature at the rate of $1.14 \mathrm{~mm} / \mathrm{C}^{\circ}$.
3. Derale lineorly to $200^{\circ} \mathrm{C}$ case temperature at the rate of $1.72 \mathrm{~mm} / \mathrm{C}^{\circ}$.
4. This parameter must be measured using pulse techniques. $\mathrm{PW}=300 \mu \mathrm{sec}$, Duty Cycla $\leq 1 \%$.

+ The fourth lead (case) is sloating for all measurements excepl Power Gain. For this parameter the fourth lead is grounded.
Indicates JEDEC registered data.
*opereffing characteristics at $25^{\circ} \mathrm{C}$ free-air temperature

|  | PARAMLTER | TEST CONDITIONS ${ }^{\text {+ }}$ | MIN | MAX | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: |
| MF | Spot Hoise figure | $\begin{aligned} & y_{C E}=6 \mathrm{v}, \quad I_{C}=1 \mathrm{ma}, R_{6}=400 \Omega, \\ & i=60 \mathrm{mc} . \end{aligned}$ |  | 6 | db |
| 6 po | Unneutralized Smal-Signol CommonEmitter Insertion Power Gain | $v_{C E}=10 \mathrm{v}, \mathrm{l}_{\mathrm{C}}=5 \mathrm{ma}, f=200 \mathrm{mc},$ See Figura 1 | 9 |  | db |
| P。 | Oscillator Power Output | $v_{c c}=15 \mathrm{v}, \mathrm{I}_{\mathrm{c}}=8 \mathrm{ma}, f=500 \mathrm{mc},$ 500 Figure 2 | 10 |  | mw |



## * PARAMETER MEASUREMENT INFORMATION



CIRCUIT COMPONENT INFORMATION
C1, C2, and C9: $0.05 \mu \mathrm{f}$
C3: 1.5 - 10 pf
C4 and C5: 1000 pf
C6 and C7: 3-15 pf
C8: $25 \mu \mathrm{f}$
R1: $2.2 \mathrm{k} \Omega$
Ll: IT 12 AWG, 2 cm ID
L2 and L3: 200 Mc RFC
L4: $1 / 2$ T 112 AWG, 3 cm ID
D1 and D2: IN3063 (or equivalent)

## FIGURE 1 - UNNEUTRALIZED 200-Mc INSERTION POWER GAIN TEST CIRCUIT



FIGURE $2 \mathbf{- 5 0 0}-\mathrm{Mc}$ OSCILLATOR POWER OUTPUT TEST CIRCUIT

[^32]
# FOR VHF AND UHF AMPLIFIER AND OSCILLATOR APPLICATIONS 

- Low Nolse Figure . . . 8 dB max at 60 MHz
- High Neutralized Power Gain . . . 15 dB min at 200 MHz
- High Oscillator Powar Output . . . 30 mW min at 500 MHz
*mechanical data


## THE ACTIVE ELEMENTS ARE ELICTRICALLY INBULATED FAOM THE CABE



ALL JEDEC TO-72 DIMENSIONS AND NOTES ARE APPLICABLE
*absolute maximum ratings at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)
Collector-Base Voltage . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 30 V
Collector-Emitter Voltage (See Note 1) . . . . . . . . . . . . . . . . . . . . . . . . . . . . 15 V
Emitter-Base Voltage . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 3 V
Continuous Collector Current . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 50 mA
Continuous Device Dissipation at (or below) $25^{\circ} \mathrm{C}$ Free-Air Temperature (See Note 2) . . . . . . . . 200 mW
Continuous Device Dissipation at (or below) $25^{\circ} \mathrm{C}$ Case Temperature (See Note 3) . . . . . . . . . . 300 mW
Storage Temperature Range . . . . . . . . . . . . . . . . . . . . . . . . . . $-65^{\circ} \mathrm{C}$ to $200^{\circ} \mathrm{C}$
Lead Temperature $1 / 16$ Inch from Case for $\mathbf{6 0}$ Seconds . . . . . . . . . . . . . . . . . . . . . $300^{\circ} \mathrm{C}$
*electrical characteristics at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

| PARAMETER | TEST CONDITIONS ${ }^{\dagger}$ | MIN | TYP MAX | UNIT |
| :---: | :---: | :---: | :---: | :---: |
| $V_{\text {(BR) }}$ CBO Collector-Base Breakdown Voltage | $I_{C}=1 \mu A, \quad I_{E}=0$ | 30 |  | $V$ |
| V(BR)CEO Collector-Emitter Breakdown Voltage | $\mathrm{I}_{\mathrm{C}}=3 \mathrm{~mA}, \quad \mathrm{I}_{\mathrm{B}}=0, \quad$ See Note 4 | 15 |  | V |
| V(BR)EBO Emitter-Base Breakdown Voltage | $\mathrm{IE}^{\prime}=10 \mu \mathrm{~A}, \mathrm{I}_{C}=0$ | 3 |  | V |
| Collector Cutoff Current | $V_{C B}=15 \mathrm{~V}, \mathrm{I}_{\mathrm{E}}=0$ |  | 10 | nA |
|  | $V_{C B}=15 \mathrm{~V}, \mathrm{I}_{\mathrm{E}}=0, \quad \mathrm{~T}_{A}=150^{\circ} \mathrm{C}$ |  | 1 | $\mu \mathrm{A}$ |
| hFE Static Forward Current Transfer Ratio | $V_{C E}=1 \mathrm{~V}, \mathrm{I}^{\prime} \mathrm{C}=3 \mathrm{~mA}$ | 20 |  |  |
| VEE Base-Emitter Voltage | $\mathrm{I}_{B}=1 \mathrm{~mA}, \mathrm{I}^{\prime}=10 \mathrm{~mA}$ |  | 1 | V |
| $\mathrm{V}_{\text {CE }}$ (sat) Collector-Emitter Saturation Voltage | $\mathrm{I}_{\mathrm{B}}=1 \mathrm{~mA}, \mathrm{IC}^{\prime}=10 \mathrm{~mA}$ |  | 0.4 | V |
| \|hfel Small-Signal Common-Emitter <br> Forward Current Transfer Ratio | $V_{C E}=10 \mathrm{~V}, \mathrm{I}_{\mathrm{C}}=4 \mathrm{~mA}, f=100 \mathrm{MHz}$ | 6 | 9 |  |
| Common-Base Open-Circuit | $V_{C B}=10 \mathrm{~V}, \mathrm{I}_{\mathrm{E}}=0, \quad f=140 \mathrm{kHz}$ |  | 1.7 | pF |
| Cobo Output Capacitance | $V_{C B}=0, \quad I E=0, \quad f=140 \mathrm{kHz}$ |  | 3 |  |
| Cibo Common-Base Open-Circuit <br> Input Capacitance | $V_{E B}=0.5 \mathrm{~V}, \mathrm{IC}=0, \quad f=140 \mathrm{kHz}$ |  | 2 | pF |
| $\mathrm{rb}^{\prime} \mathrm{C}_{\mathrm{c}} \quad$ Collector-Base Time Constant | $\mathrm{V}_{\mathrm{CB}}=10 \mathrm{~V}, \mathrm{I}_{\mathrm{E}}=-4 \mathrm{~mA}, \mathrm{f}=79.8 \mathrm{MHz}$ |  | 8 | ps |

NOTES: 1. This value applies when the beee-emitter diode is open-circulted.
2. Derate linearly to $200^{\circ} \mathrm{C}$ free-air temperature at the rate of $1.14 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$.
3. Derate IInearly to $200^{\circ} \mathrm{C}$ case temperature at the rate of $1.71 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$.
4. This parameter must be messured using pulse techniques. $t_{w}=300 \mu \mathrm{~s}$, duty cycle $<\mathbf{2 \%}$.
*JEDEC registered data. This data sheet contein all applicable regiatared data in effect at the time of publication.
tThe fourth lesd (cese) is floating for all measurements except power gain. For this mesurement, the fourth leed is grounded.
USES CHIP N22

# TYPE 2N918 <br> N-P-N SILICON TRANSISTOR 

## *operating characteristics at $25^{\circ} \mathrm{C}$ freo-air temperature

| PARAMETE |  | TEST CONDITIONS ${ }^{\dagger}$ |  |  | MIN | MAX | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| $F$ | Spot Noine Figure | $\begin{aligned} & V_{C E}=6 \mathrm{~V}, \\ & f=60 \mathrm{MHz} \end{aligned}$ | $I_{C}=1 \mathrm{~mA},$ | $R_{G}=400 n$ |  | 6 | dB |
| $\boldsymbol{G}_{\text {pe }}$ | Noutralized Small-Signal CommonEmitter Insertion Power Gain | $V_{C B}=12 V,$ <br> See Figure 1 | $1 c=8 \mathrm{~mA},$ | f=200 MHz | 18 |  | dB |
| Po | Oncillator Pownr Output | $V_{C B}=18 \mathrm{~V}$. | $\mathrm{lc}=8 \mathrm{~mA}$, | f $=500 \mathrm{MHz}$ | 30 |  | mW |
| $\eta$ | Collector Efficioncy | See Figure 2 |  |  | 25\% |  |  |

*PARAMETER MEASUREMENT INFORMATION

CIRCUIF SCNEMATIC


## NEUTRALIZATION ADJUSYMENT PROCEDURE

After funing amplifier as for nermal gain measurement, reverte input and output connections and tune $\mathbf{L 2}$ for minimum indication on detector. This sequence is repeoted until optimum settingt ore obtained for all variables.

CIRCUIT COMPONINT INFORMATION


C1: 3-12 pF C6: $0.08 \mu \mathrm{~F}$
and C7: 1000 pF R1: $100 \Omega$
C3: 1.5-7.6 pF
R2: $1 \mathrm{k} \Omega$
: 3\% T \#16 AWG, 5/18" ID, 7/18" length Turna Ratio 2 to 1

3: 8 T \#16 AWG 1/8' ID, 7/8' length.
: 200 MHz RFC

FIOURE 1-NEUTRALIZED 200-MHz INSERTION POWER GAIN

CIRCUIT SChEMATIC


FIGURE 2-500-MHz OSCILLATOR POWER OUTPUT
-JEDEC registered data
${ }^{\dagger}$ The fourth lead (case) is floating for all maasurements except power gain. For this meesurement, the fourth lead is grounded.

## TWO TRANSISTORS IN ONE PACKAGE FOR VHF AND UHF AMPLIFIER AND OSCILLATOR APPLICATIONS

- Low Noise Figure . . . 6 dB max at 60 MHz
- High Neutralized Power Gain . . . 15 dB min at 200 MHz
- High Oscillator Power Output . . . $\mathbf{3 0} \mathbf{~ m W}$ min at 500 MHz
mechanical data

absolute maximum ratings at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

$$
\text { Collector-Base Voltage . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . } 30 \text { V }
$$

Collector-Emitter Voltage (See Note 1) ..... 15 V
Emitter-Base Voltage ..... 3 V
Continuous Collector Current ..... 50 mA
Continuous Device Dissipation at (or below) $\mathbf{2 5}{ }^{\circ} \mathrm{C}$ Free-Air Temperature (See Note 2): Each Triade ..... 200 mW

Storage Temperature Range
Lead Temperature 1/16 Inch from Case for 10 Seconds $300^{\circ} \mathrm{C}$
electrical characteristics at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

| PARAMETER |  | TEST CONDITIONS | MIN | TYP MAX | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: |
| $V_{\text {(BR) }}$ CBO | Collector-Base Breakdown Voltage | $\mathrm{I}^{\prime}=1 \mu \mathrm{~A}, \quad \mathrm{IE}^{2}=0$ | 30 |  | V |
| $V_{\text {(BR)CEO }}$ | Collector-Emitter Breakdown Voltage | $I_{C}=3 \mathrm{~mA}, \quad \mathrm{I}_{\mathrm{B}}=0, \quad$ See Note 3 | 15 |  | V |
| V(BR)EBO | Emitter-Base Breakdown Voltage | $\mathrm{I}_{\mathrm{E}}=10 \mu \mathrm{~A}, ~ I_{C}=0$ | 3 |  | V |
| ${ }^{\prime} \mathrm{CBO}$ | Collector Cutoff Current | $V_{C B}=15 V_{1} I_{E}=0$ |  | 10 | nA |
|  |  | $\mathrm{V}_{C B}=15 \mathrm{~V}, \mathrm{I}_{\mathrm{E}}=0, \quad \mathrm{~T}_{A}=150^{\circ} \mathrm{C}$ |  | 1 | $\mu \mathrm{A}$ |
| hFE | Static Forward Current Transfor Ratio | $\mathrm{V}_{C E}=1 \mathrm{~V}, \mathrm{IC}^{\prime}=3 \mathrm{~mA}$ | 20 |  |  |
| $\mathrm{V}_{\text {BE }}$ | Baso-Emitter Voltage | $\mathrm{I}_{\mathrm{B}}=1 \mathrm{~mA}, \mathrm{I}_{\mathrm{C}}=10 \mathrm{~mA}$ |  | 1 | V |
| $\mathrm{V}_{\text {CE }}$ (sat) | Collector-Emitter Saturation Voltage | $\mathrm{I}_{\mathrm{B}}=1 \mathrm{~mA}, \mathrm{IC}^{2}=10 \mathrm{~mA}$ |  | 0.4 | V |
| \|hfel | Small-Signal Common-Emitter Forwerd Current Transfer Ratio | $V_{C E}=10 \mathrm{~V}, \mathrm{IC}=4 \mathrm{~mA}, f=100 \mathrm{MHz}$ | 6 | 9 |  |
| Cobo | Common-Base Open-Circuit | $\mathrm{V}_{C B}=10 \mathrm{~V}, \mathrm{I}_{\mathrm{E}}=0, \quad \mathrm{i}=1 \mathrm{MHz}$ |  | 1.7 | pF |
|  | Output Ceppacitance | $\mathrm{V}_{C B}=0, \quad \mathrm{IE}_{\mathrm{E}}=0, \quad \mathrm{f}=1 \mathrm{MHz}$ |  | 3 |  |
| $\mathrm{C}_{\text {ibo }}$ | Common-Bese Open-Circuit Input Capacitance | $\mathrm{V}_{\mathrm{EB}}=0.5 \mathrm{~V}, \mathrm{IC}=0, \quad \mathrm{f}=1 \mathrm{MHz}$ |  | 2 | pF |
| $\mathrm{rb}^{\prime} \mathrm{C}_{\mathrm{c}}$ | Collector-Base Time Constant | $\mathrm{V}_{C B}=10 \mathrm{~V}, \mathrm{I}_{\mathrm{E}}=-4 \mathrm{~mA}, \mathrm{f}=79.8 \mathrm{MHz}$ |  | 8 | ps |

NOTES: 1. This velue applies when the base-emitter diode is open-circuited.
2. Derate linearly to $175^{\circ} \mathrm{C}$ frea-air temperature at the rates of $1.33 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$ for each triode and $2 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$ for the total device.
3. This parameter must be measured using pulse tachniques. $t_{w}=\mathbf{3 0 0} \mu \mathrm{s}$, duty cycle $<\mathbf{2 \%}$.

## TYPE D2T918 <br> DUAL N-P-N SILICON TRANSISTOR

| operating characteristics at $25^{\circ} \mathrm{C}$ free-air temperature |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | PARAMETER | TEST CONDITIONS |  | MIN | MAX | UNIT |
| F | Spot Noise Figure | $\begin{aligned} & V_{C E}=6 \mathrm{~V}, \quad I C=1 \mathrm{~mA}, \\ & \mathrm{f}=60 \mathrm{MHz} \end{aligned}$ | $\mathrm{R}_{\mathrm{G}}=400 \Omega$, |  | 6 | dB |
| $\mathbf{G}_{\mathbf{p e}}$ | Neutralized Small-Signal Common- <br> Emitter Insertion Power Gain | $V_{C B}=12 \mathrm{~V}, \quad I_{C}=6 \mathrm{~mA},$ $\text { Soe Figure } 1$ | $\mathrm{f}=\mathbf{2 0 0 ~ M H z}$ | 15 |  | dB |
| Po | Oscillator Power Output | $\mathrm{V}_{\mathrm{CB}}=15 \mathrm{~V}, \mathrm{IC}=8 \mathrm{~mA}$, | $f=500 \mathrm{MHz}$ | 30 |  | mW |
| $\eta$ | Collector Efficiency | See Figure 2 |  | 25\% |  |  |

## PARAMETER MEASUREMENT INFORMATION



NEUTRALIZATION ADJUSTMENT PROCEDURE
After tuning amplifier as for normal gain measurement, reverse input and output connections and tune $\mathbf{L 2}$ for minimum indication on defector. This sequence is repeated until optimum settings are obtained for all variables.

CIRCUIT COMPONENT INFORMATION

| C1: $3-12 \mathrm{pF}$ | C6: $0.05 \mu \mathrm{~F}$ |
| :--- | :--- |
| C2 and $\mathrm{C} 7: 1000 \mathrm{pF}$ | R1: $100 \Omega$ |
| C3: $1.5-7.5 \mathrm{pF}$ | R2: $1 \mathrm{k} \Omega$ |

R2: $1 \mathrm{k} \Omega$
C4 and C5: $0.01 \mu \mathrm{~F}$

CIRCUIT SChematic


FIGURE 2-500-MHz OSCILLATOR POWER OUTPUT

## FOR LOW-LEVEL, LOW-NOISE, HIGH-GAN, AMPLIFIER APPLCATIONS

- Guaranteed $h_{\text {FE }}$ of $10 \mu \mathrm{ar} \mathrm{T}_{\mathrm{A}}=-55^{\circ} \mathrm{C}$ and $25^{\circ} \mathrm{C}$
- Guaruntoed Low-Noise Cheracteristics at $10 \mu \mathrm{~m}$
- Usable at Collector Currents as Low as 1 pa
*mechanical data

*absolute maximum ratings at $25^{\circ} \mathrm{C}$ free-air temperature (unloss otherwise noted)

motes: 1 . This valee applios when the wase-milter diado is epen-cirevited.

2. Berate linearly to $175^{\circ} \mathrm{C}$ fros-atr ismperature at the rate $2.0 \mathrm{~mm} / \mathrm{C}^{\circ}$.
3. Doecate lineorly to $175^{\circ} \mathrm{C}$ case temperature at the rate of $4.0 \mathrm{~mm} / \mathrm{C}^{\circ}$.
*Indikates JEOEC mofistored data

# TYPES 2N929, 2N930 <br> N-P-N SILICON TRANSISTORS 

*electrical characteristics of $25^{\circ} \mathrm{C}$ free-alr temperature (unless otherwise noted)

| PARAMETER |  | TEST CONDITIONS | 2N929 |  | 2N930 |  | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | MIN | max | MIN | Max |  |
| $\mathbf{V}_{\text {(ra) }}$ cto | Collocter-Emither Brockiown Voltope |  | $\mathrm{Ic}_{\mathrm{c}}=10 \mathrm{mos}, \mathrm{I}_{5}=0, \quad$ (500 Mole 4) | 45 |  | 45 |  | V |
| $V_{\text {(m)EEO }}$ | Enither-mase Ireekcown Volioge | $\mathrm{l}_{\mathrm{E}}=10 \mathrm{nc} \quad \mathrm{l}_{\mathrm{c}}=0$ | 5 |  | 5 |  | $v$ |
| $\mathrm{ICm}_{\text {ceo }}$ | Collecter Covoff Current | $v_{\text {cm }}=45 \mathrm{v}, \mathrm{I}_{\mathrm{E}}=0$ |  | 10 |  | 10 | ma |
| Icas | Collactor Cuteff Current (sen Moto 5) | $V_{C E}=45 y_{1} \quad V_{E E}=0$ |  | 10 |  | 10 | mo |
|  |  | $\mathrm{V}_{\text {ce }}=45 \mathrm{y}, \quad \mathrm{V}_{\mathrm{mE}}=0, \quad \mathrm{~V}_{\mathrm{A}}=170{ }^{\circ} \mathrm{C}$ |  | 10 |  | 10 | $\mu \mathrm{m}$ |
| Icro | Collecter Cutoff Curment | $V_{C E}=5 \mathrm{v}, \quad \mathrm{l}_{8}=0$ |  | 2 |  | 2 | ma |
| Luo | Emither Cutoff Corrout | $V_{t a}=5 \mathrm{v}_{\mathrm{t}} \quad \mathrm{I}_{\mathrm{c}}=0$ |  | 10 |  | 10 | $\pm 0$ |
| hre | Static Forward Curnant Treastor tratio | $V_{C E}=5 \mathrm{v}, \quad \mathrm{l}_{\mathrm{c}}=10 \mu \mathrm{c}$ | 40 | 120 | 100 | 300 |  |
|  |  | $\mathrm{V}_{\mathrm{CE}}=5 \mathrm{v}, \quad \mathrm{I}_{\mathrm{c}}=10 \mu \mathrm{~s}, \quad \mathrm{r}_{\mathrm{A}}=-55^{\circ} \mathrm{C}$ | 10 |  | 20 |  |  |
|  |  | $V_{C E}=5 \mathrm{v}, \quad \mathrm{I}_{\mathrm{c}}=500 \mu \mathrm{l}$ | - 60 |  | 150 |  |  |
|  |  |  |  | 350 |  | 600 |  |
| $V_{\text {m }}$ | Dese-Emither Volteyo |  | 0.6 | 1.0 | 0.6 | 1.0 | $v$ |
| $V_{\text {cuph }}$ | Collector-Emithor Saturation Valtage | $I_{8}=0.5 \mathrm{ma}, I_{c}=10 \mathrm{ma},($ See Mots 4) |  | 1.0 |  | 1.0 | $v$ |
| $h_{\text {ib }}$ | Small-Sigal Common-iase Input Impedance | $\mathrm{V}_{\mathrm{CB}}=5 \mathrm{v}, \quad \mathrm{l}_{\mathrm{E}}=-1 \mathrm{ma}, \mathrm{f}=1 \mathrm{kc}$ | 25 | 32 | 25 | 32 | othen |
| $h_{\text {rb }}$ | Small-Symol Commen-Lase Reverse Vohtope Truaster Ratio | $V_{\text {ct }}=5 \mathrm{y}, \quad \mathrm{lt}=-1 \mathrm{ma}, \mathrm{f}=1 \mathrm{kc}$ | 0 | $\begin{aligned} & 6.0 x \\ & 10^{-4} \end{aligned}$ | 0 | $\begin{aligned} & 6.0 \mathrm{x} \\ & 10^{-4} \end{aligned}$ |  |
| $h_{\text {cb }}$ | Smali-Signal Comamon-Rase Output Admittance | $V_{C i}=5 \mathrm{y}, \quad l_{E}=-1 \mathrm{mog}, \mathrm{f}=1 \mathrm{kc}$ | 0 | 1.0 | 0 | 1.0 | $\mu \mathrm{mhn}$ |
| $h_{\text {\% }}$ | Smali-Signal Common-Emititor Forward Current Iransfor metio | $V_{\mathbf{C E}}=5 \mathrm{v}, \quad \mathrm{I}_{\mathbf{C}}=1 \mathrm{mag}, \quad 1=1 \mathrm{kc}$ | 60 | 350 | 150 | 600 |  |
| $\left\|h_{\text {on }}\right\|$ | Smoth-Signal Common-Emitior <br> Forward Curront Trassior hatio | $V_{C E}=5 \mathrm{v}, \quad \mathrm{I}_{\mathrm{C}}=500 \mu \mathrm{O}, \mathrm{i}=30 \mathrm{mc}$ | 1.0 |  | 1.0 |  |  |
| $C_{0}$ | Common-Lase Opme-Qrailt Output Cepectionce | $V_{c t}=5 \mathrm{v}, \quad \mathrm{l}_{\mathrm{E}}=0, \quad 1=1 \mathrm{mx}$ |  | 8 |  | 1 | pf |

*operating charactoristices at $25^{\circ} \mathrm{C}$ free-air tomperature

| PARAMITER | TEST CONDITIONS | 2N929 | 2N930 | UNIT |
| :---: | :---: | :---: | :---: | :---: |
| 釆 Avorage Mose Figure | $\begin{aligned} & \mathrm{Y}_{\mathrm{cE}}=5 \mathrm{v}, \mathrm{I}_{\mathrm{c}}=10 \mu \mu_{\mathrm{a}}, R_{\mathrm{s}}=10 \mathrm{k} \Omega \\ & \text { Molse tandwidh } 10 \mathrm{qs} \text { to } 15.7 \mathrm{kc} \end{aligned}$ | 4 | 3 | 品 |





## Highly Reliable, Versatile Devices Designed for Amplifier, Switching and Oscillafor Applications from $<0.1 \mathrm{ma}$ to $\mathbf{> 1 5 0} \mathrm{ma}$, de to $\mathbf{3 0} \mathbf{~ m c}$ <br> - High Voltage - Low Leakage <br> - Useful $h_{\text {fE }}$ Over Wide Current Range

## *mechanical deta

Device types 2N717, 2N718, 2N718A, 2N730, 2N731, and 2N956 are in JEDEC TO-18 packages. Device types 2N696, 2N697, 2N1420, 2N1507, 2N1613, and 2N1711 are in JEDEC TO-5 packages.

*absolute maximum ratings at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

|  | $\begin{aligned} & \text { 2N696 } \\ & \text { 2N697 } \end{aligned}$ | $\begin{aligned} & 2 N 717 \\ & 2 N 718 \\ & \hline \end{aligned}$ | 2N718A | $\begin{aligned} & 2 \mathrm{~N} 730 \\ & 2 \mathrm{~N} 731 \end{aligned}$ | 2N956 | $\begin{aligned} & \text { 2N1420 } \\ & \text { 2N1507 } \\ & \hline \end{aligned}$ | 2N1613 | 2N1711 | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Collector-Base Voltage | 60 | 60 | 75 | 60 | 75 | 60 | 75 | 75 | V |
| Collector-Emitter Voltage (See Note 1) | 40 | 40 | 50 | 40 | 50 | 30 | 50 | 50 | $v$ |
| Collector-Emitter Voltage (See Note 2) |  |  | 32 |  |  |  |  |  | $v$ |
| Emitter-Base Voltage | 5 | 5 | 7 | 5 | 7 | 5 | 7 | 7 | v |
| Collector Current |  |  |  | 1.0 |  | 1.0 |  | 1.0 | 0 |
| Total Device Dissipation at (or below) $25^{\circ} \mathrm{C}$ Free-Air Temperature (See Note Indicated in Parentheses) $\rightarrow$ | $\begin{gathered} 0.6 \\ \vdots \\ \vdots \\ \hline \end{gathered}$ | $\begin{aligned} & \hline 0.4 \\ & +\dagger \\ & +(5) \\ & \hline \end{aligned}$ | 0.5 <br> (7) | $\begin{aligned} & \hline 0.5 \\ & \dagger \\ & 1+ \\ & 99 \\ & \hline \end{aligned}$ | $\begin{aligned} & 0.5 \\ & \text { (7) } \\ & \hline \end{aligned}$ | $\begin{aligned} & \hline 0.6 \\ & \dagger \\ & 13) \\ & \hline \end{aligned}$ | $\begin{aligned} & 0.8 \\ & (10) \\ & \hline \end{aligned}$ | $\begin{aligned} & 0.8 \\ & (10) \\ & \hline \end{aligned}$ | w |
| Total Device Dissipation at (or below) $25^{\circ} \mathrm{C}$ Case Temperature (See Note Indicated in Purentheses) $\rightarrow$ | $\begin{aligned} & 2.0 \\ & \vdots \\ & \vdots \\ & \text { (4) } \end{aligned}$ | $\begin{aligned} & 1.5 \\ & \dagger \\ & (6) \\ & \hline \end{aligned}$ | 1.8 <br> (8) | $\begin{aligned} & 1.5 \\ & 1 \dagger \\ & (6) \\ & \hline \end{aligned}$ | $1.8$ <br> (8) | $\begin{gathered} 2.0 \\ \vdots \\ \text { (4) } \\ \hline \end{gathered}$ | 3.0 <br> (11) | 3.0 <br> (II) | W |
| Total Device Dissipation at $100^{\circ} \mathrm{C}$ Case Temperature | $\begin{aligned} & 1.0 \\ & \dagger \\ & \hline \end{aligned}$ | $\begin{aligned} & 0.75 \\ & i+ \\ & \hline i \end{aligned}$ | 1.0 | $\begin{aligned} & 0.75 \\ & i t \\ & \hline \end{aligned}$ | 1.0 | $\begin{aligned} & 1.0 \\ & \dagger \\ & \hline \end{aligned}$ | 1.7 | 1.7 | w |
| Operating Collector Junction Temperature | 175 $\dagger$ | $175 \dagger \dagger$ | 200 | 175t† | 200 | 175 $\dagger$ | 200 | 200 | ${ }^{\circ} \mathrm{C}$ |
| Storage Temperature Range | $-65^{\circ} \mathrm{C}$ to $200^{\circ} \mathrm{C}$ |  |  |  |  |  |  |  |  |

NOTES: 1. This value applias when the basa-eacitter resistance ( $\mathrm{F}_{\mathrm{ge}}$ ) is equal to or less than 10 ohms.
2. This value applies when the base-omitter diode is apen-cireviled.
3. Derate linearly to $175^{\circ} \mathrm{C}$ fres-alt temperatere at the rate of $4.0 \mathrm{mw} / \mathrm{c}^{\circ}$.
4. Derate linestly to $175^{\circ} \mathrm{C}$ case temperature at the rate of $13.3 \mathrm{~mm} / \mathrm{c}^{\circ}$.
5. Derate Inearly to $175^{\circ} \mathrm{C}$ fro-alr temposalure at the rale of $2.67 \mathrm{~mm} / \mathrm{l}^{\circ}$.
6. Derale Iinearly to $175^{\circ} \mathrm{C}$ case temperaturs at the rate of $10.0 \mathrm{mw} / \mathrm{C}^{\circ}$.
7. Derate linearly to $200^{\circ} \mathrm{C}$ tros-air temperature at the rate of $2.26 \mathrm{mw} / \mathrm{C}^{\circ}$.
8. Deraie linearly to $200^{\circ} \mathrm{C}$ case temparature of the rate of $10.3 \mathrm{mw} / \mathrm{C}^{\circ}$.
9. Derate Ilineariy to $175^{\circ} \mathrm{C}$ treo-air temperature at the rate of $3.33 \mathrm{~mm} / \mathrm{C}^{\circ}$.
10. Derate linearly to $200^{\circ} \mathrm{C}$ fres-air temperaturs of the rats of $4.56 \mathrm{mw} / \mathrm{C}^{\circ}$.
11. Derate lineorly to $200^{\circ} \mathrm{C}$ case temperature at the rate of $17.2 \mathrm{mw} / \mathrm{C}^{\circ}$.
$\dagger$ Texas instruments guarantoes lis types 2N696, 2N697, 2N1420, and 2N1507 to be capeble of the same dissipation as reglatored and shown for types 2N1613 and 2N1711 whth appereprate derating foctors shown in Mates 10 and 11.
††texas Instruments guarantees its types 2N717, 2N718, 2N730, and 20731 to be capable of the same dissipation as registered and shown for types 2N718A and. 2N956 with appropilate derating factors shown in Motes 7 and 8.

[^33]
## TYPES 2N718A, 2N956, 2N142O, 2N1507, 2N1613, 2N771 N-P-N SILICON TRANSISTORS

*electrical charmeteristics of $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

| PARAMETER |  | TEST CONDITIONS $\quad$ TO-18-9 | 2m718A |  |  | 2N956 | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | 2N1613 | 2N1420 | 2N1507 | 2N1711 |  |
|  |  | MIN MAX | min max | min max | min max |  |
| $V_{\text {Imeeso }}$ | Collector-bene Broekdown Yoltige |  | $\mathrm{I}_{\mathrm{c}}=100 \mu \mathrm{~m}_{\mathrm{E}}=0$ | 75 | 6 | 4 | 75 | v |
| Víluceo | Collecter-Emither Irockiown Volliepo |  | $\mathrm{I}_{\mathrm{C}}=30 \mathrm{~mm}, \mathrm{I}_{\mathrm{B}}=0, \quad$ Sot Mote 12 |  |  | 25 |  | V |
| Y(a)ces | Collecter-Emither Braddewn Volleye | $\mathrm{I}_{\mathrm{C}}=100 \mathrm{mos} \mathrm{R}_{\text {值 }}=10 \Omega$, Soen Mote 12 | 50 | 30 | 30 | 50 | V |
| Y/mines | Emitter-lose Irodiown Voltepe | $\mathrm{I}_{\mathrm{E}}=100 \mu \mathrm{~m}, \mathrm{I}_{\mathbf{C}}=0$ | 7 |  |  | 7 | V |
| 'cro Collocter Cutefl currmi |  | $\mathrm{V}_{\mathrm{C}_{8}}=30 \mathrm{v}_{1} \mathrm{I}_{\mathrm{E}}=0$ |  | 1.0 | 1.0 |  | $\mu$ |
|  |  | $v_{C B}=30 v_{6} \quad I_{E}=0, \quad t_{A}=150^{\circ} \mathrm{C}$ |  | 109 | 50 |  | $\mu$ |
|  |  | $v_{C B}=0 v_{1} I_{E}=0$ | 0.010 |  |  | 0.010 | $\mu$ |
|  |  | $V_{C S}=00 r_{1} \mathrm{I}_{\mathrm{E}}=0 . \quad \mathrm{T}_{\mathrm{A}}=150^{\circ} \mathrm{C}$ | 10 |  |  | 10 | $\mu$ |
| $\mathrm{I}_{\text {CE }}$ | Collocter Cuteff Curment | $v_{C E}=20 v_{1} \mathrm{E}_{\mathrm{vE}}=100 \mathrm{k}$ \% |  |  | 10 |  | $\mu \mathrm{m}$ |
| $\mathrm{I}_{\text {EDO }}$ | Emittor Coloff Curront | $v_{\text {ge }}=5 v_{0}, l_{c}=0$ | 0.01 |  | 100 | 0.005 | $\mu$ |
| $h_{\text {PE }}$ | Stetic Forwerd Curemat Trunshor Ratio | $\mathrm{V}_{\mathbf{C E}}=10 v_{1} \mathrm{I}_{\mathbf{C}}=10 \mu \mathrm{l}$ |  |  |  | 20 |  |
|  |  | $V_{C E}=10 v_{1} I_{C}=100 \mu$ | 29 |  |  | 35 |  |
|  |  | $V_{C E}=10 v_{0} I_{C}=10 \mathrm{~ms}$, Soe Mote 12 | 35 |  |  | 75 |  |
|  |  | $\begin{aligned} & V_{\mathrm{ce}}=10 \mathrm{v}_{1} \mathrm{I}_{\mathrm{c}}=10 \mathrm{ma}, \quad \mathrm{~T}_{\mathrm{A}}=-55^{\circ} \mathrm{C}, \\ & \text { Sen Mota } 12 \end{aligned}$ | 20 |  |  | 35 |  |
|  |  |  | 40.120 | $100 \quad 300$ | $100 \quad 300$ | $100 \quad 300$ |  |
|  |  | $V_{C E}=10 \mathrm{~V}_{1} \mathrm{I}_{\mathrm{C}}=500 \mathrm{~mm}$, See Nete 12 | 20 |  |  | 40 |  |
| $V_{\text {cis }}$ | Base-Emiltar Voltage | $\mathrm{I}_{1}=15 \mathrm{me}, \mathrm{I}_{\mathrm{C}}=150 \mathrm{ma}$, See Mote 12 | 1.3 | 1.3 | 1.3 | 1.3 | $v$ |
| $V_{\text {cetrat }}$ | Collocter-Emither Saturation Voltape | $\mathrm{I}_{1}=15 \mathrm{mo}, \mathrm{I}_{\mathrm{c}}=150 \mathrm{ma}$, Sot Mote 12 | 1.5 | 1.5 | 1.5 | 1.5 | $v$ |
| $h_{i b}$ | Small-Signal Commea-liost Input Impedence | $v_{c s}=5 v_{1} \quad l_{c}=1 \mathrm{~ms}, \quad f=1 \mathrm{kc}$ | $24 \quad 34$ |  |  | $24 \quad 34$ | $\cdots$ |
|  |  | $\mathrm{V}_{\mathrm{CB}}=10 \mathrm{r}, \mathrm{l}_{\mathrm{C}}=5 \mathrm{~mm}, \quad i=1 \mathrm{kc}$ | 4 1 |  |  | 41 | stm |
| ${ }_{\text {rb }}$ | Small-Signal Commen-Ease Reverse Voltege Tramsior Retle | $\mathrm{V}_{\mathrm{ca}}=5 \mathrm{v}, \quad \mathrm{l}_{\mathrm{c}}=1 \mathrm{ma}, \quad 1=1 \mathrm{lc}$ | $\begin{array}{c\|} \hline 3 x \\ 10^{-4} \\ \hline \end{array}$ |  |  | $\begin{gathered} 5 \times \\ 10-4 \\ \hline \end{gathered}$ |  |
|  |  | $\mathbf{v}_{\mathbf{c s}}=10 \mathrm{v}, \mathrm{l}_{\mathbf{c}}=5 \mathrm{ma}, \quad \mathrm{f}=1 \mathrm{kc}$ | $\begin{gathered} \hline 3 x \\ 10-4 \\ \hline \end{gathered}$ |  |  | $\begin{gathered} 5 x \\ 10^{-4} \\ \hline \end{gathered}$ |  |
| $h_{\text {ob }}$ | Small-Signal Commen-Losso Output Mdwiltuence | $v_{C B}=5 \mathrm{v}_{\mathrm{c}}, \mathrm{l}_{\mathrm{c}}=1 \mathrm{ma}, \quad 1=1 \mathrm{kc}$ | 0.10 .5 |  |  | 0.10 .5 | $\mu$ mine |
|  |  | $\mathbf{v}_{\mathbf{c t f}}=10 \mathrm{v}_{1} \mathrm{l}_{\mathbf{c}}=5 \mathrm{me}, \quad f=1 \mathrm{kc}$ | 0.11 .0 |  |  | 0.11 .0 | $\mu$ mino |
| $h_{6}$ | Smali-Signal Cownon-Emilter Forwand Cwient Transfor latile | $V_{C E}=5 \mathrm{v}, \mathrm{I}_{\mathrm{C}}=1 \mathrm{ma}, \quad f=1 \mathrm{kc}$ | 38.100 |  |  | 50800 |  |
|  |  | $V_{C E}=10 v_{r} l_{C}=5 \mathrm{ma}, \quad i=1 \mathrm{kc}$ | 35150 |  |  | $70 \quad 300$ |  |
| $\left\|h_{6}\right\|$ | Small-Signal Common-Emitior Forward Current Tramber Ratio | $\mathbf{v}_{\mathbf{C E}}=10 \mathrm{v}, \mathrm{l}_{\mathbf{C}}=50 \mathrm{ma}, f=20 \mathrm{~mm}$ | 3.0 | 2.5 | 2.5 | 3.5 |  |
| $C_{\text {ab }}$ | Common-Lese Open-Cirait Output Coperitence | $\mathbf{v}_{\mathrm{cs}}=10 \mathrm{v}, \mathrm{l}_{\mathrm{E}}=0, \quad \mathrm{i}=1 \mathrm{mc}$ | 25 | 35 | 35 | 25 | -f |
| $c_{\text {ib }}$ | Commen-Ease Open-Circuit Input Capecilenet | $v_{\mathrm{Ea}}=0.5 \mathrm{v}, \mathrm{l}_{\mathrm{c}}=0, \quad \mathrm{f}=1 \mathrm{mc}$ | 80 |  |  | 80 | ff |

See switching characteristics for types 2N718A and 2N1613 on pages 4-30 or 4-72.
"operating characteristics at $25^{\circ} \mathrm{C}$ free-air temperature

| PARAMETER | TEST CONDITIONS | $\begin{aligned} & 10-18 \longrightarrow \\ & 10-5 \rightarrow \end{aligned}$ | $\frac{2 \text { N9S6 }}{2 \text { N171I }}$ |  | $\frac{2 N 718 A}{2 N 1613}$ |  | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  | TYP | max | TYP | MAX |  |
| NF Spol Moise Figure | $\begin{aligned} & V_{c k}=10 v_{,} I_{c}=300 \mu 0 \\ & R_{B}=510 \Omega_{i} \quad 1 \mathrm{kt} \end{aligned}$ |  | 5 | 8 | 6 | 12 | あ |

NOTE 12: These paramuters must te measured using pulse techniques. PW $\leq 300 \mu s e c$, Duty Cycie $\leq \mathbf{2 \%}$. Pulse width must te such that halving or deubling deess net cause - change groeter than the requircte accurecy of the measurement.
*Indicates JEDEC registered data

## TWO TRIODES INTERNALLY CONNECTED IN DARLINGTON CONFIGURATION

- Very High Gain . . . 1000 min at $100 \mu \mathrm{~A}$
- Low Leakage . . . 10 nA max at 60 V
- Rugged Internal Connections

*electrical characteristics at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

| PARAMETER | TEST CONDITIONS |  | MIN MAX | UNIT |
| :---: | :---: | :---: | :---: | :---: |
| $\mathrm{V}_{\text {(BR) }}$ CBO Collector-Base Breakdown Voltage | $l^{\prime} C=100 \mu A$, | $I_{E}=0$ | 75 | V |
| $V_{\text {(BR) }}$ CEO Collector-Emitter Breakdown Voltage | $\mathrm{I}^{\prime} \mathrm{C}=30 \mathrm{~mA}$, | $1_{B}=0, \quad$ See Note 4 | 40 | V |
| V(BR)EBO Emitter-Base Breakdown Voltage | $T_{E}=100 \mu A$, | ${ }^{1} C=0$ | 7 | V |
|  | $V_{C B}=60 \mathrm{~V}$, | $I_{E}=0$ | 10 | nA |
| ICBO Collector Cutoff Current | $V_{C B}=60 \mathrm{~V}$, | $I_{E}=0, \quad T_{A}=150^{\circ} \mathrm{C}$ | 10 | $\mu \mathrm{A}$ |
| Iebo Emitter Cutoff Current | $\mathrm{VEB}^{\text {c }}=5 \mathrm{~V}$, | ${ }^{1} \mathbf{C}=0$ | 10 | nA |
|  | $\mathrm{V}_{C E}=10 \mathrm{~V}$, | $\mathrm{I}_{\mathrm{C}}=100 \mu \mathrm{~A}$ | 1000 |  |
|  | $V_{C E}=10 \mathrm{~V}$. | ${ }^{1} \mathrm{C}=10 \mathrm{~mA}$ | 4000 |  |
| hFE Static Forward Current Transfer Ratio | $V_{C E}=10 \mathrm{~V}$, | $\mathrm{I}_{C}=100 \mathrm{~mA}$, See Note 4 | $7000 \quad 70000$ |  |
|  | $V_{C E}=10 \mathrm{~V}$ <br> See Note 4 | $I_{C}=100 \mathrm{~mA}, T_{A}=-55^{\circ} \mathrm{C}$ | 1000 |  |
| VBE Base-Emitter Voltage | $V_{\text {CE }}=10 \mathrm{~V}$, | ${ }^{1} \mathrm{C}=100 \mathrm{~mA}$, See Note 4 | $0.9 \quad 1.8$ | V |
| VCE(sat) Collector-Emitter Saturation Voltage | $\mathrm{I}_{\mathrm{B}}=1 \mathrm{~mA}$, | $I_{C}=100 \mathrm{~mA}$, See Note 4 | 1.6 | V |
| Cobo Common-Base Open-Circuit Output Capacitance | $V_{C B}=10 \mathrm{~V}$, | $\mathrm{IE}=0, \quad f=1 \mathrm{MHz}$ | 35 | DF |

NOTES: 1. This value applies when the emitter-base diode is open-circuited.
2. Derate Inearly to $175^{\circ} \mathrm{C}$ free-air temperature at the rate of $3.33 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$.
3. Derate linearly to $175^{\circ} \mathrm{C}$ case temperature at the rate of $10 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$.
4. These parsmeters must be measured using pulse zechniques. $t_{w}=300 \mu 5$, dutv cycle $\leqslant 2 \%$.

- JEDEC registered data. This data sheet contains all applicable registered data in effect at the time of publication.


## TWO TRIODES INTERNALLY CONNECTED IN DARLINGTON CONFIGURATION

- Very High hfe . . . 1600 min at 10 mA
- Low ICBO . . . 10 nA max at 90 V
- Rugged Internal Connections
*mechanical data

*absolute maximum ratings at $25^{\circ} \mathrm{C}$ free-air temperature (uniess otherwise noted)
Collector-Base Voltage ..... 100 V
Collector-Emitter Voltage (See Note 1) ..... 60 V
Emitter-Base Voltage ..... 15 V
Continuous Collector Current ..... 500 mA
Continuous Device Dissipation at (or below) $25^{\circ} \mathrm{C}$ Free-Air Temperature (See Note 2) ..... 0.5 W
Continuous Device Dissipation at (or below) $25^{\circ} \mathrm{C}$ Case Temperature (See Note 3) ..... 1.8 W
Storage Temperature Range ..... $-65^{\circ} \mathrm{C}$ to $200^{\circ} \mathrm{C}$
Lead Temperature 1/16 Inch from Case for 10 Seconds ..... $300^{\circ} \mathrm{C}$

NOTES: 1. This value applies when the emitter-base diodes are open-circuited.
2. Derate linearly to $200^{\circ} \mathrm{C}$ free-air temperature at the rate of $2.86 \mathrm{mw} /{ }^{\circ} \mathrm{C}$.
3. Derate linearly to $200^{\circ} \mathrm{C}$ case temperature at the rate of $10.3 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$.
-JEDEC registered data. This data sheet contains all applicable registered data in effect at the time of publicetion.

## N-P-N DARLINGTON-CONNECTED SILICON TRANSISTOR

*electrical characteristics at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise notad)

|  | PARAMETER | TEST CONDITIONS ${ }^{\text {t }}$ | MIN MAX | UNIT |
| :---: | :---: | :---: | :---: | :---: |
| $V_{\text {(BR) }}$ CBO | Collector-Base Breakdown Voltage | $I_{C}=100 \mu A, I_{E}=0$ | 100 | $V$ |
| $V_{\text {(BR)CEO }}$ | Collector-Emitter Breakdown Voltaga | $\mathrm{I}^{\prime}=30 \mathrm{~mA}, \quad \mathrm{I}_{\mathrm{B}}=0, \quad$ See Note 4 | 60 | V |
| $V_{\text {(BR)EBO }}$ | Emitter-Base Breakdown Voltage | $I_{E}=100 \mu A, I_{C}=0$ | 15 | V |
| I'cBo | Collector Cutoff Current | $\mathrm{V}_{\mathrm{CB}}=90 \mathrm{~V}, \mathrm{IE}=0$ | 10 | nA |
|  |  | $V_{C B}=90 \mathrm{~V}, \mathrm{IE}=0, \quad \mathrm{~T}_{\mathrm{A}}=150^{\circ} \mathrm{C}$ | 15 | $\mu \mathrm{A}$ |
| IEBO | Emitter Cutoff Current | $V_{E B}=10 \mathrm{~V}, \mathrm{IC}=0$ | 10 | nA |
| $h_{\text {FE }}$ | Static Forward Current Transfer Ratio (Total Device) | $V_{C E}=5 \mathrm{~V}, \quad \mathrm{IC}^{\prime}=1 \mathrm{~mA}$ | 800 |  |
|  |  | $V_{C E}=5 \mathrm{~V}, \quad \mathrm{I}_{\mathrm{C}}=10 \mathrm{~mA}$, See Note 4 | 16008000 |  |
|  |  | $\mathrm{V}_{C E}=5 \mathrm{~V}, \mathrm{I}_{\mathrm{C}}=100 \mathrm{~mA}$, See Note 4 | 2000 |  |
| hfe | Static Forward Current Transfer Ratio (Each Triode) | $V_{C E}=5 \mathrm{~V}, \quad \mathrm{IC}=10 \mathrm{~mA}$, See Note 4 | 25 |  |
| $V_{\text {BE }}$ | Base-Emitter Voltage | $\mathrm{I}_{\mathrm{B}}=0.5 \mathrm{~mA}, \mathrm{I}_{\mathrm{C}}=50 \mathrm{~mA}$, See Note 4 | 1.8 | V |
| $\mathrm{V}_{\mathrm{CE}}$ (sat) | Collector-Emitter Saturation Voltage | $\mathrm{I}_{\mathrm{B}}=0.5 \mathrm{~mA}, \mathrm{I}_{\mathrm{C}}=50 \mathrm{~mA}$, See Note 4 | 1.2 | V |
| hfe | Small-Signal Common-Emitter Forward Current Transfer Ratio | $V_{C E}=5 \mathrm{~V}, \quad \mathrm{I}_{\mathrm{C}}=1 \mathrm{~mA}, \quad f=1 \mathrm{kHz}$ | 1000 |  |
| Cobo | Common-Base Open-Circuit Output Capacitance | $\mathrm{V}_{C B}=10 \mathrm{~V}, \mathrm{IE}=0, \quad f=1 \mathrm{MHz}$ | 30 | pF |
| Cibo | Common-Base Open-Circuit Input Capacitance | $V_{E B}=0.5 \mathrm{~V}, \mathrm{IC}=0, \quad f=1 \mathrm{MHz}$ | 50 | pF |

*operating characteristics at $25^{\circ} \mathrm{C}$ free-air temperature

| PARAMETER | TEST CONDITIONS | MIN MAX | UNIT |
| :---: | :---: | :---: | :---: |
| F Spot Noise Figure | $\begin{array}{lll} V_{C E}=10 \mathrm{~V}, & I_{C}=0.1 \mathrm{~mA}, & I_{B 2}=-20 \mu \mathrm{~A}, \\ R_{\mathrm{G}}=5 \mathrm{k} \Omega & f=1 \mathrm{kHz}, & B=200 \mathrm{~Hz} \end{array}$ | 6 | dB |

NOTE 4: These parameters must be measured using puise techniques. $\mathbf{t}_{\mathbf{w}}=\mathbf{3 0 0} \mu$, duty cycle $\leqslant \mathbf{1 \%}$.
*JEDEC registered data
${ }^{\dagger}$ All measurements except $h_{F E}$ (each triode) and $F$ are made with the emitter-1, base-2 terminal (lead 4) open.


FIGURE 1


FIGURE 2

## TWO TRIODES INTERNALLY CONNECTED IN DARLINGTON CONFIGURATION

- Very High hfe . . . 4000 min at 10 mA
- Low ICBO . . . 10 nA max at $\mathbf{6 0} \mathrm{V}$
- Rugged Internal Connections
*mechanical data

*absolute maximum ratings at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)
Collector-Base Voltage ..... 60 V
Collector-Emitter Voltage (See Note 1) ..... 60 V
Emitter-Base Voltage ..... 15 V
Continuous Collector Current ..... 500 mA
Continuous Device Dissipation at (or below) $25^{\circ} \mathrm{C}$ Free-Air Temperature (See Note 2) ..... 0.5 W
Continuous Device Dissipation at (or below) $\mathbf{2 5}{ }^{\circ} \mathrm{C}$ Case Temperature (See Note 3) ..... 1.8 W
Storage Temperature Range ..... $-65^{\circ} \mathrm{C}$ to $200^{\circ} \mathrm{C}$
Lead Temperature 1/16 Inch from Case for 10 Seconds ..... $300^{\circ} \mathrm{C}$
NOTES: 1. This value applies when the emitter-base diodes are open-circuited

2. Derate linearly to $200^{\circ} \mathrm{C}$ free-air temperature at the rate of $2.86 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$.
3. Derate linearly to $200^{\circ} \mathrm{C}$ case temperature at the rate of $10.3 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$.
[^34]N-P-N DARLINGTON-CONNECTED SILICON TRANSISTOR
*electrical characteristics at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

|  | PARAMETER | TEST CONDITIONS ${ }^{\text {t }}$ | MIN MAX | UNIT |
| :---: | :---: | :---: | :---: | :---: |
| $V_{\text {(BR) }}$ CBO | Collector-Base Breakdown Voltage | $\mathrm{I}_{\mathrm{C}}=100 \mu \mathrm{~A}, \quad \mathrm{I}_{\mathrm{E}}=0$ | 60 | $V$ |
| $V_{\text {(BR) }}$ CEO | Collector-Emitter Breakdown Voltage | $\mathrm{I}_{\mathrm{C}}=30 \mathrm{~mA}, \quad \mathrm{I}_{\mathrm{B}}=0, \quad$ See Note 4 | 60 | V |
| $V_{\text {(BR)EBO }}$ | Emitter-Base Breakdown Voltage | $\mathrm{I}_{\mathrm{E}}=100 \mu \mathrm{~A}, \mathrm{I}^{\prime} \mathrm{C}=0$ | 15 | V |
| ${ }^{\text {c CBO }}$ | Collector Cutoff Current | $V_{C B}=60 \mathrm{~V}, \mathrm{I}_{\mathrm{E}}=0$ | 10 | nA |
|  |  | $V_{C B}=60 \mathrm{~V}, \mathrm{I}_{\mathrm{E}}=0, \quad \mathrm{~T}_{\mathrm{A}}=150^{\circ} \mathrm{C}$ | 10 | $\mu \mathrm{A}$ |
| IEbo | Emitter Cutoff Current | $V_{E B}=10 \mathrm{~V}, I^{\prime}=0$ | 10 | nA |
| hfe | Static Forward Current Transfer Ratio (Total Device) | $V_{C E}=10 \mathrm{~V}, I^{\prime}=0.1 \mathrm{~mA}$ | 1000 |  |
|  |  | $V_{C E}=10 \mathrm{~V}, \mathrm{I}_{\mathrm{C}}=10 \mathrm{~mA}$, See Note 4 | 4000 |  |
|  |  | $V_{C E}=10 \mathrm{~V}, I_{C}=100 \mathrm{~mA}$, See Note 4 | 7000 70,000 |  |
|  |  | $V_{C E}=10 \mathrm{~V}, \mathrm{I}^{\mathrm{C}}=100 \mathrm{~mA}, \mathrm{~T}_{\mathrm{A}}=-55^{\circ} \mathrm{C},$ <br> See Note 4 | 1000 |  |
| hFE | Static Forward Current Transfer Ratio (Each Triode) | $V_{C E}=10 \mathrm{~V}, \mathrm{I}^{\text {c }} \mathbf{C}=10 \mathrm{~mA}$, See Note 4 | 25 |  |
| $V_{\text {BE }}$ | Base-Emitter Voltage | $I_{B}=1 \mathrm{~mA}, \quad I_{C}=100 \mathrm{~mA}$, See Note 4 | 1.8 | V |
| $V_{\text {CE }}$ (sat) | Collector-Emitter Saturation Voltage | $\mathrm{I}_{\mathrm{B}}=1 \mathrm{~mA}, \quad \mathrm{I}_{\mathrm{C}}=100 \mathrm{~mA}$, See Note 4 | 1.6 | V |
| Cobo | Common-Base Open-Circuit Output Capacitance | $V_{C B}=10 \mathrm{~V}, \mathrm{I}_{\mathrm{E}}=0, \quad \mathrm{f}=140 \mathrm{kHz}$ | 20 | pF |
| $\mathrm{C}_{\text {ibo }}$ | Common-Base Open-Circuit Input Capacitance | $V_{E B}=0.5 \mathrm{~V}, \mathrm{I} C=0, \quad f=140 \mathrm{kHz}$ | 10 | pF |

*JEDEC registered data
${ }^{\dagger}$ All measurements except $h_{\text {FE }}$ (each triode) are made with the emitter-1, base-2 terminal (lead 4) open.
NOTE 4: These parameters must be measured using pulse techniques. $\mathrm{t}_{\mathbf{w}}=\mathbf{3 0 0} \mu \mathrm{s}$, duty $\mathbf{c y c l e} \leqslant 1 \%$.

## THERMAL INFORMATION

FREE-AIR TEMPERATURE DISSIPATION DERATING CURVE


FIGURE 1

CASE TEMPERATURE DISSIPATION DERATING CURVE


FIGURE 2
texas mstruments reserves the right to make changes at any time in order io improve desigh and to supply the best product possible.

## TYPES 2N1131, 2N1132 <br> P-N-P SILICON TRANSISTORS

## GENERAL PURPOSE MEDIUM-POWER TRANSISTORS <br> - 2 Watts at $25^{\circ} \mathrm{C}$ Case Temperafure <br> - Complements to 2N696 and 2N697 <br> - 10-ohm Saturation Resistance (max)

mechanical data

absolute maximum ratings at $\mathbf{2 5}^{\circ} \mathrm{C}$ ambient temperature (unless otherwise noted)


NOTES: 1. This value applies when the base-emitter diode is open-eircuited.
2. Derate linearly to $175^{\circ} \mathrm{C}$ case temperature at the rate of $13.3 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$.
3. Derate linearly to $175^{\circ} \mathrm{C}$ ambient temperature at the rate of $4 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$.
electrical characteristics af $25^{\circ} \mathbf{C}$ ambient temperature (unless otherwise noted)

| Paromefor |  | Test Conditions | Type | Min. | Max. | Unt |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| ICuo | Collector Reverse Current | $\mathrm{v}_{\mathrm{CB}}=-30{\mathrm{v}, \mathrm{I}_{\mathrm{E}}=0}$ |  |  | $-1.0$ | $\mu \mathrm{a}$ |
| Icmo | Collector Reverse Current | $\begin{aligned} & V_{C B}=-30 v_{,} I_{E}=0 \\ & T_{A}=+150^{\circ} \mathrm{C} \end{aligned}$ |  |  | -100 | $\mu$ |
| IEso | Emitter Reverse Current | $\mathrm{v}_{\mathrm{EB}}=-2 \mathrm{v}, \mathrm{l}_{\mathrm{c}}=0$ |  |  | -100 | $\mu \mathrm{a}$ |
|  | Collector-Base Breakdown Voltage | $\mathrm{I}_{\mathbf{c}}=-100 \mu \mathrm{a}, \mathrm{I}_{\mathrm{E}}=0$ |  | -50 |  | v |
| ${ }^{*} V_{\text {(m) }}$ ceeo | Collector-Emitter Breakdown Voltage | $\mathbf{I}_{\mathbf{c}}=-100 \mathrm{ma}, \mathrm{I}_{\mathrm{g}}=0$ |  | $-35$ |  | v |
| ${ }^{*} \boldsymbol{V}_{\text {(IX) }}$ CER | Collector-Emister Breakdown Voltage | $\begin{aligned} & I_{c}=-100 \mathrm{ma}, \\ & R_{\mathrm{BE}}=10 \mathrm{oms} \end{aligned}$ |  | $-50$ |  | $v$ |
| ${ }^{*}{ }_{\text {fet }}$ | DC Forward Current Transfer Ratio | $\begin{aligned} & V_{C E}=-10 v_{1} \\ & I_{c}=-150 \mathrm{ma} \end{aligned}$ | $2 \mathrm{~N} 1131$ $2 \mathrm{Nl} 132$ | $\begin{aligned} & 20 \\ & 30 \end{aligned}$ | $\begin{aligned} & 45 \\ & 90 \end{aligned}$ |  |
| $*_{\text {hfe }}$ | DC forward Curent Transfer Ratio | $v_{C E}=-10 \mathrm{v}, \mathrm{l}_{c}=-5 \mathrm{mo}$ | $\begin{aligned} & \hline 2 \mathrm{HIL31} \\ & 2 \mathrm{Kl132} \end{aligned}$ | $\begin{aligned} & 15 \\ & 25 \end{aligned}$ |  |  |
| ${ }^{*} V_{\text {E }}$ | Base-Emitfer Voltage | $\mathrm{l}_{\mathrm{B}}=-15 \mathrm{ma}, \mathrm{l}_{\mathrm{C}}=-150 \mathrm{ma}$ |  |  | $-1.3$ | v |
| ${ }^{*} V_{\text {CE }}(w+1$ | Collector-Emitter Saturation Voltage | $\mathrm{l}_{\mathrm{g}}=-15 \mathrm{ma}, \mathrm{l}_{\mathrm{c}}=-150 \mathrm{ma}$ |  |  | -1.5 | v |
| $\mathrm{hfo}_{\text {for }}$ | AC Common-Emitter Forward Current Transfer Ratio | $\begin{aligned} & \mathrm{v}_{\mathrm{CE}}=-10 \mathrm{v}, \mathrm{l}_{\mathrm{c}}=-50 \mathrm{ma} \\ & \mathrm{f} \end{aligned}$ | 2 N 1131 <br> 2 N 1132 | $\begin{aligned} & 2.5 \\ & 3 \end{aligned}$ |  |  |
| $\mathrm{c}_{\mathrm{ib}}$ | Common-Base Input Capacilance | $\begin{aligned} & v_{E B}=-0.5 v, l_{C}=0 \\ & f=1 \mathrm{mc} \end{aligned}$ |  |  | 80 | pf |
| ${ }_{\text {c }}$ b | Common-Base Output Capacitante | $\begin{aligned} & v_{C B}=-10 v_{,} l_{E}=0 \\ & f=1 \mathrm{mc} \end{aligned}$ |  |  | 45 | pf |
| $h_{6}$ | AC Common-Emitter Forward Current Transier Ratio | $\begin{aligned} V_{\mathrm{CE}} & =-5 \mathrm{v}, \mathrm{I}_{\mathrm{C}}=-1 \mathrm{ma} \\ \mathrm{f} & =1 \mathrm{kc} \end{aligned}$ | $\begin{aligned} & 2 \mathrm{NII31} \\ & 2 \mathrm{NII} 32 \end{aligned}$ | $\begin{aligned} & 15 \\ & 25 \end{aligned}$ | $\begin{aligned} & 50 \\ & 100 \end{aligned}$ |  |
| $\mathrm{hf}_{6}$ | AC Common-Emitter Forward Current Transter Ratio | $\begin{aligned} & V_{C E E}=-10 \mathrm{v}, \mathrm{l}_{\mathrm{C}}=-5 \mathrm{ma} \\ & \mathrm{f}=1 \mathrm{kc} \end{aligned}$ | $\begin{aligned} & 2 \mathrm{NI} 131 \\ & 2 \mathrm{NII} 132 \end{aligned}$ | $\begin{aligned} & 20 \\ & 30 \end{aligned}$ |  |  |
| $\mathrm{h}_{\text {ib }}$ | AC Common-Base Input Impedance | $\begin{aligned} & V_{C B}=-5 \mathrm{v}, \mathrm{l}_{\mathrm{E}}=1 \mathrm{ma} \\ & \mathrm{f}=1 \mathrm{kc} \\ & \mathrm{~V}_{\mathrm{CB}}=-10 \mathrm{v}, \mathrm{I}_{\mathrm{E}}=5 \mathrm{ma} \\ & \mathrm{f}=1 \mathrm{kc} \end{aligned}$ |  | 25 | $\begin{aligned} & 35 \\ & 10 \end{aligned}$ | ohms ohms |
| $\mathrm{h}_{\text {cb }}$ | AC Common-Base Output Admittance | $\begin{aligned} & V_{C B}=-5 v_{,} l_{E}=1 \mathrm{ma} \\ & f=1 \mathrm{kc} \\ & V_{C B}=-10 v_{1} i_{E}=5 \mathrm{ma} \\ & f=1 \mathrm{kc} \end{aligned}$ |  | $0$ | $1$ | $\mu$ mho <br> $\mu$ mho |
| $\mathrm{h}_{\text {rb }}$ | AC Common-Base Reverse Voltage Iransfer Ratio | $\begin{aligned} V_{C B} & =-5 \mathrm{v}, \mathrm{l}_{\mathrm{E}}=1 \mathrm{ma} \\ f & =1 \mathrm{kc} \\ \mathrm{v}_{\mathrm{CB}} & =-10 \mathrm{v}, \mathrm{l}_{\mathrm{E}}=5 \mathrm{ma} \\ \mathrm{f} & =1 \mathrm{kc} \end{aligned}$ |  | $\begin{aligned} & 0 \\ & 0 \end{aligned}$ | $\begin{aligned} & 8 \times 10^{-4} \\ & 8 \times 10^{-4} \end{aligned}$ |  |

*These measurements must be made with a pulse duration $\leq 300$ microseconds and a duty cycle $\leq 2$ percent.

## Oval Welded Package

## mechnonical deta

The tronsistor is in an oval welded package with glass-to-metal hermetic seal between case and leads. Unit weight is approximately 1 gram.


## *eloselute maximum repinge at $25^{\circ} \mathrm{C}$ free-air semperafure (unless otherwise noted)





## TYPES 2N1149 THRU 2N1153

N-P-N GROWN-JUNCTION SILICON TRANSISTORS
electrical characteristics at $25^{\circ} \mathrm{C}$ free-air femperature (unless otherwise noted)

|  | parameter | tost conditions | types | min $^{*}$ | typ | $\max ^{*}$ | unit |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| lewo | Collector Cutoff Current | $V_{C 1}=30 \mathrm{~V} \quad l_{1}=0$ | All |  |  | 2 | $\mu \mathrm{a}$ |
|  |  | $\begin{aligned} & Y_{c B}=30 \mathrm{~V} \quad I_{G}=0 \\ & T_{A}=150^{\circ} \mathrm{C} \end{aligned}$ | ALL |  | 3 |  | $\mu$ |
|  |  | $\begin{aligned} & V_{C 1}=5 r \\ & T_{A}=100^{\circ} \mathrm{C} \end{aligned}$ | ALL |  |  | 10 | $\mu$ |
|  |  | $\begin{aligned} & V_{\mathrm{ct}}=5 \mathrm{~V} \quad \mathrm{I}_{\mathrm{t}}=0 \\ & \mathrm{~T}_{\mathrm{A}}=150^{\circ} \mathrm{C} \end{aligned}$ | ALL |  | 0.5 | 50 | $\mu$ |
| ${ }^{81} \mathrm{~V}_{10}$ | Collector-base Braakdown Voltage | $l_{c}=50 \mu \mathrm{l} \mathrm{I}_{\mathrm{E}}=0$ | All | 45 |  |  | V |
| rceisut) | DC Collector-Emiltor Soturation Resistonte | $\mathrm{I}_{\mathrm{B}}=2.2 \mathrm{ma} \mathrm{l}_{\mathrm{C}}=5 \mathrm{ma}$ | ALL |  | 100 | 200 | ohm |
| Cob | Common-Base Output Capocitance | $\begin{aligned} & V_{c t}=5 \mathrm{r} \quad \mathrm{l}_{\mathrm{E}}=0 \\ & \mathrm{i}=1 \mathrm{mc} \end{aligned}$ | All |  | 7 |  | pf |
| Into | Common-Base Alpho Cuseff Froquency | $V_{\text {cis }}=5 \mathrm{v} \quad \mathrm{I}_{\mathrm{E}}=-1 \mathrm{mo}$ | $\begin{aligned} & \hline 2 \mathrm{~N} 1149 \\ & 2 \mathrm{~N} 1150 \\ & 2 \mathrm{~N} 1151 \\ & 2 N 1152 \\ & 2 \mathrm{~N} 1153 \\ & \hline \end{aligned}$ | 8 | $\begin{aligned} & 12 \\ & 13 \\ & 14 \\ & 15 \\ & 16 \end{aligned}$ |  | m |
| $h_{\text {fob }}$ | AC Common-Base Forward Current Tronsfor Ratio | $\begin{aligned} & v_{c ı}=5 \mathrm{v} \quad l_{\mathrm{E}}=-1 \mathrm{mo} \\ & f=1 \mathrm{kc} \end{aligned}$ | $\begin{aligned} & 2 N 1149 \\ & 2 N 1150 \\ & 2 N 1151 \\ & 2 N 1152 \\ & 2 N 1153 \\ & \hline \end{aligned}$ | $\begin{aligned} & -0.9 \\ & -0.948 \\ & -0.948 \\ & -0.9735 \\ & -0.987 \\ & \hline \end{aligned}$ | $\begin{aligned} & -0.925 \\ & -0.96 \\ & -0.975 \\ & -0.98 \\ & -0.99 \\ & \hline \end{aligned}$ | $\begin{aligned} & -0.953 \\ & -0.976 \\ & -0.989 \\ & -0.989 \\ & -0.997 \end{aligned}$ |  |
| $h_{16}$ | $\begin{aligned} & \text { AC Common-8ase } \\ & \text { laput Impodance } \end{aligned}$ | $\begin{array}{ll} V_{c a}=5 \mathrm{v} & \mathrm{l}_{\mathrm{E}}=-1 \mathrm{ma} \\ f=1 \mathrm{kc} \end{array}$ | ALL | 30 | 42 | 80 | ohm |
| $h_{\text {co }}$ | $\begin{aligned} & \text { AC Common-Base } \\ & \text { Output Admiltance } \end{aligned}$ | $\begin{aligned} & V_{c \mathrm{c}}=5 \mathrm{r} \quad \mathrm{I}_{\mathrm{i}}=-1 \mathrm{ma} \\ & \mathrm{f}=1 \mathrm{kc} \end{aligned}$ | ALL | 0 | 0.4 | 1.2 | $\boldsymbol{\mu}$ mino |
| $h_{\text {rb }}$ | AC Common-Aase Revarse Voliage Transfor Ratio | $\begin{aligned} & V_{\mathrm{ct}}=5 \mathrm{v} \quad \mathrm{l}_{\mathrm{E}}=-1 \mathrm{mo} \\ & \mathrm{f}=1 \mathrm{kc} \end{aligned}$ | $\begin{aligned} & \hline 2 N 1149 \\ & 2 N 1150 \\ & 2 N 1151 \\ & 2 N 1152 \\ & 2 N 1153 \\ & \hline \end{aligned}$ | 0 0 0 0 0 | $\begin{aligned} & 120 \times 10^{-6} \\ & 250 \times 10^{-6} \\ & 400 \times 10^{-6} \\ & 400 \times 10^{-6} \\ & 400 \times 10^{-6} \end{aligned}$ | $\begin{aligned} & 500 \times 10^{-6} \\ & 1000 \times 10^{-6} \\ & 1000 \times 10^{-6} \\ & 1000 \times 10^{-6} \\ & 1000 \times 10^{-6} \end{aligned}$ |  |

*Indkates JEDEC raglsterad data
functional tests at $25^{\circ} \mathrm{C}$ free-air temperature

|  | parametar | test conditions | types | min | typ | max | Unlt |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| $\mathrm{G}_{\mathrm{p}}$ | Common-Emitter Power Gain | $\begin{array}{ll} V_{C E}=20 \mathrm{v} & \mathrm{l}_{\mathrm{E}}=-2 \mathrm{mu} \\ R_{\epsilon}=1 \mathrm{k} \Omega & R_{L}=20 \mathrm{~K} \Omega \\ f=1 \mathrm{kc} & V_{\theta}=0.02 \mathrm{v} \end{array}$ | $\begin{aligned} & \hline 2 N 1149 \\ & 2 N 1150 \\ & 2 N 1151 \\ & 2 N 1152 \\ & 2 N 1153 \\ & \hline \end{aligned}$ |  | $\begin{aligned} & \hline 35 \\ & 39 \\ & 39 \\ & 42 \\ & 42.5 \\ & \hline \end{aligned}$ |  | あ |
|  | Spot Noise Figure | $\begin{aligned} & V_{C E}=5 \mathrm{v} \quad I_{E}=-1 \mathrm{mo} \\ & R_{G}=1 \mathrm{k} \Omega \quad \mathrm{f}=1 \mathrm{kc} \\ & B W=1 \mathrm{cydo} / \mathrm{sec} \\ & \hline \end{aligned}$ | ALL |  | 20 |  | あ |

POWER GAIN TEST CIRCUIT



## FORMERLY TYPES 951, 952, AND 953, RESPICTIVELY

## mechanical dafa

The transistor is in an oval welded package with glass-to-metal hermetic seal between case and leads. Unit weight is approximately 1 gram. The mounting clamp is hardware supplied with the transistor.

*absolute maximum ratings at $25^{\circ} \mathrm{C}$ case temperature (unless otherwise noted)


HOTE 1: Derate linearly to $150^{\circ} \mathrm{C}$ case tumperalive at the rete of $\mathbf{0} \mathbf{m w} /{ }^{\circ} \mathrm{C}$.

- Indicates JEDEC ragistered data


## TYPES 2N1154, 2N1155, 2N1156 <br> N-P-N GROWN-JUNCTION SILICON TRANSISTORS

*electrical characteristics at $25^{\circ} \mathrm{C}$ case temperature

|  | parameter | test conditions | type | min | max | unit |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| $1 \mathbf{l o s}$ | Collector Cutoff Current | $V_{C B}=50 \mathrm{~V} \quad \mathrm{I}_{\mathrm{E}}=0$ | 2N1154 |  | 5 | $\mu \mathrm{a}$ |
|  |  | $V_{C B}=80 \mathrm{v} \quad \mathrm{I}_{\mathrm{E}}=0$ | 2N1155 |  | 6 | $\mu \mathrm{a}$ |
|  |  | $\mathrm{V}_{\mathrm{CB}}=120 \mathrm{v} \quad \mathrm{I}_{\mathrm{E}}=0$ | 2N1156 |  | 8 | $\mu$ |
| $V_{\text {bE }}$ | Base-Emitter Voltage | $\mathrm{I}_{\mathrm{B}}=2.2 \mathrm{ma} \quad \mathrm{I}_{\mathrm{C}}=20 \mathrm{ma}$ | 2N1154 |  | 1 | $\vee$ |
|  |  | $\mathrm{I}_{\mathrm{B}}=2.2 \mathrm{ma} \quad \mathrm{I}_{\mathrm{C}}=15 \mathrm{ma}$ | 2N1155 |  | 1 | $v$ |
|  |  | $\mathrm{I}_{\mathrm{B}}=2.2 \mathrm{ma} \quad \mathrm{I}_{\mathrm{C}}=10 \mathrm{ma}$ | 2N1156 |  | 1 | $v$ |
| ${ }^{\text {ceelsat }}$ ) | DC Collector-Emitter Saturation Resistance | $\mathrm{I}_{\mathrm{B}}=2.2 \mathrm{ma} \quad \mathrm{IC}_{\mathrm{c}}=20 \mathrm{ma}$ | 2N1154 |  | 300 | ohm |
|  |  | $\mathrm{I}_{\mathrm{B}}=2.2 \mathrm{mo} \quad \mathrm{I}_{\mathrm{C}}=15 \mathrm{ma}$ | 2N1155 |  | 350 | ohm |
|  |  | $\mathrm{I}_{\mathrm{B}}=2.2 \mathrm{ma} \quad \mathrm{I}_{\mathrm{C}}=10 \mathrm{ma}$ | 2N1156 |  | 400 | ohm |
| $\mathrm{h}_{\mathrm{fb}}$ | AC Common-Base Forward Current Transfer Ratio | $\begin{aligned} & V_{C B}=10 v \quad I_{E}=-5 \mathrm{ma} \\ & \mathrm{f}=1 \mathrm{kc} \end{aligned}$ | 2N1154 <br> 2N1155 <br> 2N1156 | -0.9 | -1 |  |
| $h_{\text {ib }}$ | AC Common-Base Input Impedance | $\begin{aligned} & V_{\mathrm{CB}}=10 \mathrm{v} \quad \mathrm{I}_{\mathrm{E}}=-5 \mathrm{ma} \\ & \mathrm{f}=1 \mathrm{kc} \end{aligned}$ | $\begin{aligned} & 2 \mathrm{~N} 1154 \\ & 2 \mathrm{~N} 1155 \\ & 2 \mathrm{~N} 1156 \end{aligned}$ |  | 30 | ohm |
| $h_{\text {ob }}$ | AC Common-Base Output Admittance | $\begin{aligned} & V_{C B}=10 \mathrm{v} \quad I_{\mathrm{E}}=-5 \mathrm{ma} \\ & \mathrm{f}=1 \mathrm{kc} \end{aligned}$ | 2H1154 2 N 1155 <br> 2N1156 |  | 2 | $\mu \mathrm{mho}$ |
|  | AC Common-Base Reverse Voltage Transfer Retio | $\begin{aligned} & V_{C B}=10 \mathrm{v} \quad \mathrm{I}_{\mathrm{E}}=-5 \mathrm{ma} \\ & \mathrm{f}=1 \mathrm{kc} \end{aligned}$ | 2N1154 $2 N 1155$ 2N1156 |  | $\begin{aligned} & 300 x \\ & 10^{-6} \end{aligned}$ |  |

*functional tests at $25^{\circ} \mathrm{C}$ case temperature

| $\mathrm{G}_{\mathrm{pe}}$ | Common-Emitter <br> Power Gain (See Circuit) | $\begin{array}{ll} V_{C E}=28 \mathrm{v} & \mathrm{I}_{\mathrm{C}}=20 \mathrm{ma} \\ \mathbf{R}_{\mathrm{L}}=1 \mathrm{k} \Omega & \mathrm{f}=1 \mathrm{kc} \\ \mathbf{V}_{\mathbf{q}}=0.2 \mathrm{v} & \\ \hline \end{array}$ | 2N1154 | 30 | db |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | $\begin{array}{ll} V_{C E}=45 \mathrm{v} & \mathrm{I}_{\mathrm{C}}=15 \mathrm{ma} \\ \mathbf{R}_{\mathrm{L}}=2 \mathrm{k} \Omega & \mathrm{I}=1 \mathrm{kc} \\ \mathrm{~V}_{\mathrm{g}}=0.2 \mathrm{v} & \end{array}$ | 2N1155 | 30 | db |
|  |  | $\begin{array}{ll} V_{C E}=67.5 \mathrm{v} & \mathrm{I}_{\mathrm{C}}=10 \mathrm{ma} \\ \mathbb{R}_{\mathbf{L}}=4 \mathrm{k} \Omega & \mathrm{f}=1 \mathrm{kc} \\ \mathbf{V}_{\mathrm{g}}=0.2 \mathrm{v} & \\ \hline \end{array}$ | 2N1156 | 30 | db |

[^35]
# TYPES 2N1154, 2N1155, 2N1156 N-P-N GROWN-JUNCTION SILICON TRANSISTORS 



## TYPICAL CHARACTERISTICS



## Highly Reliable, Versatile Devices Designed for Amplifier, Switching and Oscillator Applications from $<0.1 \mathrm{ma}$ to $>\mathbf{1 5 0} \mathrm{ma}$ de to $\mathbf{3 0} \mathrm{mc}$ <br> - High Voltage - Low Leakage <br> - Useful $h_{\text {FE }}$ Over Wide Current Range

*mechanical data
Device types 2N717, 2N718, 2N718A, 2N730, 2N731, and 2N956 are in JEDEC TO-18 packages. Device types 2N696, 2N697, 2N1420, 2N1507, 2N1613, and 2N1711 are in JEDEC TO-5 packages.

*absolute maximum ratings at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

|  | $\begin{aligned} & 2 \mathrm{~N} 696 \\ & 2 \mathrm{~N} 697 \\ & \hline \end{aligned}$ | $\begin{aligned} & 2 N 717 \\ & 2 N 718 \\ & \hline \end{aligned}$ | 2N718A | $\begin{array}{r} 2 \mathrm{~N} 730 \\ 2 \mathrm{~N} 731 \\ \hline \end{array}$ | 2N956 | $\begin{aligned} & 2 N 1420 \\ & 2 N 1507 \\ & \hline \end{aligned}$ | 2N1613 | 2N1711 | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Collector-Bass Voltage | 60 | 60 | 75 | 60 | 75 | 60 | 75 | 75 | $v$ |
| Collictor-Emittor Voltage (seo Mote 1) | 40 | 40 | 50 | 40 | 50 | 30 | 50 | 50 | $v$ |
| Collector-Emittor Voltage (See Mote 2) |  |  | 32 |  |  |  |  |  | $v$ |
| Emilter-Lose Voltage | 5 | 5 | 7 | 5 | 7 | 5 | 7 | 7 | $v$ |
| Collector Current |  |  |  | 1.0 |  | 1.0 |  | 1.0 | 0 |
| Total Deviose Dissipation at (or below) $25^{\circ} \mathrm{C}$ free-Air Temperature (See Mote Indicated in Parentheses) $\rightarrow$ | $\begin{gathered} 0.6 \\ \dagger \\ 13) \\ \hline \end{gathered}$ | $\begin{aligned} & 0.4 \\ & \dagger \\ & \dagger \\ & (5) \\ & \hline \end{aligned}$ | 0.5 <br> (7) | $\begin{aligned} & 0.5 \\ & \dagger \dagger \\ & 19) \\ & \hline \end{aligned}$ | 0.5 <br> (7) | $\begin{aligned} & 0.6 \\ & i \\ & 13) \\ & \hline \end{aligned}$ | 0.8 <br> (10) | $\begin{aligned} & 0.8 \\ & (10) \\ & \hline \end{aligned}$ | W |
| Total Dovice Dissipation at (or below) $25^{\circ} \mathrm{C}$ Case Temperoture (See Mote Indicatod in Parentheses) $\rightarrow$ | $\begin{aligned} & 2.0 \\ & \dagger \\ & 1 \\ & \hline \end{aligned}$ | $\begin{aligned} & 1.5 \\ & \dagger \\ & 16 \\ & \hline \end{aligned}$ | 1.8 <br> (8) | $\begin{aligned} & 1.5 \\ & 1 \dagger \\ & (6) \\ & \hline \end{aligned}$ | 1.8 <br> (8) | $\begin{gathered} 2.0 \\ \dagger \\ (4) \end{gathered}$ | 3.0 <br> (11) | $\begin{aligned} & 3.0 \\ & \text { (11) } \end{aligned}$ | W |
| Total Device Dissipation of $100^{\circ} \mathrm{C}$ Cose Temporature | $\begin{aligned} & 1.0 \\ & i \\ & \hline \end{aligned}$ | $\begin{aligned} & 0.75 \\ & \dagger \dagger \\ & \hline \end{aligned}$ | 1.0 | $\begin{aligned} & 0.75 \\ & i+ \\ & \hline \end{aligned}$ | 1.0 | $\begin{aligned} & 1.0 \\ & i \end{aligned}$ | 1.7 | 1.7 | w |
| Operating Collector Junction Temperuture | 175 $\dagger$ | $175 \dagger \dagger$ | 200 | 175 $\dagger \dagger$ | 200 | 175† | 200 | 200 | ${ }^{\circ} \mathrm{C}$ |
| Storoge Temperature Range | $-65^{\circ} \mathrm{C}$ to $200^{\circ} \mathrm{C}$ |  |  |  |  |  |  |  |  |

MOTES: 1. This velwe applios when the bess-amitter rosistance $\left(\mathbb{R}_{\mathrm{B}}\right)$ is equal to of less than 10 chms.
2. Thls value epplites when the beso-mmitter diode is open-circulited.
3. Derate linearly to $175^{\circ} \mathrm{C}$ fron-air temperatere at the rate of $4.0 \mathrm{mw} / \mathrm{c}^{\circ}$.
4. Derate limestly to $175^{\circ} \mathrm{C}$ cese temperature at the rate of $13.3 \mathrm{~mm} / \mathrm{C}^{\circ}$.
5. Derate linentry to $175^{\circ} \mathrm{C}$ tres-alr temparature at the rate of $2.67 \mathrm{~mm} / \mathrm{c}^{\circ}$.
6. Devate linearly to $175^{\circ} \mathrm{C}$ cese semparature at the rath of $10.0 \mathrm{~mm} / \mathrm{c}^{\circ}$.
7. Derate linearly to $200^{\circ} \mathrm{C}$ freo-air temperature of the rate of $2.26 \mathrm{~mm} / \mathrm{c}^{\circ}$.
8. Derate linearly to $200^{\circ} \mathrm{C}$ case temperature of the rate of $10.1 \mathrm{mw} / \mathrm{C}^{\circ}$.
9. Devate limearly to $175^{\circ} \mathrm{C}$ troe-alt temperature af the rate of $3.33 \mathrm{~mm} / \mathrm{C}^{\circ}$.
10. Berafe linesily to $200^{\circ} \mathrm{C}$ froo-air temperatare af the rate of $4.56 \mathrm{~mm} / \mathrm{C}^{\circ}$.
11. Derate Ilnearly te $200^{\circ} \mathrm{C}$ cese temperatura at the rate of $17.2 \mathrm{mw} / \mathrm{C}^{\circ}$.
†Texas Instruments gucrantions ith types 2M696, 2M697, 2N1420, and 2N1507 to be eapoble of the same dilasipation as raglatered and shown for typer 2N1613 and 2N1711 whith appreprlate derefling factors shown in Mates 10 and 11.
$\dagger \dagger$ Toxas Instrumonts guorantees ins types 2N717, $2 N 714,2 N 730$, and $2 N 731$ to be capeble of the same dissipation as registored and shown for types 207114 A and. $2 \mathrm{N956}$ with appropilafe derating fasfors shown lin Nofes 7 and 8.
*Indiceles Jepec ropistered data.

## TYPES 2N718A, 2N956, 2N1420, 2N1507, 2N1613, 2N1711 N-P-N SILICON TRANSISTORS

*electrical characteristics of $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

| Parammiter |  | TEST CONDITIONSTO-18 <br>  <br> $10-5 \rightarrow$ | 2N718A |  |  | 2N956 | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | 2N1613 | 2N1420 | 2N1507 | 2N1711 |  |
|  |  | MIN MAX | min max | MIN Max | min max |  |
|  |  |  | $\mathrm{I}_{\mathbf{C}}=160 \mu 0, \mathrm{I}_{\mathrm{E}}=0$ | 75 | 4 | $\omega$ | 75 | $v$ |
| Vimicio Collocter-Emithor Irockdown Viltope |  |  | $\mathrm{I}_{\mathrm{c}}=30 \mathrm{~mm}, \mathrm{I}_{1}=0, \quad$ Sen Mote 12 |  |  | 25 |  | $v$ |
| $V_{\text {fajces }}$ | Collcker-Emitter Brokkown Voltap | $\mathrm{I}_{\mathrm{c}}=100 \mathrm{ma}, \mathrm{C}_{\text {他 }}=10 \Omega$, Soe Mote 12 | 50 | 30 | 30 | 50 | $v$ |
| Y(m)Em | Emilter-lose liceokdown Yoltuge | $\mathrm{I}_{\mathbf{E}}=100 \mu_{4, l_{C}}=0$ | 7 |  |  | 7 | $v$ |
| $I_{\text {ceo }}$ | Collecter Cutaff Curreat | $v_{c!}=30 \mathrm{v}, \mathrm{I}_{\mathrm{E}}=0$ |  | 1.0 | 1.0 |  | $\mu$. |
|  |  | $v_{C B}=30 \mathrm{v}, \mathrm{I}_{\mathrm{E}}=0, \quad \mathrm{~T}_{\mathrm{A}}=150^{\circ} \mathrm{C}$ |  | 100 | 50 |  | $\mu$ |
|  |  | $r_{c t}=64, I_{\mathrm{E}}=0$ | 0.010 |  |  | 0.010 | $\mu \mathrm{e}$ |
|  |  | $v_{C B}=00 \% \mathrm{I}_{\mathrm{E}}=0, \quad \mathrm{~T}_{\mathrm{A}}=150^{\circ} \mathrm{C}$ | 10 |  |  | 10 | $\mu \mathrm{m}$ |
| ${ }^{\text {Cex }}$ | Collectoc Curoff Currout | $\mathrm{v}_{\mathrm{CE}}=20 \mathrm{v}, \mathrm{R}_{\mathrm{EE}}=100 \mathrm{kM}$ |  |  | 10 |  | $\mu$ |
| $\mathrm{I}_{\mathrm{EDO}}$ | Emilter Cutoff Curront | $\mathrm{V}_{\mathrm{E}}=5 \mathrm{y}, \mathrm{I}_{\mathrm{C}}=0$ | 0.01 |  | 100 | 0.005 | $\mu$ |
| $h_{\text {FE }}$ | Stetic Fowward Corrent Tramsler Retio | $V_{C E}=10 \mathrm{r}, \mathrm{I}_{\mathrm{C}}=10 \mu \mathrm{~s}$ |  |  |  | 20 |  |
|  |  | $v_{C E}=10 \mathrm{r}, \mathrm{I}_{C}=100 \mu \mathrm{a}$ | 20 |  |  | 35 |  |
|  |  | $\mathrm{r}_{C E}=10 \mathrm{r}, \mathrm{I}_{\mathrm{C}}=10 \mathrm{ma}$, Seo Mote 12 | 35 |  |  | 73 |  |
|  |  | $\begin{aligned} & Y_{C E}=10 \mathrm{v}, \mathrm{I}_{\mathrm{C}}=10 \mathrm{ma}, \mathrm{~T}_{\mathrm{A}}=-55^{\circ} \mathrm{C}, \\ & \text { Sen Moto } 12 \end{aligned}$ | 20 |  |  | 35 |  |
|  |  | $V_{C E}=10 y_{,} I_{C}=150 \mathrm{~mm}$, See Mote 12 | 40180 | $100 \quad 300$ | $100 \quad 300$ | $100 \quad 300$ |  |
|  |  | $V_{C E}=10 \mathrm{v}_{1} \mathrm{I}_{C}=500 \mathrm{~mm}$, Soe Mote 12 | 20 |  |  | 40 |  |
| $V_{\text {me }}$ | Cose-Emiltor Voltage | $\mathrm{I}_{8}=15 \mathrm{~mm}, \mathrm{I}_{\mathrm{C}}=150 \mathrm{~mm}$, Seo Mole 12 | 1.3 | 1.3 | 1.3 | 1.3 | $v$ |
| $\nabla_{\text {CEIsat }}$ | Colloctor-Emitter Saturation Voltaye | $\mathrm{I}_{5}=15 \mathrm{ma}, \mathrm{I}_{C}=150 \mathrm{me}$, Soe Note 12 | 1.5 | 1.5 | 1.5 | 1.5 | $v$ |
| ${ }^{\text {ib }}$ | Sraill-Sigatil Commmon-inse Input Impedente | $v_{C I}=5 v_{1} \quad 1_{C}=1 \mathrm{mo}, 1=1 \mathrm{kc}$ | $24 \quad 34$ |  |  | $24 \quad 34$ | chm |
|  |  | $V_{C B}=10 \mathrm{v}^{\prime} \mathrm{I}_{\mathrm{C}}=5 \mathrm{~mm}, \quad 1=1 \mathrm{kc}$ | 4 B |  |  | 48 | cinm |
| ${ }_{\text {brb }}$ | Smell-Sigual Corimen-Laso Reverse Voliege Tremstor Rathe | $\mathbf{v}_{\mathrm{cs}}=5 \mathrm{v}, \quad \mathrm{l}_{\mathbf{c}}=1 \mathrm{~ms}, \quad i=1 \mathrm{kc}$ | $\begin{gathered} \hline 3 x \\ 10-4 \\ \hline \end{gathered}$ |  |  | $\begin{gathered} 5 x \\ 10-4 \end{gathered}$ |  |
|  |  | $\mathbf{v}_{\mathbf{c a}}=10 \mathrm{v}^{\prime} \mathrm{l}_{\mathbf{C}}=5 \mathrm{ma}, \quad 1=1 \mathrm{kc}$ | $\begin{gathered} 3 x \\ 10^{-4} \end{gathered}$ |  |  | $\begin{gathered} 5 x \\ 10^{-4} \end{gathered}$ |  |
| $h_{\text {ob }}$ | Smell-Sigenl Commen-lesa Output Adiniftemci | $\mathrm{v}_{\mathrm{Cs}}=5 \mathrm{v}, \mathrm{l}_{\mathrm{c}}=1 \mathrm{ma}, \quad 1=1 \mathrm{kc}$ | 0.10 .5 |  |  | 0.10 .5 | $\mu \mathrm{mmio}$ |
|  |  | $v_{\text {ct }}=10 v_{0} \quad I_{\mathrm{c}}=5 \mathrm{ma}, \quad 1=1 \mathrm{kc}$ | $0.1 \quad 1.0$ |  |  | 0.11 .0 | $\mu \mathrm{mmo}$ |
| $W_{6}$ | Small-Signal Commen-Emittry Fowwerl Curroat Trensior liatio |  | $30 \quad 100$ |  |  | $50 \quad 200$ |  |
|  |  | $y_{C E}=10 \mathrm{v}, \mathrm{I}_{\mathrm{C}}=5 \mathrm{ma}, \quad 1=1 \mathrm{kc}$ | $35 \quad 150$ |  |  | $70 \quad 300$ |  |
| $\left\|h_{\text {fol }}\right\|$ | Small-Signal (comman-Emitter Forward (erremt Irronstor Retio | $v_{C E}=10 \mathrm{v}, \mathrm{I}_{\mathrm{C}}=50 \mathrm{ma}, \quad t=20 \mathrm{mx}$ | 3.0 | 2.5 | 2.5 | 3.5 |  |
| $c_{\text {cb }}$ | Common-lese Open-Circuit Output Cepeciteace | $\mathbf{v}_{\mathrm{ca}}=10 \mathrm{v}, \mathrm{l}_{\mathrm{E}}=0, \quad t=1 \mathrm{mc}$ | 25 | 35 | 35 | 25 | pf |
| $c_{i b}$ | Common-Dose Open-Girculf Input Copecitence | $\mathbf{v}_{\mathrm{Es}}=0.5 \mathrm{v} . \mathrm{l}_{\mathrm{c}}=0, \quad t=1 \mathrm{mc}$ | 00 |  |  | 60 | p ${ }^{\text {f }}$ |

See operating and switching characteristics for types 2N718A, 2N956, 2N1613, and 2N1711 on paga 4-30.

WOTE 12: These meramolen must the mossurad using polse techniqws. PW $\leq \mathbf{3 0 0} \mu \mathrm{sec}$, Duty Cycle $\leq \mathbf{2 \%}$. Pulse width must be sucb that halving or doubling does not casso - change groator then the repuind ecewrey of the measuramont.
*Imalicalos JEEEC registarad dato

## FOR GENERAL PURPOSE AMPLIFIER APPLICATIONS

- V(BR)CEO . . . 60 V Min
- hFE... 60 to 200
mechanical data

THE COLLECTOR IS IN ELECTRICAL CONTACT WITH THE CASE


ALL JEDEC TO-39 DIMENSIONS AND NOTES ARE APPLICABLE*

*absolute maximum ratings at $\mathbf{2 5}{ }^{\circ} \mathbf{C}$ free-air temperature (unless otherwise noted)
Collector-Base Voltage ..... 80 VCollector-Emitter Voltage (See Note 1)60 V
Emitter-Base Voltage ..... 5 V
Continuous Collector Current ..... 50 mA
Continuous Device Dissipation at (or below) $25^{\circ} \mathrm{C}$ Free-Air Temperature (See Note 2) ..... 600 mW
Storage Temperature Range ..... $-65^{\circ} \mathrm{C}$ to $200^{\circ} \mathrm{C}$ ..... $-65^{\circ} \mathrm{C}$ to $200^{\circ} \mathrm{C}$Lead Temperature 1/16 Inch from Case for 10 Seconds$230^{\circ} \mathrm{C}$
electrical characteristics at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

| PARAMETER | TEST CONDITIONS |  | MIN MAX | $\begin{array}{\|c\|} \hline \text { UNIT } \\ \hline V \\ \hline \end{array}$ |
| :---: | :---: | :---: | :---: | :---: |
| $V_{\text {(BR) }}$ CBO Collactor-Base Breakdown Voltage | ${ }^{1} \mathrm{C}=10 \mu \mathrm{~A}, \quad I_{E}=0$ |  | 80* |  |
| $\mathbf{V}_{\text {(BR) }}$ CEO Collector-Emitter Breakdown Voltage | $\mathrm{I}^{\prime} \mathrm{C}=10 \mathrm{~mA}, \mathrm{I}_{\mathrm{B}}=0$, | See Note 3 | $60^{*}$ | V |
| Collector Cutoff Current | $V_{C B}=40 \mathrm{~V}, \mathrm{I}_{\mathrm{E}}=0$ |  | $1{ }^{17}$ | $\mu \mathrm{A}$ |
|  | $\mathrm{V}_{\mathrm{CB}}=40 \mathrm{~V}, \mathrm{I}_{\mathrm{E}}=0$, | $\mathrm{T}_{\mathrm{A}}=150^{\circ} \mathrm{C}$ | 100 |  |
| IEBO Emitter Cutoff Current | $\mathrm{V}_{\mathrm{EB}}=5 \mathrm{~V}, \quad \mathrm{IC}=0$ |  | 10* | $\mu \mathrm{A}$ |
| hFE Static Forward Current Transfer Ratio | $\mathrm{V}_{C E}=5 \mathrm{~V}, \mathrm{I}^{\prime} \mathrm{C}=5 \mathrm{~mA}$, | See Note 3 | $60^{*} \quad 200^{*}$ |  |
| VBE Base-Emitter Voltage | $\mathrm{I}_{\mathrm{B}}=2 \mathrm{~mA}, \quad \mathrm{I}^{\prime}=10 \mathrm{~mA}$, | See Note 3 | 0.35* $1.5^{*}$ | V |
| VCE(sat) Collector-Emitter Saturation Voltage | $I_{B}=2 \mathrm{~mA}, \quad I_{C}=10 \mathrm{~mA}$, | See Note 3 | 1* | V |
| $h_{\text {ie }}$ Small-Signal Common-Emitter <br> Input Impedance | $V_{C E}=5 \mathrm{~V}, \quad \mathrm{I}^{\prime}=5 \mathrm{~mA}$, | $\mathrm{f}=1 \mathrm{kHz}$ | 1.8* | $k \Omega$ |
| Small-Signal Common-Emitter Forward Current Transfer Ratio | $V_{C E}=5 \mathrm{~V}, \quad \mathrm{I}_{\mathrm{C}}=1 \mathrm{~mA}$ | $f=1 \mathrm{kHz}$ | 60 |  |
|  | $V_{C E}=5 \mathrm{~V}, \mathrm{I}^{\prime} \mathrm{C}=5 \mathrm{~mA}$ |  | 80* 200* |  |
|  | $\begin{aligned} & V_{C E}=5 \mathrm{~V}, \quad I^{\prime}=5 \mathrm{~mA}, \\ & T_{A}=-55^{\circ} \mathrm{C} \end{aligned}$ |  | 40 |  |
| $h_{\text {fel }} \quad$Small-Signal Common-Emitter <br> Forward Current Transfer Ratio | $V_{C E}=5 \mathrm{~V}, \quad I^{\prime}=5 \mathrm{~mA}$, | $f=30 \mathrm{MHz}$ | 2 |  |
| Cobo Common-Base Open-Circuit <br> Output Capacitance  | $V_{C B}=5 \mathrm{~V}, \quad I^{\prime}=0$, | $f=1 \mathrm{MHz}$ | 10* | pF |

NOTES: 1. This value applies when the base-emitter diode is open-circuited.
2. Derate linearly to $175^{\circ} \mathrm{C}$ free-air temperature at the rate of $4 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$.
3. These parameters must be measured using pulse techniques. $t_{w}=300 \mu$ s, duty cycle $<\mathbf{2 \%}$.

[^36]- JEDEC registored data. This data sheet contains all applicable registered data in effect at the time of publication.

USES CHIP N23

# Highly Roliable, Versatile Devices Designed for Amplifier, Switching and Oscillator Applications from $<0.1 \mathrm{ma}$ to $>150 \mathrm{ma}$, de to 30 mc 

\author{

- High Voltage - Low Leakage <br> - Useful $\mathrm{h}_{\mathrm{fE}}$ Over Wide Current Range
}


## *mechanical data

Device types 2N717, 2N718, 2N718A, 2N730, 2N731, and 2N956 are in JEDEC TO-18 packages. Device types 2N696, 2N697, 2N1420, 2N1507, 2N1613, and 2N1711 are in JEDEC TO-5 packages.

*absolute maximum ratings of $25^{\circ} \mathrm{C}$ free-air tempercture (unless otherwise noted)

|  | $\begin{array}{\|l\|} \hline 2 \mathrm{~N} 696 \\ \hline 2 \mathrm{~N} 697 \\ \hline \end{array}$ | $\begin{array}{\|l\|} \hline 2 \mathrm{NF} 17 \\ 2 \mathrm{NF} 18 \\ \hline \end{array}$ | 2N718A | $\begin{array}{\|l} 2 N 730 \\ 2 N 731 \\ \hline \end{array}$ | 2N956 | $\begin{array}{\|l\|} \hline 2 \mathrm{~N} 1420 \\ 2 \mathrm{~N} 1507 \\ \hline \end{array}$ | 2N1613 | 2N1711 | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Collector-Base Voltage | 60 | 60 | 75 | 60 | 75 | 60 | 75 | 75 | v |
| Collector-Emitter Volioge (Sen Note 1) | 40 | 40 | 50 | 40 | 50 | 30 | 50 | 50 | $v$ |
| Colloctor-Emitter Voltage (Seo Noto 2) |  |  | 32 |  |  |  |  |  | V |
| Emitter-Base Voltage | 5 | 5 | 7 | 5 | 7 | 5 | 7 | 7 | V |
| Collector Current |  |  |  | 1.0 |  | 1.0 |  | 1.0 | 0 |
| Total Dovica Dissipation of (or below) $25{ }^{\circ} \mathrm{C}$ Free-Air Temperature (See Mote Indikated in Parenthesss) $\rightarrow$ | $\begin{gathered} 0.6 \\ \dagger \\ (3) \\ \hline \end{gathered}$ | $\begin{aligned} & 0.4 \\ & f \dagger \\ & (5) \\ & \hline \end{aligned}$ | $\begin{aligned} & 0.5 \\ & (7) \\ & \hline \end{aligned}$ | $\begin{aligned} & 0.5 \\ & \dagger \\ & 1 \\ & (9) \\ & \hline \end{aligned}$ | $0.5$ <br> (7) | $\begin{aligned} & 0.6 \\ & \dagger \\ & 13) \\ & \hline \end{aligned}$ | 0.8 <br> (10) | 0.8 <br> (10) | W |
| Total Dovice Dissipation af (or below) $25^{\circ} \mathrm{C}$ Case Temporature <br> (Se0 Hote Indicated in Porentheses) $\rightarrow$ | $\begin{gathered} 2.0 \\ \dagger \\ 1 \\ \text { (4) } \\ \hline \end{gathered}$ | $\begin{aligned} & 1.5 \\ & \dagger \dagger \\ & (6) \\ & \hline \end{aligned}$ | $1.8$ <br> (8) | $\begin{aligned} & 1.5 \\ & \dagger \dagger \\ & (6) \\ & \hline \end{aligned}$ | $\begin{aligned} & 1.8 \\ & \text { (8) } \\ & \hline \end{aligned}$ | $\begin{aligned} & 2.0 \\ & \dagger \\ & \text { (4) } \\ & \hline \end{aligned}$ | $\begin{aligned} & 3.0 \\ & \text { (11) } \\ & \hline \end{aligned}$ | 3.0 <br> (11) | w |
| Total Device Dissipotion of $100^{\circ} \mathrm{C}$ Case Temporature | $\begin{aligned} & 1.0 \\ & \dagger \end{aligned}$ | $\begin{aligned} & 0.75 \\ & \dagger \dagger \end{aligned}$ | 1.0 | $0.75$ | 1.0 | $\frac{1.0}{i}$ | 1.7 | 1.7 | w |
| Operating Collector Junction Temperature | 175† | 175t† | 200 | 175†† | 200 | 175 $\dagger$ | 200 | 200 | ${ }^{\circ} \mathrm{C}$ |
| Storage Temperature Range | $-65^{\circ} \mathrm{C}$ to $200^{\circ} \mathrm{C}$ |  |  |  |  |  |  |  |  |

MOTES: 1. This value applins whto the best-anitter resisitace (fes) is equal to ar lass then 10 dhams.
2. This value applios whem the beso-minitar diedo is apen-circuited.

1. Derofe limenty to $175^{\circ} \mathrm{C}$ froe-alir temperature of the rete of $4.0 \mathrm{~mm} / \mathrm{c}^{\circ}$.
2. Dorate lineerty to $175^{\circ} \mathrm{C}$ cast tumperatione of the rete of $13.3 \mathrm{~mm} / \mathrm{C}^{\circ}$.
3. Derate linocrly to $175^{\circ} \mathrm{C}$ froo-air temperature at the rets of $2.67 \mathrm{~mm} / \mathrm{C}^{\circ}$.
4. Borate lineerly to $175^{\circ} \mathrm{C}$ cesse temperature af the rate of $10.0 \mathrm{~mm} / \mathrm{c}^{\circ}$.
5. Derats linearly te $200^{\circ} \mathrm{C}$ freo-air temperation at the rate of $2.66 \mathrm{~mm} / \mathrm{c}^{\circ}$.
6. Derate linearly to $200^{\circ} \mathrm{C}$ cass temprature at the rete of $10.3 \mathrm{~mm} / \mathrm{C}^{\circ}$.
7. Derete lineerly to $175^{\circ} \mathrm{C}$ free-atir temporature of the rate of $3.33 \mathrm{mw} / \mathrm{C}^{\circ}$.
8. Derate Ineorly to $200^{\circ} \mathrm{C}$ frow-air temporative at the rate of $4.56 \mathrm{~mm} / \mathrm{C}^{\circ}$.
9. Derate lineerly to $200^{\circ} \mathrm{C}$ cese tmaperature at the rete of $17.2 \mathrm{~mm} / \mathrm{C}^{\circ}$.
trexes Instruments guarantees lis types 2M696, 2N697, 2N1420, and 2N1507 to be capmble of the same dilsalpation as registerod and shown for types 2N1613 and 2W1511 wht appropilate dereting foctors shown in Motes 10 and 11.
$\dagger \dagger$ Texas Instruments guaranteen in rypes 206717, 2NF18, 2N730, and 2N731 to be eappible of the same dimplpation as registored and shown for types
 toess shewi $\ln$ Noles 7 and 8.
[^37]
## TYPES 2N718A, 2N956, 2N1420, 2N1507, 2N1613, 2N1711 N-P-N SILICON TRANSISTORS

*electrical characteristics af $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

*operating characteristics at $25^{\circ} \mathrm{C}$ free-air temperature

| Parameter | TEST CONDITIONS | $\begin{aligned} & T 0-18 \rightarrow \\ & 70-5 \rightarrow \end{aligned}$ | 2N956 |  | $\frac{2 \text { N718A }}{2 \text { N1613 }}$ |  | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  | TYP | MAX | TYP | max |  |
| NF Spot Moss Flaurs | $\begin{aligned} & V_{c t}=10 v_{,} I_{c}=300 \mu \mathrm{ag} \\ & R_{G}=510 \Omega, f=1 \mathrm{kc} \end{aligned}$ |  | 5 | 8 | 6 | 12 | db |

*awitching characteristics at $25^{\circ} \mathrm{C}$ froe-air temperature

| PARAMETER | TEST CONDITIONS | 10-18 $\rightarrow$ | $\frac{2 N 718 A}{2 N 1613}$ |  | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | 70.5 - |  |  |  |
|  |  |  | TYP | MAX |  |
| ${ }_{1}$ Total Swithing Time | Sen Figure ${ }^{*}$ |  | 20 | 30 | nsot |

NOTE 12: Those perametors must we meseried using pulse tochniques. PW $\leq \mathbf{3 0 0} \mu \mathrm{sec}$, Duty Cycle $\leq \mathbf{2 \%}$. Puise width must be such that haiving of doubling does not couse a change greater than the required accuracy of the measurament.
*Indicotos JEDEC ragistarad data

- The referenced figure is shown on page 4-30.

Designed for Medium-Power Switching, Oscillator and Pulse Timing Circuits<br>- Highly Stable Negative Resistance<br>and Firing Voltage<br>- Low Firing Current<br>- High Pulse Current Capebiltities<br>- Simplified Circuit Design

## *mechanical data

Package outline is similar to JEDEC TO-5 except for lead position. Approximately weight is $\mathbf{1}$ gram.

| *all leads insulated from case. <br> NOTES A. This zone is controfled for attomatic handling. The variation in actual diameter within this zone shall not exceed 0.010 . <br> B. Measured from max. diameter of the actual device. <br> C. The specified lead diameter applies in the zone between 0.050 and 0.250 trom the base sest. Between 0.250 mdd 1.5 maximum of 0.021 dam. eter is held. Oulside of these zones the lead diameter is not controlled. <br> DIMENSIONS ARE IN INCNES UNLESS OTHERWISE SPRCIFIED |  |
| :---: | :---: |

*absolute maximum ratings at $\mathbf{2 5}{ }^{\circ} \mathrm{C}$ free-air femperature (unless otherwise notod)





*Indicatos JEDEC rogistored data

## TYPES 2N1671, 2N1671A, 2N1671B, 2N2160 P-N BAR-TYPE SILICON UNIJUNCTION TRANSISTORS

*electrical characteristies at $25^{\circ} \mathrm{C}$ free-air temperature

| PARAMETER |  | TEST CONDITIONS | 2N1671 |  | 2N16714 |  | 2N16718 |  | 2 M 2160 |  | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | MIN | max | MIN | MAX | MIN | max | MIN | MAX |  |
| Pemer | Slafic Iatarose Resitrence |  | $v_{\text {man }}=3 y_{1} 1_{5}=0$ | 4.7 | 8.1 | 4.1 | 9.1 | 4.7 | 9.1 | 4.6 | 12 | 40 |
| $\eta$ | Intrinsk stendifi mevie | $\begin{aligned} & V_{\text {bivn }}=10 \mathrm{v} \\ & \text { Sen Fipure } 1 \end{aligned}$ | 0.47 | 0.08 | 0.47 | 0.62 | 0.47 | 0.62 | 0.47 | 0.00 |  |
| Isalameti) | Medralated latortese Curront | $\mathrm{V}_{\mathrm{mat}}=10 \mathrm{r}_{1} \mathrm{I}_{\mathrm{E}}=50 \mathrm{ma}$ | 4.8 | 21 | 6.4 | 22 | 6.8 | 22 | 6.4 | $\cdots$ | me |
| IEROO | Emititer Rownse Cormint |  |  | -12 |  | -12 |  | -0.2 |  | -12 | $\mu$ |
| Ip | Poelc-Foini Emithor Corrout | $\gamma_{\text {bin }}=25 \mathrm{v}$ |  | 23 |  | 25 |  | 1 |  | 25 | $\mu \mathrm{m}$ |
| $Y_{\text {genteat }}$ | Emiltor Selvration Yolteso |  |  | 5 |  | 5 |  | 5 |  |  | $\checkmark$ |
| $\mathrm{I}_{1}$ | Velley-Polat Emitior Curront | $v_{m 01}=20 y_{1} n_{2}=100 n$ | 1 |  | 1 |  | 1 |  | 1 |  | m |
| Vobt | Iaso-Dwe Prom Pulse Yeltago | $v_{1}=20 v_{1} n_{n 1}=20 \Omega$ <br> Sex Figune 2 |  |  | 3 |  | 1 |  | 3 |  | V |

*Indicatos JEDEC ragisternd date

## PARAMETER MEASUREMENT INFORMATION


$M_{1}: 100 \mu \mathrm{~A}$ Full Scale
$\boldsymbol{\eta}$ - Intrinsic Standoff Ratio - This parameter is defined in tarms of the peak-point voltage, $\mathbf{V}_{\mathbf{p}}$, by means of the equation: $\mathbf{V}_{\mathbf{p}}=\eta$ $V_{\mathrm{Bn}}+V_{f}$, where $V_{f}$ is obout 0.56 volt of $25^{\circ} \mathrm{C}$ and decreases with temperature at about 2 millivalts/deg.

The circuit used to meosure $\eta$ is shown in the figure. In this cireuif, $\mathbf{R}_{\mathbf{t}}, C_{1}$ and the unijunction transistor form a relaxation oscillator, and the remainder of the circuit serves as a peok-voltage detector with the diode $D_{1}$ automatically subtracting the voltage $V_{f}$. To use the circuit, the "cal" button is pushed, and $R_{3}$ is adjusted to make the current mater $M_{1}$ read full scale. The "eal" button then is released and the value of $\eta$ is read directly from the meter, with $\eta=1$ corresponding to fulliscale deflection of $100 \mu \mathrm{~A}$.
$D_{1}$ : 1N457, or aquivalent, with the following charestaristics:
$V_{F}=0.565 V_{\text {at }} I_{f}=50 \mu \mathrm{~A}$,
$\mathrm{I}_{\mathrm{R}} \leq 2 \mu \mathrm{~A}$ of $\mathrm{V}_{\mathrm{R}}=20 \mathrm{~V}$
OR INTRINSIC STANDOFF RATIO ( $\eta$
-BASE-ONE VOLTAGE
vs
EMITTER CURRENT


FIGURE 3- GENERAL STATIC EMITTER CHARACTERISTIC CURVE

# Highly Reliable, Versatile Devices Designed for Amplifier, Switching and Oscillator Applications from $<0.1 \mathrm{ma}$ to $>150 \mathrm{ma}$, de to 30 mc 

\author{

- High Voltage - Low Leakage <br> - Useful $\mathrm{h}_{\mathrm{fE}}$ Over Wide Curremt Range
}


## *mechanical dafa

Device types 2N717, 2N718, 2N718A, 2N730, 2N731, and 2N956 are in JEDEC TO-18 packages.
Device types 2N696, 2N697, 2N1420, 2N1507, 2N1613, and 2N1711 are in JEDEC TO-5 packages.

*absolute maximum ratings at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

|  | $\begin{array}{r} \text { 2N696 } \\ \text { 2N697 } \\ \hline \end{array}$ | $\begin{array}{r} 2 N 717 \\ 2 N 718 \\ \hline \end{array}$ | 2N718A | $\begin{aligned} & 2 \mathrm{~N} 730 \\ & 2 \mathrm{~N} 731 \\ & \hline \end{aligned}$ | 2N956 | $\begin{aligned} & 2 \mathrm{~N} 1420 \\ & 2 \mathrm{~N} 1507 \\ & \hline \end{aligned}$ | 2N1613 | 2N1711 | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Colliector-Base Voltoge | 60 | 60 | 75 | 60 | 75 | 60 | 75 | 75 | $v$ |
| Collector-Emitter Voltage (See Note 1) | 40 | 40 | 50 | 40 | 50 | 30 | 50 | 50 | $v$ |
| Collictor-Emitter Voliage (Soe Note 2) |  |  | 32 |  |  |  |  |  | $v$ |
| Emitter-Base Voltage | 5 | 5 | 7 | 5 | 7 | 5 | 7 | 7 | $v$ |
| Collector Current |  |  |  | 1.0 |  | 1.0 |  | 1.0 | 0 |
| Total Device Dissipation at (ar below) $25^{\circ} \mathrm{C}$ Freo-Air Temperature (See Mote Indicated in Parentheses) $\rightarrow$ | $\begin{gathered} 0.6 \\ \dagger \\ \vdots \\ \hline \end{gathered}$ | $\begin{aligned} & 0.4 \\ & \dagger \\ & (5) \\ & \hline \end{aligned}$ | 0.5 <br> (7) | $\begin{aligned} & 0.5 \\ & 1+ \\ & (9) \\ & \hline \end{aligned}$ | $\begin{aligned} & 0.5 \\ & (7) \\ & \hline \end{aligned}$ | $\begin{gathered} 0.6 \\ \dagger \\ \text { (3) } \\ \hline \end{gathered}$ | $\begin{aligned} & \hline 0.8 \\ & (10) \\ & \hline \end{aligned}$ | $\begin{aligned} & 0.8 \\ & (10) \\ & \hline \end{aligned}$ | w |
| Total Device Dissipation ot (or below) $25^{\circ} \mathrm{C}$ Cose Temperature (See Note Indicated in Porenthoses) $\rightarrow$ | $\begin{gathered} 2.0 \\ \dagger \\ \text { (4) } \\ \hline \end{gathered}$ | $\begin{aligned} & 1.5 \\ & \dagger \dagger \\ & (6) \end{aligned}$ | $1.8$ <br> (8) | $\begin{aligned} & 1.5 \\ & \dagger \\ & \text { (6) } \\ & \hline \end{aligned}$ | $1.8$ <br> (8) | $\begin{aligned} & 2.0 \\ & \dagger \\ & \text { (4) } \end{aligned}$ | 3.0 <br> (11) | 3.0 <br> (11) | * |
| Total Device Dissipation of $100^{\circ} \mathrm{C}$ Case Temperature | $1.0$ | $\begin{aligned} & 0.75 \\ & \dagger \dagger \end{aligned}$ | 1.0 | $\begin{aligned} & 0.75 \\ & t+ \end{aligned}$ | 1.0 | $i$ | 1.7 | 1.7 | w |
| Operating Collector Junction Temperature | 175 $\dagger$ | 175¢† | 200 | $175 \dagger \dagger$ | 200 | 175 $\dagger$ | 200 | 200 | ${ }^{\circ} \mathrm{C}$ |
| Storage Temperature Range | $-65^{\circ} \mathrm{C}$ to $200^{\circ} \mathrm{C}$ |  |  |  |  |  |  |  |  |

WOTES: 1 . This valwe applies when the beso-mitter rassitance ( $R_{\text {mes }}$ ) is equal to or less thea 10 chms.
2. This valwe applies whan the base-maititer diade is epen-circuitod.
3. Derate linearly to $175^{\circ} \mathrm{C}$ free-air temperature af ths rate of $4.0 \mathrm{~mm} / \mathrm{C}^{\circ}$.
4. Derate lineserly to $175^{\circ} \mathrm{C}$ case temperature of the reto of $13.3 \mathrm{~mm} / \mathrm{c}^{\circ}$.
5. Deratio Ilinearly to $175^{\circ} \mathrm{C}$ free-air remperature at the rele of $2.67 \mathrm{mw} / \mathrm{c}^{\circ}$.
6. Derate IIncasly to $175^{\circ} \mathrm{C}$ case temperature of the rate of $10.0 \mathrm{~mm} / \mathrm{c}^{\circ}$.
7. Derete linearly to $200^{\circ} \mathrm{C}$ fret-air temperature at the rate of $2.06 \mathrm{~mm} / \mathrm{c}^{\circ}$.
8. Derate lineoriy to $200^{\circ} \mathrm{C}$ cese semperature at the reta of $10.3 \mathrm{mw} / \mathrm{C}^{\circ}$.
9. Derate linearily to $173^{\circ} \mathrm{C}$ fres-air temperature at the rate of $3.33 \mathrm{~mm} / \mathrm{c}^{\circ}$.
10. Berate Inesarly to $200^{\circ} \mathrm{C}$ free-alr memperature at the rate of $4.56 \mathrm{~mm} / \mathrm{c}^{\circ}$.
11. Derate linearly to $200^{\circ} \mathrm{C}$ case temperature at the rate of $17.2 \mathrm{mw} / \mathrm{c}^{\circ}$.
$\dagger$ Toxas Instruments guaramiess is types-2M696, 2N697, 2N1420, and 2M1507 to be capable of the mome divipation as registorad and shown for types 2 N 1613 ond 2 NI 711 with appropiate deration fectors shown in Wofes 10 and 11.
††Texas Instruments guarentees its types 2N717, 2N71s, $2 N 730$, and 2N731 to be capmble of the same dissipation as reglaterad and shown for types
 rers shown in Motes 7 and 8.

[^38]
## TYPES 2N718A, 2N956, 2N1420, 2N1507, 2N1613, 2NT71 N-P-N SILICON TRANSISTORS

*electrical characteristics af $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)


See switching characteristics for types 2N718A and 2N613 on peges 4-30 or 4-72.
*operating characteristics at $25^{\circ} \mathrm{C}$ free-air temperafure

| PARAMETER | TEST CONDITIONS |  | $\xrightarrow{10.18 \rightarrow}$ | $\frac{2 \text { N956 }}{2 N 1711}$ |  | $\begin{aligned} & \hline \text { 2N718A } \\ & \hline 2 N 1613 \end{aligned}$ |  | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  | TYP | max | TYP | MAX |  |
| MF Spol Moise ligure | $\begin{aligned} & V_{c E}=10 v, I_{c}= \\ & R_{G}=510 \hat{\Omega}, 1 \end{aligned}$ | $\begin{aligned} & 300 \mu \mathrm{l} \\ & \mathrm{lkc} \end{aligned}$ |  | 5 | 8 | 6 | 12 | db |

NOTE 12: These parameters must be mrasured using pulse tochniques. pw $\leq 300$ $\mu$ sec, Duty Cycle $\leq 2 \%$. Pulse width must be such that halving or doubling does nat cause a change greater than the required accurecy of the measurement.
*Indicalus JEDEC registered date

Highly Reliable, Versatile Devices Dasigned for Amplifier, Switching and Oscillator Applications from $<0.1 \mathrm{ma}$ to $>150 \mathrm{ma}$ de to $\mathbf{3 0} \mathbf{~ m c}$

- High Voltage - Low Leakage
mechanical dafa
Device types $2 N 719,2 N 719 A, 2 N 720,2 N 720 A, 2 N 870$ and $2 N 871$ are in JEDEC TO-18 packages*. Device types 2N698, 2N699, 2N1889, 2N1890, and 2N1893 are in JEDEC TO-39 packages*.

*absolute maximum ratings at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

|  | 2N698 | 2N699 | $\begin{array}{\|l\|} \hline \text { 2N719 } \\ \text { 2N720 } \\ \hline \end{array}$ | 2N719A | 2N720A | $\begin{aligned} & \text { 2N870 } \\ & 2 N 871 \end{aligned}$ | $\left.\begin{array}{\|c\|} \hline 2 N 1889 \\ 2 N 1890 \end{array} \right\rvert\,$ | 2N1893 | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Collector-Base Voltage | 120 | 120 | 120 | 120 | 120 | 100 | 100 | 120 | $v$ |
| Collector-Emitter Voltage (See Note 1) | 80 | 80 | 80 | 80 | 100 | 80 | 80 | 100 | $v$ |
| Collector-Emitter Voltage (See Note 2) | 60 |  |  | 60 | 80 | 60 | 60 | 80 | $v$ |
| Emitter-Base Voltoge | 7 | 5 | 5 | 7 | 7 | 7 | 7 | 7 | $v$ |
| Collector Current |  |  |  | 1.0 |  |  |  | 0.5 | 0 |
| Total Device Dissipation at (or below) $25^{\circ} \mathrm{C}$ Free-Air Temperature (See Note Indicated in Parentheses) $\qquad$ | 0.8 <br> (3) | $\begin{gathered} 0.6 \\ t \\ (5) \end{gathered}$ | $\begin{array}{r} 0.4 \\ \ddagger \\ (7) \\ \hline \end{array}$ | $\begin{aligned} & 0.5 \\ & (9) \\ & \hline \end{aligned}$ | $0.5$ <br> (9) | 0.5 <br> (9) | 0.8 <br> (3) | (3) | w |
| Total Device Dissipation at (or below) $25^{\circ} \mathrm{C}$ Case Temperature (See Note Indicated in Porentheses) $\qquad$ | $\begin{array}{r} 3.0 \\ + \\ (4) \\ \hline \end{array}$ | $\begin{array}{r} 2.0 \\ \uparrow \\ \text { (6) } \\ \hline \end{array}$ | $\begin{array}{r} 1.5 \\ \ddagger \\ (8) \\ \hline \end{array}$ | $\begin{aligned} & 1.8 \\ & (10) \\ & \hline \end{aligned}$ | $\begin{array}{r} 1.8 \\ (10) \\ \hline \end{array}$ | $\begin{aligned} & 1.8 \\ & (10) \\ & \hline \end{aligned}$ | $\begin{gathered} 3.0 \\ t \\ (4) \\ \hline \end{gathered}$ | $\begin{array}{r} 3.0 \\ \dagger \\ \text { (4) } \\ \hline \end{array}$ | w |
| Storage Temperature Range | $-65^{\circ} \mathrm{C}$ to $200^{\circ} \mathrm{C}$ |  |  |  |  |  |  |  |  |

WOTES: I. This values applies whan the bese-minter resistance ( $R_{\text {me }}$ ) is equal to or less than 10 ehmes.
2. This volues applies when the base-emitrer diede is apen-circuited.
3. Derale linearly to $200^{\circ} \mathrm{C}$ free-air temperatere of the rete of $4.57 \mathrm{~mm} /{ }^{\circ} \mathrm{C}$.
4. Derate linearly $10200^{\circ} \mathrm{C}$ case temperalure at the rate of $17.2 \mathrm{mw} /{ }^{\circ} \mathrm{C}$.
S. Derete linearly to $175^{\circ} \mathrm{C}$ free-air tmmperatione at the rate of $4.0 \mathrm{~mm} /{ }^{\circ} \mathrm{C}$.
6. Derate linesrly to $175^{\circ} \mathrm{C}$ case temperature at the rete of $13.3 \mathrm{~mm} /{ }^{\circ} \mathrm{C}$.
7. Derate linearly to $175^{\circ} \mathrm{C}$ freo-air temperatwe at the rete of $2 . \mathbf{V}^{\mathrm{mm}} /{ }^{\circ} \mathrm{C}$.
8. Derate linearly to $175^{\circ} \mathrm{C}$ case temperature of the rate of $10.0 \mathrm{mw} /{ }^{\circ} \mathrm{C}$.
9. Derate linearly to $200^{\circ} \mathrm{C}$ free-air temperature at the rate of $2 . \mathrm{Ke} \mathrm{mw} /{ }^{\circ} \mathrm{C}$.
10. Derate linearly $10200^{\circ} \mathrm{C}$ case temperature ot the rele of $10.3 \mathrm{~mm} /{ }^{\circ} \mathrm{C}$.

## *JEDEC registered data.

-The JEDEC registered outline for these devices is TO-5.
TO-39 falls within TO-5 with the exception of lesd length.
'Toxes Instruments guarantoes these devices in TO-39 packeges dete-coded 7326 or highar to be cepable of increseed diecipation as follows: 0.8 W at $\mathrm{T}_{A}<25^{\circ} \mathrm{C}$ derated tineerly to $\mathrm{T}_{A}=200^{\circ} \mathrm{C}$ at the rate of $4.57 \mathrm{~mW} / /^{\circ} \mathrm{C}$, or 10 W at $\mathrm{T}_{\mathrm{C}}<25^{\circ} \mathrm{C}$ (5.71 W at $\mathrm{T}^{2}=100^{\circ} \mathrm{C}$ ) derated limatry to $\mathrm{T}_{\mathrm{C}}=\mathbf{2 0 0 ^ { \circ }} \mathrm{C}$ at the rate of $57.1 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$.
$\ddagger$ Texes Instruments guarantees its types 2N719 and 2N720 to be capable of the same diszipation registored and shown for types 2N719A. 2N720A, 2N870, and 2N871 with eppropriate derating factors shown in Notes 9 and 10.

## TYPES 2N720. 2N720A, 2N870, 2N871, 2N1889, 2N1890, 2N1893 M-P-N SILICON TRANSISTORS

*electrical characteristics at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)


MOTE 11: These paramelers must be measured usidy pulse techniques. PW $\leq 300 \mu$ sace., Duty cycle $\leq 2 \%$
pulse width must be such that halving or doubling does not couse a change greater than the
required accuracy of the measurement.
*Indicates JEDEC registured data.

# HIGHLY RELIABLE, VERSATILE DEVICES CHARACTERIZED ESPECIALLY FOR SMALL-SIGNAL APPLICATIONS 

- High Voltage - Low Leakage
- Useful hfe Over Wide Current Range
- Both Common-Emitter and Common-Base Small-Signal Characterization


## mechanical data

| 2NO10, $2 N 911,2 N 912$ |
| :--- | :--- | :--- |

absoluta maximum ratings at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)


## TYPES 2N910, 2N911, 2N912, 2N1973, 2N1974, 2N1975 N-P-N SILICON TRANSISTORS

*electrical characteristics at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)


## *operating characteristics at $\mathbf{2 5}{ }^{\circ} \mathbf{C}$ free-air temperature

| paramettr | TEST CONDITIONS | 10.18 - | 2N910 | 2N911 | 2N912 | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | T0.39 $\rightarrow$ | 2N1973 | 2N1974 | 2N1975 |  |
|  |  |  | MAX | MAX | MaX |  |
| WF Spot Moise Eigure | $\begin{aligned} & V_{C!}=10 v, l_{c}=300 \mu \mathrm{c}, \mathrm{R}_{G}=510 \Omega \\ & \mathrm{f}=1 \mathrm{kc} . \text { Molse Bondwidth }=200 \mathrm{qs} \end{aligned}$ |  | 12 | 15 | 18 | db |

 a change greater then the repulrod eccurscy of the measurament.
*Indieates JEOEC Rugisterad Dala.

## TWO TRANSISTORS IN ONE PACKAGE FOR DIFFERENTIAL AMPLIFIER APPLICATIONS

- Medium Power
- High Operating Voltaga


## *mechanical data


*absolute maximum ratings at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

|  |  | 2060 |  | $\begin{aligned} & 223 \\ & 2234 \end{aligned}$ |  |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  | $\begin{aligned} & \text { EACH } \\ & \text { TRIODE } \end{aligned}$ | TOTAL DEVICE | $\begin{gathered} \text { EACH } \\ \text { TRIODE } \end{gathered}$ | TOTAL DEVICE | T |
| Collector-Base Voltage | 100 |  | 100 |  | V |
| Collector-Emitter Voltage (See Note 1) | 80 |  | 80 |  | V |
| Collector-Emitter Voltage (See Note 2) | 60 |  | 60 |  | V |
| Emitter-Base Voltage | 7 |  | 7 |  | V |
| Continuous Collector Current | 500 |  | 500 |  | mA |
| Continuous Device Dissipation at (or below) $25^{\circ} \mathrm{C}$ Free-Air Temperature (See Note 3) | 0.5 | 0.6 | 0.5 | 0.6 | W |
| Continuous Device Dissipation at (or below) $25^{\circ} \mathrm{C}$ Case Temperature (See Notes 4 and 5) | 1.5 | 3 | 1.6 | 3 | W |
| Continuous Device Dissipation at $100^{\circ} \mathrm{C}$ Case Temperature | 0.86 | 1.7 | 0.91 | 1.7 | W |
| Operating Collector Junction Temperature | 200 |  | 200 |  | C |
| Storage Temperature Range | $-65^{\circ} \mathrm{C}$ to $200^{\circ} \mathrm{C}$ |  |  |  |  |
| Lead Temperature 1/16 Inch from Case for 10 Seconds | $300^{\circ} \mathrm{C}$ |  |  |  |  |

NOTES: 1. These values apply when the base-emitter resistance ( $\mathrm{A}_{\mathrm{BE}}$ ) is equal to or less than 10 ohms.
2. These values apply when the base-emitter diode is open-circuited.
3. Derate linearly to $200^{\circ} \mathrm{C}$ free-air temperature at the rate of $2.86 \mathrm{~mW} / f^{\circ} \mathrm{C}$ for each triode and $3.43 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$ for total device.
4. Derate $2 N 2060$ linearly to $200^{\circ} \mathrm{C}$ case temperature at the rate of $8.6 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$ for each triode and $17.2 \mathrm{~mW} / /^{\circ} \mathrm{C}$ for total device.
5. Derste 2 N 2223 and 2 N 2223 A linearly to $200^{\circ} \mathrm{C}$ case temperature at the rate of $9.1 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$ for each triode and $17.2 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$ for total device.
6. The terminals of the triode not under rest are open-circuited for the measurement of these characteristics.
7. This parameter must be measured using pulse techniques. $t_{w}=300 \mu \mathrm{~s}$, duty cycle $\leqslant \mathbf{1 \%}$.
8. The lower of the two $h_{F E}$ reading is taken as $h_{F E I}$.
9. This parameter is measured in an amplifier with response down 3 dB at 25 Hz and 10 kHz and a high-frequency rolloff of 6 dB/octave.
*electrical characteristics at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)
individual triode characteristics (see note 6)

| PARAMETER |  | TEST CONDITIONS | 2N2060 | $\begin{array}{\|c\|} \hline \text { 2N2223 } \\ \text { 2N2223A } \\ \hline \end{array}$ | UN:T |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | MIN MAX | MIN MAX |  |
| $V_{\text {(BR) }}$ CBO | Collector-Base Breakdown Voltage |  | $I_{C}=100 \mu A, I_{E}=0$ | 100 | 100 | V |
| $V_{(B R) C E O}$ | Collector-Emitter Breakdown Voltage | $\mathrm{I}_{\mathrm{C}}=30 \mathrm{~mA}, \mathrm{I}_{\mathrm{B}}=0, \quad$ See Note 7 | 60 | 60 | V |
| V(BR)CER | Collector-Emitter Breakdown Voltage | $\mathrm{I}^{\prime} \mathrm{C}=100 \mathrm{~mA}, \mathrm{R}_{\mathrm{BE}}=10 \Omega$, See Note 7 | 80 | 80 | V |
| V(BR)EBO | Emitter-Base Breakdown Voltaga | $\mathrm{I}_{\mathrm{E}}=100 \mu \mathrm{~A}, \mathrm{I}^{\prime} \mathrm{C}=0$ | 7 | 7 | V |
| ICBO | Collector Cutoff Current | $V_{C B}=80 \mathrm{~V}, \mathrm{I}_{\mathrm{E}}=0$ | 2 | 10. | nA |
|  |  | $V_{C B}=80 \mathrm{~V}, \mathrm{I}_{\mathrm{E}}=0, \quad \mathrm{~T}_{\mathrm{A}}=150^{\circ} \mathrm{C}$ | 10 | 15 | $\mu \mathrm{A}$ |
| IEbo | Emitter Cutoff Current | $V_{E B}=5 \mathrm{~V}, \quad I_{C}=0$ | 2 | 10 | nA |
| hFE | Static Forward Current Transfer Ratio | $V_{C E}=5 \mathrm{~V}, \quad I_{C}=10 \mu \mathrm{~A}$ | $25 \quad 75$ | 15 |  |
|  |  | $V_{C E}=5 \mathrm{~V},{ }^{\prime} \mathrm{C}=100 \mu \mathrm{~A}$ | $30 \quad 90$ | $25 \quad 150$ |  |
|  |  | $V_{C E}=5 \mathrm{~V}, \quad \mathrm{I}_{\mathbf{C}}=1 \mathrm{~mA}$ | $40 \quad 120$ |  |  |
|  |  | $V_{C E}=5 \mathrm{~V},{ }^{1} \mathrm{C}=10 \mathrm{~mA}$, See Note 7 | 50150 | $50 \quad 200$ |  |
| $V_{B E}$ | Base-Emitter Voltage | $I_{B}=5 \mathrm{~mA}, \quad I_{C}=50 \mathrm{~mA}$ | 0.9 | 0.9 | V |
| $V_{\text {ce }}$ (sat) | Collector-Emitter Saturation Voltage | $I_{B}=5 \mathrm{~mA}, \quad I_{C}=50 \mathrm{~mA}$ | 1.2 | 1.2 | V |
| $h_{\text {ib }}$ | Small-Signal Common-Base Input Impedance | $V_{C B}=5 \mathrm{~V}, \quad \mathrm{l}=1 \mathrm{~mA}, \quad f=1 \mathrm{kHz}$ | $20 \quad 30$ | $20 \quad 30$ | $\Omega$ |
| $h_{\text {rb }}$ | Small-Signal Common-Base Reverse Voltage Transfer Ratio |  |  | $\underset{10^{-4}}{3 x}$ |  |
| hob | Smali-Signal Common-Base Output Admittance |  |  | 0.5 | $\mu \mathrm{mho}$ |
| $h_{\text {ie }}$ | Small-Signal Common-Emitter Input Impedance | $V_{C E}=5 \mathrm{~V}, \quad \mathrm{I}_{\mathrm{C}}=1 \mathrm{~mA}, \quad f=1 \mathrm{kHz}$ | 10004000 |  | $\Omega$ |
| $h_{\text {fe }}$ | Small-Signal Common-Emitter Forward Current Transfer Ratio |  | $50 \quad 150$ | 40200 |  |
| $h_{\text {Oe }}$ | Small-Signal Common-Emitter Output Admittance |  | 16 |  | $\mu \mathrm{mho}$ |
| \|hel | Small-Signal Common-Emitter Forward Current Transfer Ratio | $V_{C E}=10 \mathrm{~V}, \mathrm{I}^{\prime}=50 \mathrm{~mA}, f=20 \mathrm{MHz}$ | 3 | 2.5 |  |
| Cobo | Common-Base Open-Circuit Output Capacitance | $V_{C B}=10 \mathrm{~V}, \mathrm{I}_{\mathrm{E}}=0, \quad f=1 \mathrm{MHz}$ | 15 | 15 | pF |
| Cibo | Common-Base Open-Circuit Input Capacitance | $V_{E B}=0.5 \mathrm{~V}, \mathrm{I}_{\mathrm{C}}=0, \quad f=1 \mathrm{MHz}$ | 85 | 85 | pF |

triode matching characteristics

*operating characteristics at $25^{\circ} \mathrm{C}$ free-air temperature
individual triode characteristics (see note 6)

| PARAMETER | TEST CONDITIONS | $\begin{array}{\|c\|} \hline \text { 2N2060 } \\ \hline \text { MAX } \\ \hline \end{array}$ | UNIT |
| :---: | :---: | :---: | :---: |
| F Spot Noise Figure | $\mathrm{V}_{\text {CE }}=10 \mathrm{~V}, \mathrm{I}_{\mathrm{C}}=300 \mu \mathrm{~A}, \mathrm{R}_{\mathrm{G}}=510 \Omega, \mathrm{f}=1 \mathrm{kHz}$ | 8 | dB |
| F Average Noise Figure | $V_{C E}=10 \mathrm{~V}, \mathrm{I}_{\mathrm{C}}=300 \mu \mathrm{~A}, \mathrm{R}_{\mathrm{G}}=1 \mathrm{k} \Omega$, Noise Bandwidth $=15.7 \mathrm{kHz}$, See Note 9 | 8 | dB |

- JEDEC registered data


## FOR MEDIUM-POWER, GENERAL PURPOSE APPLICATIONS

- High Breakdown Voltage Combined with Low Saturation Voltage
- hFE ... Guaranteed from $10 \mu \mathrm{~A}$ to 1 A
mechanical data

absolute maximum ratings at $\mathbf{2 5}^{\circ} \mathbf{C}$ case temperature (unless otherwise noted)
Collector-Base Voltage ..... $120 V^{*}$
Collector-Emitter Voltage (See Note 1) ..... $65 V^{*}$
Collector-Emitter Voltage (See Note 2) ..... $80 V^{*}$
Emitter-Base Voltage ..... 7 V*
Continuous Collector Current ..... $1 A^{*}$
Continuous Device Dissipation at (or below) $\mathbf{2 5}{ }^{\circ} \mathrm{C}$ Free-Air Temperature (See Note 3) ..... 1 W*
Continuous Device Dissipation at (or below) $\mathbf{2 5}{ }^{\circ} \mathrm{C}$ Case Temperature (See Note 4) ..... $10 W^{\dagger}$
Storage Temperature Range ..... $-65^{\circ} \mathrm{C}$ to $200^{\circ} \mathrm{C}$ *
Lead Temperature 1/16 Inch from Case for 10 Seconds ..... $300^{\circ} \mathrm{C}^{*}$

NOTES: 1. This value applies when the base-emitter diode is open-circuited.
2. This value applies when the base-emitter resistance $\mathrm{R}_{\mathrm{BE}}<10 \Omega$.
3. Derate linearly to $200^{\circ} \mathrm{C}$ free-air temperature at the rate of $5.71 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$.
4. Derate the 10 -watt rating linearly to $200^{\circ} \mathrm{C}$ case temperature at the rate of $57.1 \mathrm{mw} /{ }^{\circ} \mathrm{C}$. Derate the 5 -watt (JEDEC registered) rating linearly to $200^{\circ} \mathrm{C}$ case temperature at the rate of $28.6 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$.

[^39]
## TYPES 2N2102, 2N2102A N-P-N SILICON TRANSISTORS

*electrical characteristics at $\mathbf{2 5}{ }^{\circ} \mathbf{C}$ case temperature (unless otherwise noted)


NOTES: 5. These parameters must be measured using pulse techniques. $\mathrm{t}_{\mathrm{w}}=\mathbf{3 0 0} \mu \mathrm{s}$, duty cycle $\leqslant \mathbf{2 \%}$.
6. $V_{R T}$ is determined by measuring the emitter-base floating potential, $V_{E B(f)}$. Collector-base voltage, $V_{C B}$, is increased until $V_{E B(f)}=1.5 \mathrm{~V}$; this value of $V_{C B}=\left(V_{R T}+1.5 \mathrm{~V}\right)$.

## *thermal characteristics

|  | PARAMETER | MAX | UNIT |
| :--- | :--- | :---: | :---: |
| $R_{\theta J C}$ | Junction-to-Case Thermal Resistance | 35 | ${ }^{\circ} \mathrm{CN}$ |
| $\mathbf{R}_{\theta \text { JA }}$ | Junction-to-Free-Air Thermal Resistance | 175 |  |

[^40]
# TYPES 2N2102, 2N2102A N-P-N SILICON TRANSISTORS 

## *operating charactaristics at $\mathbf{2 5}{ }^{\circ} \mathrm{C}$ case temperature

|  | PARAMETER | TEST CONDITIONS | MIN MAX | UNIT |
| :---: | :---: | :---: | :---: | :---: |
|  | Spot Noise Figure | $\begin{aligned} & V_{C E}=10 \mathrm{~V}, \quad \mathrm{IC}=0.3 \mathrm{~mA}, f=1 \mathrm{kHz}, \\ & R_{\mathrm{G}}=1 \mathrm{k} \Omega \end{aligned}$ | 6 | dB |

*switching characteristics at $\mathbf{2 5}{ }^{\circ} \mathrm{C}$ case temperature

| PARAMETER | TEST CONDITIONS | MIN | MAX | UNIT |
| :---: | :---: | :---: | :---: | :---: |
| t $\quad$ Total Switching Time | See Figure 1 | 30 | n 5 |  |

## *PARAMETER MEASUREMENT INFORMATION



FIGURE 1-SWITCHING TIME MEASUREMENT CIRCUIT

NOTES: 7. The input waveform is supplied by a mercury relay pulse generator with the following characteristica: $t_{r}<1 \mathrm{~ns}, \mathrm{t}_{\mathrm{f}}<\mathbf{1} \mathrm{ns}$, $t_{\text {w }}=15 \mathrm{~ns}, Z_{\text {out }}=50 \Omega$. Adjust R1 and the input pulse amplitude to obtain the specified voltege levels at Point $A$
8. Waveforms are monitored on a sampling oscilloscope ( $\mathrm{t}_{\mathrm{r}}<0.4 \mathrm{~ns}$ ) using a 2-k $\Omega$ probe.
*JEDEC registered data

## TYPES 2N1671, 2N1671A, 2N167BB, 2N2160 P-N BAR-TYPE SILICON UNLJUNCTION TRANSISTORS

Designed for Medium-Power Switching, Oscillator and Pulse Timing Circuits<br>- Highly Stable Negative Resistance<br>and Firing Voltage<br>- Low Firing Current<br>- High Pulse Current Capabilities<br>- Simplified Circuit Design

mechanical dafa
Package outline similar to JEDEC TO-5 except for lead position. Approximate weight 1 gram.

*absolute maximum ratings af $25^{\circ} \mathrm{C}$ free-air temperafure (unless otherwise noted)


NOTES: 1. Capocitor discharge $-10 \mu \mathrm{f}$ or less, 30 woits or less - fotal interbase power fissipation mest be limited by externat cirrultry.
2. Derole linearly to $140^{\circ} \mathrm{C}$ froe-air temperature of the rate of $3.9 \mathrm{mw} /{ }^{\circ} \mathrm{C}$. $\left\{2 \mathrm{~W} 1671\right.$ serias only, thermal resistence to cast $\left.=0.10^{\circ} \mathrm{C} / \mathrm{mm}.\right)$
3. Texas tastruments guarantees a maximum eqereting temperature of $175^{\circ} \mathrm{C}$ free-air. Berste lineorly at the refe of $3 \mathrm{mw} /{ }^{\circ} \mathrm{C}$.
4. Texes linstruments guarantees a maximum sterege femparature of $175^{\circ} \mathrm{C}$.
*Indicates JEDEC registerad dato

# TYPES 2N1671, 2N1671A, 2N1671B, 2N2160 P-N BAR-TYPE SILICON UNIJUNCTION TRANSISTORS 

*electrical charecteristics af $25^{\circ} \mathrm{C}$ free-alir temperafure

| PARAMETER |  | TEST COmpITIOMS | 20161671 |  | 2N1671A |  | 2N16718 |  | 2N2100 |  | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | MUN | MAX | Man | MAX | MIN | MAX | MIN | MAX |  |
| In |  |  | $v_{\text {en }}=3 v_{\text {g }} \mathrm{l}_{\mathrm{g}}=0$ | 4.7 | 9.1 | 4.7 | 1.1 | 4.7 | 4.1 | 4.1 | 12 | 10 |
| $\eta$ | Intriosk Stentert inetio | $\begin{aligned} & \operatorname{lngmal}=10 \% \\ & \operatorname{sen} \text { Fiyme } 1 \end{aligned}$ | 0.47 | 0.4 | 0.4 | 0.62 | 0.47 | 0.6 | 0.47 | 0.00 |  |
| Intmant | Movelated Intertere Curreal |  | 4.8 | 22 | 6.4 | 22 | 4.8 | 2 | 6.4 | 31 | $m$ |
| Itato | Emittor Rewown Curruat | $\mathrm{V}_{\mathrm{at}}=30 \mathrm{v}_{\mathrm{l}} \mathrm{m}_{\mathrm{m}}=0$ |  | -12 |  | -12 |  | -8.2 |  | -12 | $\mu 0$ |
| $t$. | Poum-Pinat Emither Corrout | $\mathrm{V}_{8 \mathrm{~m}}=8 \mathrm{~s}$ |  | 25 |  | 25 |  | 1 |  | 25 | $\mu$ |
|  | Emither Salvetion Vellage | $v_{\text {man }}=10 v_{0} 1_{5}=50 \mathrm{mo}$ |  | 5 |  | 5 |  | 5 |  |  | $\checkmark$ |
| Iv | Valley-Pidal Emither Comem |  | 1 |  | 4 |  | 1 |  | 1 |  | me |
| $V_{001}$ | Soso-0m Pat fube Yoltep | $y_{1}=20 y_{n}=20 \Omega$ <br> Son Fipun 1 |  |  | 3 |  | 3 |  | 3 |  | $v$ |

-Iadizates JEDEC registerad data

## PARAMETER MEASUREMENT INFORMATION



M1 $100 \mu \mathrm{~A}$ Full scole
$\boldsymbol{\eta}$-Intrinsic Standoff Ratio - This parameter is defined in terms of the peak-point valtage, $\mathbf{V}_{p}$, by means of the equation: $\mathbf{V}_{p} \boldsymbol{\eta}$ $V_{\text {min }}$, $V_{f}$, where $V_{f}$ is about 0.56 valt at $25^{\circ} \mathrm{C}$ and decreases with temperature at about 2 millivalts/deg.

The circuit used to measure $\eta$ is shown in the figure. In this cirevit, $R, C$, and $^{\text {a }}$ the unijunction transistor form a relaxation aseil lator, and the remainder of the circuit serves as a peak-valtage defector with the diode $D_{1}$ automatically subtrocting the voltage $V_{f}$. To use the circuit, the "cal" bumon is pushed, and $R_{3}$ is adjusted to make the current meter $M_{1}$ read full scale. The "cal" button then is released and the value of $\eta$ is read directly from the meter, with $\eta \quad$ l corresponding to fulliscale deflection of $100 \mu \mathrm{~A}$.
$D_{1}$ : 1MA57, or equivalent, with the following chaceateristics:
$V_{F}=0.565 \mathrm{~V}$ at $\mathrm{I}_{\mathrm{F}}=50 \mu \mathrm{~A}$,
$I_{R} \leq 2 \mu A$ of $V_{R}=20 V$
FIGURE 1 - TEST CIRCUIT FOR INTRINSIC STANDOFF RAIIO ( $\eta$ )


EMITTER-BASE-ONE VOLTAGE
VM
EMITTER CURRENT


FIGURE 3 - GENTRAL STATIC EMITTER CHARACTERISTIC CURVE

## FOR MEDIUM-POWER SWITCHING AND AMPLIFIER APPLICATIONS

- High Breakdown Voltage Combined with Very Low Saturation Voltage
- hFE-Guaranteed from $100 \mu$ a to 1 amp
mechanical data

absolute maximum ratings at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

|  | $\begin{array}{r} \hline \text { 2N2192 } \\ \text { 2N2192A } \\ \hline \end{array}$ | $\begin{array}{\|c\|} \hline \text { 2N2193 } \\ \text { 2N2193A } \\ \hline \end{array}$ | $\begin{array}{\|c\|} \hline \text { 2N2194 } \\ \text { 2N2194A } \\ \hline \end{array}$ | $\begin{gathered} \text { 2N2243 } \\ \text { 2N2243A } \\ \hline \end{gathered}$ | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: |
| Collector-Base Voltage | 60* | 80* | 60* | $120^{*}$ | $v$ |
| Collector-Emitter Voltage (See Note 1) | 40* | $50^{*}$ | 40* | 80* | $v$ |
| Emitter-Base Voltage | 5* | $8^{*}$ | 5 * | 7* | $v$ |
| Collector Current | $1^{*}$ | ${ }^{\text {² }}$ | $1^{*}$ | 1* | a |
| Total Device Dissipation at (or below) $25^{\circ} \mathrm{C}$ Free-Air Temperature-(See Note 2) | 0.8* | 0.8* | 0.8* | 0.8* | w |
| Total Device Dissipation at (or below) $25^{\circ} \mathrm{C}$ Case Temperature (See Note 3) | $\begin{array}{r} 10^{\dagger} \\ 2.8^{*} \\ \hline \end{array}$ | $\begin{array}{r} 10^{\dagger} \\ 2.8^{*} \\ \hline \end{array}$ | $\begin{array}{r} 10^{\dagger} \\ 2.8^{\prime \prime} \\ \hline \end{array}$ | $\begin{array}{r} 10^{\dagger} \\ 2.8^{*} \\ \hline \end{array}$ | w |
| Storage Temperature Range | $-65^{\circ} \mathrm{C}$ to $200^{\circ} \mathrm{C}^{\prime \prime}$ |  |  |  |  |
| Lead Temperature 1/16 Inch from Case for 10 Seconds | $300^{\circ} \mathrm{C}{ }^{*}$ |  |  |  |  |

NOTES: 1, This value applies when the base-emitter diode is open-circulted.
2. Derate linearly to $200^{\circ} \mathrm{C}$ free-air temperature at the rate of $4.57 \mathrm{mw} /{ }^{\circ} \mathrm{C}$.
3. Derate the 10 -watt rating linearly to $200^{\circ} \mathrm{C}$ cage temperature at the rate of $57.1 \mathrm{mw} /{ }^{\circ} \mathrm{C}$. Derate the 2.8 -watt (JEDEC registered) reting linearly to $200^{\circ} \mathrm{C}$ case temperature at the rate of $16 \mathrm{mw} /{ }^{\circ} \mathrm{C}$.

[^41]
## TYPES 2N2192, 2N2192A, 2N2193, 2N2193A, 2N2194, 2N2184A N-P-N SILICON TRAN8ISTORS

*electrical charactoristics af $28^{\circ} \mathrm{C}$ free-air tomporature (unless othorwise noted)

*switching characteristics at $25^{\circ} \mathrm{C}$ free-air temperature

| PARAMETER | TEST CONDITIONS | 2N2192 2N2192A <br> 2N2193 2N2193A <br> 2N2194 2N2194A | UNIT |
| :---: | :---: | :---: | :---: |
|  |  | MAX |  |
| $t_{\text {tr }} \quad$ Rise Time | See Figure 1 | 70 | nsec |
| $t_{3} \quad$ Storage Time |  | 150 | nsec |
| $t_{f} \quad$ Fall Time |  | 50 | nsec |

MOTE 4: These paramoters must te masured esing pulse texhmiqws. PW $=\mathbf{3 0 0} \mu \mathrm{sec}$, Duty Cycle $\leq \mathbf{2 \%}$.

[^42]
## TYPES 2N2192, 2N2192A, 2N2193, 2N2193A, 2N2194, 2N2194A N-P-N SILICON TRANSISTORS

## PARAMETER MEASUREMENT INFORMATION



See Notes a and b VOLTAGE WAVEFORMS

test circuit

CIRCUIT CONDITIONS

|  | 2N2192, 92A | 2N2193, 93A <br> 2N2194,94A |
| :---: | :---: | :---: |
| $\mathrm{V}_{1 \mathrm{~N}}$ | 7.5 V | 15 V |
| $\mathrm{~V}_{\mathrm{B}}$ | 7.5 V | 15 V |

*FIEURE 1 - SWITCHINE TIMES - $i_{\text {r }}, t_{p} t_{s}$

NOTES: a. The input waveform is supplied by a generator with the following characteristics: $t_{r}=20 \boldsymbol{n s e c}, t_{f}=20 \mathrm{nsec}, \boldsymbol{Z}_{\text {out }}=50 \boldsymbol{\Omega}$, $\mathrm{PW}=10 \mu \mathrm{sec}, \mathrm{PRR}=\mathbf{5 k c}$.
b. Waveforms are monitored on an oscilloscope with the following characteristics: $t_{r} \leqslant 14 \mathrm{nsec}, \mathrm{R}_{\text {in }}=10 \mathrm{M} \Omega$. $\mathrm{C}_{\text {in }}=11.5 \mathrm{pf}$. *Indicates JEDEC registered data

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# SILECT ${ }^{\dagger}$ TRANSISTORS $\ddagger$ FOR MEDIUM-POWER SWITCHING AND AMPLIFIER APPLICATIONS 

- High V(BR)CBO ... 80 V Min (A5T2193)
- hFE Guaranteed from $100 \mu \mathrm{~A}$ to 1 A
- fT . . . 50 MHz Min
- Electrically Similar to 2N2192A, 2N2193A


## mechanical data

These transistors are encapsulated in a plastic compound specifically designed for this purpose, using a highly mechanized process developed by Texas Instruments. The case will withstand soldering temperatures without deformation. These devices exhibit stable characteristics under high-humidity conditions and are capable of meeting MIL-STD-202C, Method 106B. The transistors are insensitive to light.

absolute maximum ratings at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

| A5T2192 | A5T2193 |
| :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- |

NOTES: 1. These values apply when the base-emitter diode is open-circuited.
2. Derate linearly to $150^{\circ} \mathrm{C}$ free-air temperature at the rate of $5 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$.
3. Derse linearly to $150^{\circ} \mathrm{C}$ lead temperature at the rate of $10 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$. Lead temperature is measured on the collector lead $\mathbf{1 / 1 6}$ inch from the case.
4. This rating applies with the entire case (including the leads) maintained at $25^{\circ} \mathrm{C}$. Derate linearly to $150^{\circ} \mathrm{C}$ case-and-lead temperature at the rate of $12.8 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$.
$\dagger$ Trademark of Texas Instruments USES CHIP N23
$\ddagger$ U.S. Patent No. 3,439,238

## TYPES A5T2192, A5T2193

N-P-N SILICON TRANSISTORS
electrical characteristics at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

| Parameter | TEST CONDITIONS | A5T2192 | A5T2193 | UNIT |
| :---: | :---: | :---: | :---: | :---: |
|  |  | MIN MAX | MIN MAX |  |
| $\mathrm{V}_{\text {(BR) }}$ CBO Collector-Base Breakdown Voltage | $\mathrm{I}_{\mathrm{C}}=100 \mu \mathrm{~A}, \mathrm{I}_{\mathrm{E}}=0$ | 60 | 80 | $v$ |
| $V_{\text {(BR)CEO }}$ Collector-Emitter Breakdown Voltage | $\mathrm{I}^{\prime}=25 \mathrm{~mA}, \quad \mathrm{I}_{\mathrm{B}}=0, \quad$ See Note 5 | 40 | 50 | v |
| $\mathrm{V}_{\text {(BR)EBO }}$ Emitter-Base Breakdown Voltage | $\mathrm{I}_{\mathrm{E}}=100 \mu \mathrm{~A}, \mathrm{I}^{\prime}=0$ | 5 | 8 | V |
| Coilector Cutoff Current | $\mathrm{V}_{C B}=30 \mathrm{~V}, \mathrm{I}_{\mathrm{E}}=0$ | 10 |  | nA |
|  | $V_{C B}=30 \mathrm{~V}, \mathrm{I}_{\mathrm{E}}=0, \quad \mathrm{~T}_{\mathrm{A}}=100^{\circ} \mathrm{C}$ | 1 |  | $\mu \mathrm{A}$ |
|  | $\mathrm{V}_{\mathrm{CB}}=60 \mathrm{~V}, \mathrm{I}_{\mathrm{E}}=0$ |  | 10 | nA |
|  | $V_{C B}=60 \mathrm{~V}, \mathrm{I}_{\mathrm{E}}=0, \quad \mathrm{~T}_{\mathrm{A}}=100^{\circ} \mathrm{C}$ |  | 2 | $\mu \mathrm{A}$ |
| Emitter Cutoff Current | $V_{E B}=3 V_{\text {, }} \quad I_{C}=0$ | 50 |  | nA |
|  | $V_{E B}=5 \mathrm{~V}$, $\mathrm{IC}^{\prime}=0$ |  | 50 |  |
| Static Forward Current <br> Transfer Ratio | $V_{C E}=10 \mathrm{~V}, \mathrm{IC}=100 \mu \mathrm{~A}$ | 15 | 15 |  |
|  | $\mathrm{V}_{C E}=10 \mathrm{~V}, \mathrm{I}^{\text {C }}=10 \mathrm{~mA}$ | 75 | 30 |  |
|  | V $\mathrm{V}_{\text {CE }}=10 \mathrm{~V}, 1 \mathrm{IC}=150 \mathrm{~mA}$ | 100 300 | $40 \quad 120$ |  |
|  | $\mathrm{V}_{\text {CE }}=10 \mathrm{~V}, \mathrm{I}_{\mathrm{C}}=500 \mathrm{~mA}$ See Note 5 | 35 | 20 |  |
|  | $\mathrm{V}_{\text {CE }}=10 \mathrm{~V}, \mathrm{IC}^{\prime}=1 \mathrm{~A}$ | 15 | 15 |  |
|  | $\mathrm{V}_{\text {CE }}=1 \mathrm{~V}, \mathrm{I}^{\prime} \mathrm{C}=150 \mathrm{~mA}$ | 70 | 30 |  |
| VBE Base-Emitter Voltage | $\mathrm{I}_{\mathrm{B}}=15 \mathrm{~mA}, \quad \mathrm{I}_{\mathrm{C}}=150 \mathrm{~mA}$, See Note 5 | 1.3 | 1.3 | V |
| $\mathrm{V}_{\text {CEI }}$ sat) Collector-Emitter Saturation Voltage | $\mathrm{I}_{\mathrm{B}}=15 \mathrm{~mA}, \mathrm{I}_{\mathrm{C}}=150 \mathrm{~mA}$, See Note 5 | 0.25 | 0.25 | v |
| $\mathbf{h}_{\text {fel }}$ Small-Signal Common-Emitter <br> Forward Current Transfer Ratio | $\mathrm{V}_{C E}=10 \mathrm{~V}, \mathrm{IC}=50 \mathrm{~mA}, \mathrm{f}=20 \mathrm{MHz}$ | 2.5 | 2.5 |  |
| cobo $\begin{aligned} & \text { Common-Base Open-Circuit } \\ & \text { Output Capacitance }\end{aligned}$ | $V_{C B}=10 \mathrm{~V}, \mathrm{I}_{\mathrm{E}}=0, \quad f=1 \mathrm{MHz}$ | 20 | 20 | pF |

switching characteristics at $25^{\circ} \mathrm{C}$ free-air temperature

| PARAMETER | TEST CONDITIONS | A5T2192 | A5T2193 | UNIT |
| :---: | :---: | :---: | :---: | :---: |
|  |  | MIN MAX | MIN MAX |  |
| ${ }_{4}$ H Rise Time | See Figure 1 | 70 | 70 | ns |
| $t_{s} \quad$ Storage Time |  | 150 | 150 | ns |
| $\mathrm{t}_{\mathrm{f}}$ ( Fall Time |  | 50 | 50 | ns |

NOTE 5: These parameters must be measured using pulse techniques. $t_{w}=300 \mu \mathrm{~s}$, duty cycle $\leqslant 2 \%$.


NOTES: a. The input waveform is supplied by a generator with the following characteristics: $t_{r}=20 \mathrm{~ns}, \mathrm{t}_{\mathrm{f}}=20 \mathrm{~ns}, \mathrm{Z}_{\text {out }}=50 \Omega, \mathrm{t}_{\mathrm{w}}=\mathbf{2}=\boldsymbol{1 0} \mu_{\text {, }}$ $P R R=5 \mathrm{kHz}$.
b. Waveforms are monitored on an oscilloscope with the following charactaristics: $t_{r} \leqslant 14 \mathrm{~ns}, \mathrm{R}_{\mathrm{in}}=10 \mathrm{M} \Omega, \mathrm{C}_{\mathrm{in}}=11.5 \mathrm{pF}$.

# TYPES 2N2217 THRU 2N2222, 2N2218A, 2N2219A, 2N2221A, 2N2222A <br> N-P-N SILICON TRANSISTORS 

BULLETIN NO. DL-S 7311916, MARCH 1973

## DESIGNED FOR HIGH-SPEED, MEDIUM-POWER SWITCHING AND GENERAL PURPOSE AMPLIFIER APPLICATIONS

- hFE .. . Guaranteed from $\mathbf{1 0 0} \mu \mathrm{A}$ to $\mathbf{5 0 0} \mathrm{mA}$
- High fT at 20 V, 20 mA . . 300 MHz (2N2219A, 2N2222A) 250 MHz (all others)
- 2N2218, 2N2221 for Complementary Use with 2N2904, 2N2906
- 2N2219, 2N2222 for Complementary Use with 2N2905, 2N2906
*mechanical data
Device types 2N2217, 2N2218, 2N2218A, 2N2219, and 2N2219A are in JEDEC TO-5 packages.
Device types 2N2220, 2N2221, 2N2221A, 2N2222, and 2N2222A are in JEDEC TO-18 packages.

*absolute maximum ratings at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

|  | $\begin{array}{\|l\|} \hline \text { 2N2217 } \\ \text { 2N2218 } \\ \text { 2N2219 } \end{array}$ | $\left\lvert\, \begin{aligned} & \text { 2N2218A } \\ & \text { 2N2219A } \end{aligned}\right.$ | $\begin{array}{\|l\|} \hline \text { 2N2220 } \\ \text { 2N2221 } \\ \text { 2N2222 } \end{array}$ | $\left\lvert\, \begin{aligned} & \text { 2N2221A } \\ & \text { 2N2222A } \end{aligned}\right.$ | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: |
| Collector-Base Voltage | 60 | 75 | 60 | 75 | V |
| Collector-Emitter Voltage (See Note 1) | 30 | 40 | 30 | 40 | V |
| Emitter-Base Voltage | 5 | 6 | 5 | 6 | V |
| Continuous Collector Current | 0.8 | 0.8 | 0.8 | 0.8 | A |
| Continuous Device Dissipation at (or below) $25^{\circ} \mathrm{C}$ Free-Air Temperature (See Notes 2 and 3) | 0.8 | 0.8 | 0.5 | 0.5 | W |
| Continuous Device Dissipation at (or below) $25^{\circ} \mathrm{C}$ Case Temperature (See Notes 4 and 5) | 3 | 3 | 1.8 | 1.8 | W |
| Operating Collector Junction Temperature Range | -65 to 175 |  |  |  | C |
| Storage Temperature Range | -65 to 200 |  |  |  | C |
| Lead Temperature 1/16 Inch from Case for 10 Seconds | 230 |  |  |  | C |

NOTES: 1. Thesa values apply between 0 and 500 mA collector current when the base-emitter diode is open-circuited.
2. Derate $2 N 2217,2 N 2218,2 N 2218 A, 2 N 2219$, and $2 N 2219 A$ linearly to $175^{\circ} \mathrm{C}$ free-air temperature at the rate of $5.33 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$.
3. Derate 2 N2 220, 2 N2221, $2 N 2221 A, 2 N 2222$, and $2 N 2222 A$ linearly to $175^{\circ} \mathrm{C}$ free-air temperature at the rate of $3.33 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$.
4. Derate 2 N2217, $2 N 2218,2 N 2218 A, 2 N 2219$, and $2 N 2219 A$ linearly to $175^{\circ} \mathrm{C}$ case temperature at the rate of $20.0 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$.
5. Derate $2 N 2220,2 N 2221,2 N 2221 A, 2 N 2222$, and $2 N 2222 A$ linearly to $176^{\circ} \mathrm{C}$ case temperature at the rate of $12.0 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$.

- JEDEC registered data. This data sheet contains all applicable registered data in effect at the time of publication.

USES CHIP N24

## TYPES 2N2217 THRU 2N2222, 2N2218A, 2N2219A, 2N2221A, 2N2222A N-P-N SILICON TRANSISTORS

## 2N2217 THRU 2N2222

*electrical characteristics at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

| PARAMETER |  | TEST CONDITIONS | $\begin{aligned} & \text { TO-5 } \rightarrow \\ & \text { TO-18 } \rightarrow \end{aligned}$ | $\begin{aligned} & \hline \text { 2N2217 } \\ & \hline \text { 2N2220 } \\ & \hline \end{aligned}$ |  | $\begin{aligned} & \hline \text { 2N2218 } \\ & \hline \text { 2N2221 } \\ & \hline \end{aligned}$ |  | $\begin{aligned} & \text { 2N2219 } \\ & \hline \text { 2N2222 } \end{aligned}$ |  | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  |  |  |  |  |  |  |
|  |  | MIN |  | MAX | MIN | MAX | MIN | MAX |  |
| $\mathrm{V}_{\text {(BR) } \mathrm{CBO}}$ | Collector-Base <br> Breakdown Voltage |  | $\mathrm{I}^{\prime}=10 \mu \mathrm{~A}, \quad \mathrm{I}_{\mathrm{E}}=0$ |  | 60 |  | 60 |  | 60 |  | $v$ |
| $V_{\text {(BR)CEO }}$ | Collector-Emitter | $\mathrm{I}^{\prime}=10 \mathrm{~mA}, \mathrm{I}_{\mathrm{B}}=0$. | See Note 6 | 30 |  | 30 |  | 30 |  | $v$ |
|  | Breakdown Voltage |  |  |  |  |  |  |  |  |  |
| $V_{\text {(bR)Ebo }}$ | Emitter-Base <br> Breakdown Voltage | $\mathrm{I}_{\mathrm{E}}=10 \mu \mathrm{~A}, ~ \mathrm{I}_{\mathrm{C}}=0$ |  | 5 |  | 5 |  | 5 |  | v |
|  | Collector Cutoff Current | $\mathrm{V}_{C B}=50 \mathrm{~V}, \mathrm{I}_{\mathrm{E}}=0$ |  | 10 |  | 10 |  | 10 |  | nA |
|  |  | $\begin{array}{ll}\mathrm{V}_{C B}=50 \mathrm{~V}, \mathrm{I}_{\mathrm{E}}=0, & \mathrm{~T}_{A}=150^{\circ} \mathrm{C} \\ \mathrm{V}_{E B}=3 \mathrm{~V}, \mathrm{I}^{\prime}=0 & \end{array}$ |  | 10 |  | 10 |  | 10 |  | $\mu \mathrm{A}$ |
| IEBO | Emitter Cutoff Current |  |  |  | 10 | 10 |  |  | 10 | $\stackrel{\mu}{n} \mathrm{~A}$ |
| hfe | Static Forward Current <br> Transfer Ratio | $\mathrm{V}_{\mathrm{CE}}=10 \mathrm{~V}, \mathrm{I}^{\text {C }}=100 \mu \mathrm{~A}$ |  |  |  | 20 |  | 35 |  |  |
|  |  | $V_{C E}=10 \mathrm{~V}, \mathrm{C}=1 \mathrm{~mA}$ |  | 12 |  | 25 |  | 50 |  |  |
|  |  | $\begin{array}{\|l\|} \hline V_{C E}=10 \mathrm{~V}, I_{C}=150 \mathrm{~mA} \\ V_{C E}=10 \mathrm{~V}, \mathrm{I}_{\mathrm{C}}=500 \mathrm{~mA} \\ \hline \end{array}$ | See Note 6 | 17 |  | 35 |  | 75 |  |  |
|  |  |  |  | 20 | 60 | 40 | 120 | $100 \quad 300$ |  |  |
|  |  |  |  |  |  | 20 |  | 30 |  |  |
|  |  | $\mathrm{V}_{\mathrm{CE}}=1 \mathrm{~V}, \mathrm{I}_{\mathrm{C}}=150 \mathrm{~mA}$ |  | 10 |  | 20 |  | 50 |  |  |
| $V_{\text {be }}$ | Base-Emitter Voltage | $\mathrm{I}_{\mathrm{B}}=15 \mathrm{~mA}, \mathrm{I}_{\mathrm{C}}=150 \mathrm{~mA}$ | See Note 6 | 1.3 |  | 1.3 |  | 1.3 |  | $\checkmark$ |
|  |  | $\mathrm{I}_{\mathrm{B}}=50 \mathrm{~mA}, \mathrm{I}_{\mathrm{C}}=500 \mathrm{~mA}$ |  |  |  |  | 2.6 |  | 2.6 |  |
| $V_{\text {CE }}$ (sat) | Collector-Emitter Saturation Voltage | $\mathrm{I}_{\mathrm{B}}=15 \mathrm{~mA}, \mathrm{I}_{\mathrm{C}}=150 \mathrm{~mA}$ | See Note 6 |  | 0.4 |  | 0.4 |  | 0.4 | $\checkmark$ |
|  |  | $\mathrm{I}_{\mathrm{B}}=50 \mathrm{~mA}, \mathrm{I}^{\prime}=500 \mathrm{~mA}$ |  |  |  |  | 1.6 |  | 1.6 |  |
| Pfel | Small-Signal <br> Common-Emitter <br> Forward Current <br> Transfer Ratio | $V_{C E}=20 \mathrm{~V}, I_{C}=20 \mathrm{~mA}, f=100 \mathrm{MHz}$ |  | 2.5 |  | 2.5 |  | 2.5 |  |  |
| ${ }_{\text {f }}$ | Transition Frequency | $\mathrm{V}_{\text {CE }}=20 \mathrm{~V}, \mathrm{IC}=20 \mathrm{~mA}$, | See Note 7 | 250 |  | 250 |  | 250 |  | MHz |
| Cobo | Common-Base <br> Open-Circuit <br> Output Capacitance | $V_{C B}=10 \mathrm{~V}, \mathrm{l}_{\mathrm{E}}=0, \quad \mathrm{f}=1 \mathrm{MHz}$ |  | 8 |  | 8 |  | 8 |  | pF |
| $h_{\text {ielreal }}$ | Real Part of Small-Signal Common-Emitter Input Impedance | $V_{C E}=20 \mathrm{~V}, 1 \mathrm{C}=20 \mathrm{~mA}, f=300 \mathrm{MHz}$ |  | 60 |  | 60 |  | 60 |  | $\Omega$ |

NOTES: 6. These parameters must be measured using puise techniques. $t_{w}=300 \mu \mathrm{~s}$, duty cycle $\leqslant 2 \%$.
7. To obtain $f_{T}$, the $h_{\text {fe }}$ l response with frequency is extrapolated at the rate of -6 dB per octave from $f=100 \mathrm{MHz}$ to the frequency at which $h_{f e} l=1$.
switching characteristics at $25^{\circ} \mathrm{C}$ free-air temperature

| PARAMETER |  | TEST CONDITIONS ${ }^{\text { }}$ |  |  | TYP | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| $\mathrm{t}_{\mathrm{d}}$ | Delay Time | $\mathrm{V}_{\mathrm{CC}}=30 \mathrm{~V}$, $\mathrm{I}_{\mathrm{C}}=150 \mathrm{~mA}$, <br> $\mathrm{V}_{\mathrm{BE}(\mathrm{Off})}=-0.5 \mathrm{~V}$, $=15 \mathrm{~mA}$, <br> $\mathrm{V}_{\mathrm{CC}}$  <br> See Figure 1 , |  |  | 5 | ns |
| $t_{\text {tr }}$ | Rise Time |  |  |  | 15 | ns |
| ${ }_{\text {t }}$ | Storage Time | $\mathrm{V}_{\mathrm{CC}}=30 \mathrm{~V}$, $\mathrm{IC}=150 \mathrm{~mA}$, <br> $\mathrm{I}_{\mathrm{B}(2)}=-15 \mathrm{~mA}(1)=15 \mathrm{~mA}$,  <br> See Figure 2  |  |  | 190 | ns |
| ${ }_{\text {t }}$ | Fall Time |  |  |  | 23 | ns |

[^43]
## TYPES 2N2217 THRU 2N2222, 2N2218A, 2N2219A, 2N2221A, 2N2222A N-P-N SILICON TRANSISTORS

## 2N2218A, 2N2219A, 2N2221A, 2N2222A

*electrical characteristics at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

| PARAMETER |  | TEST CONDITIONS | TO-5 $\rightarrow$ | 2N2218A |  | 2N2219A |  | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | TO-18 $\rightarrow$ | 2N2221A |  | 2N2222A |  |  |
|  |  | MIN | MAX | MIN | MAX |  |  |
| $V_{\text {(BR) }}$ CBO | Collector-Base Breakdown Voltage |  | $I_{C}=10 \mu A, \quad I_{E}=0$ |  | 75 |  | 75 |  | V |
| $V_{\text {(BR)CEO }}$ | Collector-Emitter Breakdown Voitage | $I_{C}=10 \mathrm{~mA}, I_{B}=0$, | See Note 6 | 40 |  | 40 |  | V |
| V(BR)EBO | Emitter-Base Breakdown Voltage | $I_{E}=10 \mu A, I_{C}=0$ |  | 6 |  | 6 |  | V |
| ICBO | Collector Cutoff Current | $V_{C B}=60 \mathrm{~V}, \mathrm{IE}_{\mathrm{E}}=0$ |  |  | 10 |  | 10 | nA |
|  |  | $V_{C B}=60 \mathrm{~V}, \mathrm{I}_{\mathrm{E}}=0$, | $T_{A}=150^{\circ} \mathrm{C}$ |  | 10 |  | 10 | $\mu \mathrm{A}$ |
| lcev | Collector Cutoff Current | $V_{C E}=60 \mathrm{~V}, V_{B E}=-3 \mathrm{~V}$ |  |  | 10 |  | 10 | nA |
| IBEV | Base Cutoff Current | $V_{C E}=60 \mathrm{~V}, \mathrm{~V}_{\mathrm{BE}}=-3 \mathrm{~V}$ |  |  | -20 |  | -20 | nA |
| IE8O | Emitter Cutoff Current | $V_{E B}=3 \mathrm{~V}, \mathrm{I}^{2}=0$ |  |  | 10 |  | 10 | nA |
| hfe | Stetic Forwerd Current Transfer Ratio | $V_{C E}=10 \mathrm{~V}, \mathrm{I}_{\mathrm{C}}=100 \mu \mathrm{~A}$ |  | 20 |  | 35 |  |  |
|  |  | $V_{C E}=10 \mathrm{~V}, \mathrm{I}_{\mathrm{C}}=1 \mathrm{~mA}$ |  | 25 |  | 50 |  |  |
|  |  | $V_{\text {CE }}=10 \mathrm{~V}, \mathrm{I}^{\text {C }}=10 \mathrm{~mA}$ | See Note 6 | 35 |  | 75 |  |  |
|  |  | $\mathrm{V}_{\text {CE }}=10 \mathrm{~V}, \mathrm{I}_{\mathrm{C}}=150 \mathrm{~mA}$ |  | 40 | 120 | 100 | 300 |  |
|  |  | $V_{C E}=10 \mathrm{~V}, 1 \mathrm{C}=500 \mathrm{~mA}$ |  | 25 |  | 40 |  |  |
|  |  | $V_{C E}=1 \mathrm{~V}, I_{C}=150 \mathrm{~mA}$ |  | 20 |  | 50 |  |  |
|  |  | $\begin{aligned} & V_{C E}=10 \mathrm{~V}, I_{C}=10 \mathrm{~mA}, \\ & T_{A}=-55^{\circ} \mathrm{C} \end{aligned}$ |  | 15 |  | 35 |  |  |
| VeE | Base-Emitter Voltage | $\mathrm{I}_{\mathrm{B}}=15 \mathrm{~mA}, \mathrm{I}^{\prime}=150 \mathrm{~mA}$ | See Note 6 | 0.6 | 1.2 | 0.6 | 1.2 | $V$ |
|  |  | $I_{B}=50 \mathrm{~mA}, I_{C}=500 \mathrm{~mA}$ |  |  | 2 |  | 2 |  |
| VCEisat) | Collector-Emitter Saturation Voltage | $\mathrm{I}_{B}=15 \mathrm{~mA}, I^{\prime}=150 \mathrm{~mA}$ | See Note 6 |  | 0.3 |  | 0.3 | V |
|  |  | $I_{B}=50 \mathrm{~mA}, I_{C}=500 \mathrm{~mA}$ |  |  | 1 |  | 1 |  |
| $h_{\text {ise }}$ | Small-Signal Common-Emitter Input Impedence | $V_{C E}=10 \mathrm{~V}, I^{\prime}=1 \mathrm{~mA}$ | $\mathrm{f}=1 \mathrm{kHz}$ | 1 | 3.5 | 2 | 8 | $k \Omega$ |
|  |  | $V_{C E}=10 \mathrm{~V}, I_{C}=10 \mathrm{~mA}$ |  | 0.2 | 1 | 0.25 | 1.25 |  |
| $\mathrm{hfa}_{\text {fa }}$ | Small-Signal Forward Current Transfer Ratio | $V_{C E}=10 \mathrm{~V}, I_{C}=1 \mathrm{~mA}$ |  | 30 | 150 | 50 | 300 |  |
|  |  | $V_{C E}=10 \mathrm{~V}, \mathrm{I}_{\mathrm{C}}=10 \mathrm{~mA}$ |  | 50 | 300 | 75 | 375 |  |
| $h_{\text {re }}$ | Smail-Signal Common-Emitter Reverse Voltage Transfer Ratio | $V_{C E}=10 \mathrm{~V}, I_{C}=1 \mathrm{~mA}$ |  |  | $5 \times 10^{-4}$ |  | $8 \times 10^{-4}$ |  |
|  |  | $V_{C E}=10 \mathrm{~V}, I_{C}=10 \mathrm{~mA}$ |  |  | $2.5 \times 10^{-4}$ |  | $4 \times 10^{-4}$ |  |
| $h_{\text {ce }}$ | Small-Signal Common-Emitter Output Admittance | $V_{C E}=10 \mathrm{~V}, I_{C}=1 \mathrm{~mA}$ |  | 3 | 15 | 5 | 35 | $\mu \mathrm{mho}$ |
|  |  | $V_{C E}=10 \mathrm{~V}, I^{\prime}=10 \mathrm{~mA}$ |  | 10 | 100 | 25 | 200 |  |
| Mfel | Small-Signal Common-Emitter Forward Current Tranafer Ratio | $V_{C E}=20 \mathrm{~V}, 1 \mathrm{C}=20 \mathrm{~mA}$, | $f=100 \mathrm{MHz}$ | 2.5 |  | 3 |  |  |
| 4 | Transition Frequency | $V_{C E}=20 \mathrm{~V}, 1 \mathrm{C}=20 \mathrm{~mA}$, | See Note 7 | 250 |  | 300 |  | MHz |
| Cobo | Common-Base Open-Circuit Output Capacitance | $V_{C B}=10 \mathrm{~V}, \mathrm{I}_{\mathrm{E}}=0$, | $f=100 \mathrm{kHz}$ |  | 8 |  | 8 | pF |
| $\mathrm{C}_{\text {ibo }}$ | Common-Bese Open-Circuit Input Capacitance | $V_{E E}=0.5 \mathrm{~V}, \mathrm{I}_{\mathrm{C}}=0$, | $\mathrm{f}=100 \mathrm{kHz}$ |  | 25 |  | 25 | pF |
| $h_{\text {iel }}$ (real) | Real Part of Small-Signal Common-Emitter Input Impedance | $V_{C E}=20 \mathrm{~V}, \mathrm{I}_{\mathrm{C}}=20 \mathrm{~mA}$, | $f=300 \mathrm{MHz}$ |  | 60 |  | 60 | $\Omega$ |
| $\mathrm{rb}_{\mathrm{b}}{ }^{\text {c }}{ }_{c}$ | Collector-Base Time Constant | $V_{C E}=20 \mathrm{~V}, \mathrm{I}^{\prime}=20 \mathrm{~mA}$, | $f=31.8 \mathrm{MHz}$ |  | 150 |  | 150 | ps |

NOTES: 6. Theas permeters must be measured using pulse techniques. $t_{w}=300 \mu s$, duty cycle $<2 \%$.
7. To obtain $\mathrm{f}_{\mathrm{T}}$, the $\mathrm{M}_{\mathrm{f}}$ el remponse with frequency is extrapolated at the rate of $-\mathbf{6 d B}$ per octave from $\mathrm{f}=100 \mathrm{MHz}$ to the frequency at which $\left|h_{f o}\right|=1$.

## - JEDEC registered data

## TYPES 2N2217 THRU 2N2222, 2N2218A, 2N2219A, 2N2221A, 2N2222A N-P-N SILICON TRANSISTORS

## *operating characteristics at $\mathbf{2 5}{ }^{\circ} \mathrm{C}$ free-air temperature

| PARAMETER | TEST CONDITIONS | 2N2218A | 2N2219A | UNIT |
| :---: | :---: | :---: | :---: | :---: |
|  |  | 2N2221A | 2N2222A |  |
|  |  | MAX | MAX |  |
| F Spot Noise Figure | $V_{C E}=10 \mathrm{~V}, \mathrm{I}_{\mathrm{C}}=100 \mu \mathrm{~A}, \mathrm{R}_{\mathrm{G}}=1 \mathrm{k} \Omega, \mathrm{f}=1 \mathrm{kHz}$ |  | 4 | dB |

*switching characteristics at $25^{\circ} \mathrm{C}$ free-air temperature

| PARAMETER | TEST CONDITIONS ${ }^{\dagger}$ | TO-5 $\rightarrow$ | 2N2218A | 2N2219A | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | TO-18 $\rightarrow$ | 2N2221A | 2N2222A |  |
|  |  |  | MAX | MAX |  |
| t ${ }_{\text {d }}$ Delay Time | $\begin{aligned} & V_{C C}=30 \mathrm{~V}, \quad I C=150 \mathrm{~mA}, \\ & V_{B E(\text { off })}=-0.5 \mathrm{~V}, \end{aligned}$ | $I_{B(1)}=15 \mathrm{~mA},$ <br> See Figure 1 | 10 | 10 | ns |
| $\mathrm{If}_{\mathbf{r}}$ Rise Time |  |  | 25 | 26 | ns |
| ${ }^{\text {r A A Active Region Time Constant }} \ddagger$ |  |  | 2.5 | 2.5 | ns |
| $\mathrm{t}_{\mathbf{3}}$ Storage Time | $\begin{aligned} & V_{C C}=30 V, \quad I_{C}=150 \mathrm{~mA}, \\ & I_{B(2)}=-15 m A \end{aligned}$ | $I_{\mathrm{B}}(1)=15 \mathrm{~mA} \text {, }$ <br> See Figure 2 | 225 | 225 | ns |
| tf Fall Time |  |  | 60 | 60 | ns |

tVoltege and current values shown are nominal; exact values vary silghty with translator parameters.
\#Under the given conditions $\tau_{A}$ is equal to $\frac{t_{r}}{10}$.
*PARAMETER MEASUREMENT INFORMATION


FIGURE 1-DELAY AND RISE TIMES


NOTES: a. The input waveforms have the following characteristica: For Figure $1, \mathrm{t}_{\mathrm{r}}<\mathbf{2} \mathrm{ns}, \mathrm{t}_{\mathrm{w}}<\mathbf{2 0 0} \mathrm{ns}$, duty eycle $<\mathbf{2 \%}$; for Figure $\mathbf{2}$ $t_{f} \leqslant 5 \mathrm{~ns}, \mathrm{t}_{\mathrm{w}} \approx 100 \mu \mathrm{~s}$, duty evcie $\leqslant 17 \%$.
b. All waveforme are monitored on an oscilloscope with the following characteristics: $\mathrm{t}_{\mathrm{r}} \leqslant 5 \mathrm{~ns}, \mathrm{R}_{\mathrm{In}} \geqslant 100 \mathrm{k} \Omega, \mathrm{C}_{\mathrm{in}} \leqslant 12 \mathrm{pF}$.
*JEDEC registered data

## TYPES D2T2218, D2T2218A, D2T2219, D2T2219A DUAL N-P-N SILICON TRANSISTORS

## TWO GENERAL PURPOSE TRANSISTORS IN ONE PACKAGE

- Each Triode Electrically Simliar to 2N2218, 2N2218A, 2N2219, 2N2219A Transistors
- For Complementary Use with D2T2904, D2T2904A, D2T2905, D2T2905A Dual P-N-P Transistors
mechanical data

absolute maximum ratings at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

|  |  | $\begin{aligned} & \hline \text { D2T2218 } \\ & \text { D2T2219 } \end{aligned}$ | $\begin{aligned} & \text { D2T2218A } \\ & \text { D2T2219A } \end{aligned}$ | UNIT |
| :---: | :---: | :---: | :---: | :---: |
| Collector-Base Voltage |  | 60 | 75 | V |
| Collector-Emitter Voltage (See Note 1) |  | 30 | 40 | V |
| Emitter-Base Voltage |  | 5 | 6 | V |
| Continuous Collector Current |  | 800 |  | mA |
| Continuous Device Dissipation at (or below) $25^{\circ} \mathrm{C}$ | Each Triode |  |  | mW |
| Free-Air Temperature (See Note 2) | Total Device | 600 |  |  |
| Continuous Device Dissipation at (or below) $25^{\circ} \mathrm{C}$ | Each Triode | 1 |  | W |
| Case Temperature (See Note 3) | Total Device |  |  |  |
| Storage Temperature Range |  | -65 to 200 |  | C |
| Lead Temperature 1/16 Inch from Case for 10 Seconds |  | 300 |  | C |

NOTES: 1. These values apply batween 0 and $\mathbf{5 0 0} \mathrm{mA}$ collector current when the bese-emitter is open-clrcuited.
2. Derate ilnearly to $200^{\circ} \mathrm{C}$ fres-air tempersture at the rate of $2.28 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$ for each triode and $3.43 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$ for the total device.
3. Derate linearly to $200^{\circ} \mathrm{C}$ cese temperature ot the rates of $5.7 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$ for each triode and $11.4 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$ for the total devica.

## TYPES D2T2218, D2T2218A, D2T2219, D2T2219A <br> DUAL N-P-N SILICON TRANSISTORS

## D2T2218, D2T2219 <br> electrical characteristics at $\mathbf{2 5}{ }^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

| PARAMETER | TEST CONDITIONS |  | D2T2218 | D2T2219 | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  | MIN MAX | MIN MAX |  |
| $\mathrm{V}_{(B R)}$ CBO Collector-Base Breakdown Voltage | $I_{C}=10 \mu A, \quad I_{E}=0$ |  | 60 | 60 | V |
| $\bar{V}_{(B R) C E O}$ Collector-Emitter Breakdown Voltage | $\mathrm{I}^{\prime} \mathrm{C}=10 \mathrm{~mA}, \quad \mathrm{I}_{\mathrm{B}}=0$, | See Nate 4 | 30 | 30 | V |
| $\mathbf{V}_{\text {(BR)EBO }}$ Emitter-Base Breakdown Voltage | $I_{E}=10 \mu A, \quad I^{\prime} C=0$ |  | 5 | 5 | V |
| Icbo Collector Cutoff Current | $\mathrm{V}_{C B}=50 \mathrm{~V}, \mathrm{IE}=0$ |  | 10 | 10 | nA |
|  | $V_{C B}=50 \mathrm{~V}, \quad \mathrm{IE}^{\prime}=0$, | $T_{A}=150^{\circ} \mathrm{C}$ | 10 | 10 | $\mu \mathrm{A}$ |
| IEBO Emitter Cutoff Current | $V_{E B}=3 \mathrm{~V}$, IC $=0$ |  | 10 | 10 | nA |
| hFE Static Forward Current Transfer Ratio | $V_{C E}=10 \mathrm{~V}, \quad I_{C}=100 \mathrm{~mA}$ |  | 20 | 35 |  |
|  | $V_{C E}=10 \mathrm{~V}, \quad I_{C}=1 \mathrm{~mA}$ |  | 25 | 50 |  |
|  | $V_{\text {CE }}=10 \mathrm{~V}, I_{C}=10 \mathrm{~mA}$ | See Note 4 | 35 | 75 |  |
|  | $V_{C E}=10 \mathrm{~V}, \mathrm{I}^{\prime}=150 \mathrm{~mA}$ |  | $40 \quad 120$ | $100 \quad 300$ |  |
|  | $V_{C E}=10 \mathrm{~V}, \quad I_{C}=500 \mathrm{~mA}$ |  | 20 | 30 |  |
|  | $V_{C E}=1 \mathrm{~V}, \quad I_{C}=150 \mathrm{~mA}$ |  | 20 | 50 |  |
| VBE Base-Emitter Voltege | $I_{B}=15 \mathrm{~mA}, \quad I_{C}=150 \mathrm{~mA}$ | See Note 4 | 1.3 | 1.3 | V |
|  | $\mathrm{I}_{\mathrm{B}}=50 \mathrm{~mA}, \quad \mathrm{I}_{\mathrm{C}}=500 \mathrm{~mA}$ |  | 2.6 | 2.6 |  |
| Collector-Emitter Saturation Voltege | $I_{B}=15 \mathrm{~mA}, \quad I_{C}=150 \mathrm{~mA}$ | See Note 4 | 0.4 | 0.4 | V |
|  | $I_{B}=50 \mathrm{~mA}, \quad I_{C}=500 \mathrm{~mA}$ |  | 1.6 | 1.6 |  |
| Mfel Smali-Signal Common-Emitter | $V_{C E}=20 \mathrm{~V}, \quad I_{C}=20 \mathrm{~mA}$, | $f=100 \mathrm{MHz}$ | 2.5 | 2.5 |  |
| $\mathrm{f}_{\mathbf{T}} \quad$ Transition Frequency | $V_{C E}=20 \mathrm{~V}, \quad I_{C}=20 \mathrm{~mA}$, | See Note 5 | 250 | 250 | MHz |
| Cobo Common-Base Open-Circuit <br> Output Capacitance  | $V_{C B}=10 \mathrm{~V}, \quad \mathrm{I}_{\mathrm{E}}=0$, | $\mathrm{f}=1 \mathrm{MHz}$ | 8 | 8 | pF |
| $h_{i e}$ (real) Real Part of Small-Signal <br> Common-Emitter Input Impedance | $V_{C E}=20 \mathrm{~V}, \quad \mathrm{I}_{\mathrm{C}}=20 \mathrm{~mA}$, | $\mathrm{f}=300 \mathrm{MHz}$ | 60 | 60 | $\Omega$ |

NOTES: 4. These parameters must be messured using pulse techniques. $t_{w}=\mathbf{3 0 0} \mu \mathrm{s}$, duty cycle $<\mathbf{2 \%}$.
5. To obtain $t_{T}$, the $\left|h_{\text {fe }}\right|$ response with frequency is extrapolated at the rate of -6 dB per octave from $\mathrm{f}=\mathbf{1 0 0} \mathbf{M H z}$ to the frequency at which $\left.\right|_{\mathrm{f}_{\mathrm{fe}}} \mid=1$.
switching characteristics at $25^{\circ} \mathrm{C}$ free-air temperature

| PARAMETER |  | TEST CONDITIONS ${ }^{\dagger}$ |  | TYP | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: |
| $t_{d}$ | Delay Time | $\begin{aligned} & V_{C C}=30 \mathrm{~V}, \quad I_{C}=150 \mathrm{~mA}, \\ & V_{B E}(\mathrm{off})=-0.5 \mathrm{~V}, \\ & \hline \end{aligned}$ | $I_{B(1)}=15 \mathrm{~mA},$ <br> See Figure 1 | 5 | ns |
| $t_{r}$ | Rise Time |  |  | 15 | ns |
| $t_{5}$ | Storage Time | $V_{C C}=30 V, \quad I C=160 m A$, $I_{B(1)}=15 \mathrm{~mA}$, <br> $I_{B}(2)=-15 \mathrm{~mA}$, See Figure 2 |  | 190 | ns |
| $t_{f}$ | Fall Time |  |  | 23 | ns |

tVoltage and current values shown are nominal; exact values vary slightly with transistor parameters.

## TYPES D2T2218, D2T2218A, D2T2219, D2T2219A DUAL N-P-N SILICON TRANSISTORS

## D2T2218A, D2T2219A

electrical characteristics at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)


NOTES: 4. These parameters must be measured using pulse techniques. $t_{w}=300 \mu 5$, duty cycle $\leqslant 2 \%$.
5. To obtain $f_{T}$, the $\mathbf{M f e l}_{\text {fesponse }}$ with frequency is extrapolated at the rate of -6 dB per octave from $f=100 \mathrm{MHz}$ to the frequency at which $\left|h_{f e}\right|=1$.

## TYPES D2T2218, D2T2218A, D2T2219, D2T2219A DUAL N-P-N SILICON TRANSISTORS

operating characteristics at $\mathbf{2 5}{ }^{\circ} \mathbf{C}$ free-air temperature

| PARAMETER | TEST CONDITIONS | D2T2218A | D2T2219A | UNIT |
| :---: | :---: | :---: | :---: | :---: |
|  |  | MAX | MAX |  |
| F Spot Noise Figure | $V_{C E}=10 \mathrm{~V}, \mathrm{C}=100 \mu \mathrm{~A}, \mathrm{R}_{\mathrm{G}}=1 \mathrm{k} \Omega, f=1 \mathrm{kHz}$ |  | 4 | dB |

switching characteristics at $\mathbf{2 5}{ }^{\circ} \mathrm{C}$ free-air temperature

| PARAMETER |  | TEST CONDITIONS $\dagger$ |  | D2T2218A | D2T2218A | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | MAX | MAX |  |
| $t_{d}$ | Delay Time |  |  | $\begin{aligned} & V_{C C}=30 \mathrm{~V}, \quad I C=150 \mathrm{~mA}, \\ & V_{B E(\text { off })}=-0.5 \mathrm{~V} . \end{aligned}$ | $I_{B}(1)=15 \mathrm{~mA} \text {. }$ <br> See Figure 1 | 10 | 10 | ns |
| $\mathrm{t}_{\mathrm{r}}$ | Plise Time | 25 | 25 |  |  | ns |
|  | Active Region Time Constant ${ }^{\ddagger}$ | 2.5 | 2.5 |  |  | ns |
| $\mathrm{t}_{\mathbf{s}}$ | Storage Time | $\begin{array}{ll} \hline V_{C C}=30 \mathrm{~V}, \quad I_{C}=150 \mathrm{~mA}, & I_{B}(1)=15 \mathrm{~mA}, \\ I_{B(2)}=-15 \mathrm{~mA}, & \text { See Figure } 2 \end{array}$ |  | 225 | 225 | ns |
| $t_{f}$ | Fall Time |  |  | 60 | 60 | ns |

$\dagger$ Voltage and current values shown are nominal, exact values vary sightly with transistor parameters.
$\ddagger$ Under the given conditions $\tau_{A}$ is equal to $\frac{t_{r}}{10}$.
PARAMETER MEASUREMENT INFORMATION


TEST CIRCUIT


VOLTAGE WAVEFORMS
FIGURE 1-DELAY AND RISE TIMES


NOTES: a. The input waveforms have the following characteristics: For Figure $1, \mathrm{t}_{\mathrm{r}} \mathbf{<} \mathbf{2} \mathbf{n s}, \mathrm{t}_{\mathbf{w}}<\mathbf{2 0 0} \mathrm{ns}$, duty cycle $\mathbf{6} \mathbf{2 \%}$; for Figure $\mathbf{2}$, $t_{f} \leqslant 5 \mathrm{~ns}, \mathrm{t}_{\mathrm{w}} \approx 100 \mu \mathrm{~s}$, duty cycle $\leqslant \mathbf{1 7 \%}$.
b. All waveforms are monitored on an oscilloscope with the following characteristics: $t_{r}<6 \mathrm{~ns}, R_{i n}>100 \mathrm{k} \boldsymbol{\Omega}, \mathrm{C}_{\mathrm{in}} \leqslant 12 \mathrm{p} F$.

## SILECT ${ }^{\dagger}$ TRANSISTORS $\ddagger$

 DESIGNED FOR HIGH-SPEED, MEDIUM-POWER SWITCHING AND GENERAL PURPOSE AMPLIFIER APPLICATIONS featuring- High fT . . . . 350 MHz typ at $10 \mathrm{~V}, 20 \mathrm{~mA}$
- Low VCE(sat) .... 0.13 V typ at 150 mA
- High Maximum IC . . . . 800 mA
- A5T2222 Electrically Similar to 2N2222, 2N3116, and 2N4952
- TIS109 Processing Includes Operational Aging at $\mathbf{3 0 0} \mathbf{~ m W}$ for 24 Hours
- TIS110 Electrically Similar to 2N4400
- TIS111 Electrically Similar to 2N4401


## mechanical data

These transistors are encapsulated in a plastic compound specifically designed for this purpose, using a highly mechanized process developed by Texas Instruments. The case will withstand soldering temperatures without deformation. These devices exhibit stable characteristics under high-humidity conditions and are capable of meeting MIL-STD-202C, Method 106B. The transistors are insensitive to light.

absolute maximum ratings at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)


[^44] from the case.

[^45]
## TYPES A5T2222, TIS109 N-P-N SILICON TRAMSISTORS

electrical characteristics at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

| PARAMETER |  | TEST CONDITIONS |  | A5T2222 | TIS 109 | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | MIN MAX | MIN MAX |  |
| $V_{\text {(BR) }}$ CBO | Collector-Base Breakdown Voltage |  |  | $I^{\prime} C=10 \mu A, \quad I_{E}=0$ |  | 60 | 60 | $V$ |
| $V_{\text {(BR)CEO }}$ | Collector-Emitter Breakdown Voltage | $I_{C}=10 \mathrm{~mA}, I_{B}=0$, | See Note 4 | 30 | 30 | $V$ |
| V(BR)EBO | Emitter-Base Breakdown Voltage | $I_{E}=10 \mu A, \quad I_{C}=0$ |  | 5 | 5 | $V$ |
| ICBO | Collector Cutoff Current | $V_{C B}=20 \mathrm{~V}, \mathrm{I}_{\mathrm{E}}=0$ |  |  | 100 | nA |
|  |  | $\mathrm{V}_{C B}=50 \mathrm{~V}, \mathrm{I}_{\mathrm{E}}=0$ |  | 10 |  | nA |
|  |  | $V_{C B}=50 \mathrm{~V}, I_{E}=0$, | $T_{A}=100^{\circ} \mathrm{C}$ | 3 | 3 | $\mu \mathrm{A}$ |
| IEBO | Emitter Cutoff Current | $V_{E B}=3 \mathrm{~V}, I^{\prime}=0$ |  | 10 | 10 | nA |
| hFE | Static Forward Current Transfer Ratio | $V_{C E}=10 \mathrm{~V}, \mathrm{I}_{\mathrm{C}}=100 \mu \mathrm{~A}$ |  | 35 | 20 |  |
|  |  | $\mathrm{V}_{\text {CE }}=10 \mathrm{~V}, \mathrm{IC}=1 \mathrm{~mA}$ |  | 50 | 30 |  |
|  |  | $V_{C E}=10 \mathrm{~V}, I_{C}=10 \mathrm{~mA}$ | See Note 4 | 75 | 40 |  |
|  |  | $V_{C E}=10 \mathrm{~V}, \mathrm{I}^{\prime} \mathrm{C}=150 \mathrm{~mA}$ |  | $100 \quad 300$ | 100400 |  |
|  |  | $V_{C E}=10 \mathrm{~V}, \mathrm{I}^{\prime} \mathrm{C}=500 \mathrm{~mA}$ |  | 30 | 20 |  |
|  |  | $V_{C E}=1 \mathrm{~V}, I_{C}=150 \mathrm{~mA}$ |  | 50 | 35 |  |
| $V_{B E}$ | Base-Emitter Voltage | $I_{B}=15 \mathrm{~mA}, I^{\prime} C=150 \mathrm{~mA}$ | See Note 4 | 1.3 | 1.3 | $V$ |
|  |  | $\mathrm{I}_{B}=50 \mathrm{~mA}, \quad 1 \mathrm{C}=500 \mathrm{~mA}$ |  | 2.6 | 2.6 | V |
| $\mathbf{V}_{\text {cE }}(\mathrm{sat})$ | Collector-Emitter Saturation Voltage | $\mathrm{I}_{\mathrm{B}}=15 \mathrm{~mA}, \mathrm{I}_{\mathrm{C}}=150 \mathrm{~mA}$ | See Note 4 | 0.4 | 0.4 | V |
|  |  | $\mathrm{I}_{\mathrm{B}}=50 \mathrm{~mA}, \mathrm{I}^{2}=500 \mathrm{~mA}$ |  | 1.6 | 1.6 | V |
| \| $\mathrm{hfol}_{\text {l }}$ | Small-Signal Common-Emitter Forward Current Transfer Ratio | $V_{C E}=10 \mathrm{~V}, \mathrm{IC}=20 \mathrm{~mA}$, | $f=100 \mathrm{MHz}$ | 2.5 | 2.5 |  |
| $f 1$ | Transition Frequency | $V_{C E}=10 \mathrm{~V}, \mathrm{IC}=20 \mathrm{~mA}$, | See Note 5 | 250 | 250 | MHz |
| Cobo | Common-Base Open-Círcuit Output Capacitance | $V_{C B}=10 \mathrm{~V}, \mathrm{I}_{\mathrm{E}}=0$. | $f=1 \mathrm{MHz}$ | 8 | 10 | pF |
| $\mathrm{C}_{\text {ibo }}$ | Common-Base Open-Circuit Input Capacitance | $V_{E B}=0.5 \mathrm{~V}, \mathrm{I}_{\mathrm{C}}=0$, | $\mathrm{f}=1 \mathrm{MHz}$ | 25 | 25 | pF |
| Re( $\mathbf{h i e}_{\text {ie }}$ ) | Real Part of Small-Signal Common-Emitter Input Impedance | $V_{C E}=10 \mathrm{~V}, I_{C}=20 \mathrm{~mA}$, | $f=300 \mathrm{MHz}$ | 60 | 60 | $\Omega$ |

NOTES: 4. These parameters must be measured using pulse techniques. $t_{w}=300 \mu s$, dutv cycle $\leqslant 2 \%$.
6. To obtain $f$, the $\mathrm{h}_{\mathrm{fe}}$ l response with frequency is extrapolated at the rate of -6 ds per octave from $\mathrm{f}=10 \mathrm{MHz}$ to the frequancy at which $\left|h_{f e}\right|=1$.

## switching characteristics at $25^{\circ} \mathrm{C}$ free-air temperature

| PARAMETER | TEST CONDITIONS ${ }^{\dagger}$ |  | TYP | UNIT |
| :---: | :---: | :---: | :---: | :---: |
| $t_{\text {d }}$ Delay Time | $V_{C C}=30 \mathrm{~V}$, $I_{C}=150 \mathrm{~mA}$, <br> $\mathrm{I}_{\mathrm{B}(1)}=15 \mathrm{~mA}$,  <br> $V_{B E(0 f f)}=-0.5 \mathrm{~V}$, See Figure 1 |  | 5 | ns |
| $t_{r}$ Rise Time |  |  | 15 | ns |
| $t_{\text {s }}$ Storage Time | $V_{C C}=30 \mathrm{~V}$, $I_{C}=150 \mathrm{~mA}$, <br> $\mathrm{I}_{\mathrm{B}}(1)=15 \mathrm{~mA}$,  <br> $\mathrm{I}_{\mathrm{B}}(2)=-15 \mathrm{~mA}$, See Figure $2^{\circ}$ |  | 190 | ns |
| $t_{f}$ Fall Time |  |  | 23 | ns |

[^46]
# DESIGNED FOR MEDIUM-POWER SWITCHING AND GENERAL PURPOSE AMPLIFIER APPLICATIONS 

- High Breakdown Voltage Combined with Very-Low Saturation Voltage
- hFE . . . Guaranteed from $100 \mu \mathrm{~A}$ to $\mathbf{5 0 0} \mathrm{mA}$
- High fT . . . 250 MHz Min at $\mathbf{2 0}$ V, 20 mA
mechanical data


NC-No Internel connection

absolute maximum ratings at $25^{\circ} \mathbf{C}$ free-air temperature (unless otherwise noted)

> EACH TOTAL TRIODE DEVICE 60 V
> 30 V
> 5 V
> 0.8 A
> $0.5 \mathrm{~W}^{\dagger} \quad 1.5 \mathrm{~W}^{\dagger}$
> $-55^{\circ} \mathrm{C}$ to $150^{\circ} \mathrm{C}$
> $-260^{\circ} \mathrm{C} \longrightarrow$

Collector-Base Voltage
Collector-Emitter Voltage (See Note 1)
Emitter-Base Voltage
Continuous Collector Current
Continuous Device Dissipation at (or below) $25^{\circ} \mathrm{C}$ Free-Air Temperature (See Note 2)
Storage Temperature Range
Lead Temperature 1/16 Inch from Case for 10 Seconds

NOTES: 1. This value applies between 0.01 mA and 500 mA collector current when the emitter-bace diode it open-circuited.
2. Derate linearly to $150^{\circ} \mathrm{C}$ free-air temperature at the rates of $4 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$ for each triode and $12 \mathrm{~mW} / \mathrm{m}^{\circ} \mathrm{C}$ for the total device.

[^47]
## TYPE 02T2222

## QUAD N-P-N SILICON TRANSISTOR

electrical characteristics at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

| PARAMETER | TEST CONDITIONS |  | MIN MAX | UNIT |
| :---: | :---: | :---: | :---: | :---: |
| $\mathrm{V}_{(3 R)}$ CBO Collector-Base Breakdown Voltage | $I_{C}=10 \mu A, \quad I_{E}=0$ |  | 60 | V |
| $V_{\text {(BR)CEO }}$ Collector-Emitter Breakdown Voltage | $I_{C}=10 \mathrm{~mA}, \quad I_{B}=0$, | See Note 3 | 30 | V |
| V(BR)EBO Emittar-Base Breakdown Voltage | $I_{E}=10 \mu A, \quad I_{C}=0$ |  | 5 | $\checkmark$ |
|  | $V_{C B}=50 \mathrm{~V}, \quad I_{E}=0$ |  | 10 | nA |
| ICBO Collector Cutoff Current | $V_{C B}=50 \mathrm{~V}, \quad I_{E}=0$, | $T_{A}=100^{\circ} \mathrm{C}$ | 3 | HA |
| Iebo Emitter Cutoff Current | $V_{E B}=3 \mathrm{~V}, \quad \mathrm{I}^{\prime}=0$ |  | 10 | nA |
| EBO | $V_{C E}=10 \mathrm{~V}, \quad I_{C}=100 \mathrm{~mA}$ |  | 35 |  |
|  | $V_{C E}=10 \mathrm{~V}, 1 \mathrm{l}=1 \mathrm{~mA}$ |  | 50 |  |
|  | $V_{C E}=10 \mathrm{~V}, \quad I_{C}=10 \mathrm{~mA}$ |  | 75 |  |
| hfe Static Forward Current Transfer Ratio | $V_{C E}=10 \mathrm{~V}, \quad I_{C}=150 \mathrm{~mA}$ | See Note 3 | $100 \quad 300$ |  |
|  | $V_{C E}=10 \mathrm{~V}$, $I_{C}=500 \mathrm{~mA}$ |  | 30 |  |
|  | $V_{C E}=1 \mathrm{~V}, \quad I_{C}=150 \mathrm{~mA}$ |  | 50 |  |
|  | $I_{B}=15 \mathrm{~mA}, \quad I_{C}=150 \mathrm{~mA}$ | See Nate 3 | 1.3 | $V$ |
| VBE Base-Emitter Voltage | $I_{B}=50 \mathrm{~mA}, \quad 1 C=600 \mathrm{~mA}$ | Soe Nota 3 | 2.6 | $\checkmark$ |
|  | $I_{B}=15 \mathrm{~mA}, \quad I^{\prime}=150 \mathrm{~mA}$ | See Note 3 | 0.4 | $V$ |
| VCE(sat) Collector-Emitter Seturation Voitage | $I_{B}=50 \mathrm{~mA}, \quad I_{C}=500 \mathrm{~mA}$ |  | 1.6 |  |
| hfol Smail-Signal Common-Emitter | $V_{C E}=10 \mathrm{~V}, \quad 1 \mathrm{C}=20 \mathrm{~mA}$, | $f=100 \mathrm{MHz}$ | 2.5 |  |
| ${ }^{\mathbf{f}} \mathrm{T}$ T Transition Frequency | $V_{C E}=10 \mathrm{~V}, \quad I_{C}=20 \mathrm{~mA}$, | See Note 4 | 250 | MHz |
| Cobo Common-Base Open-Circuit Output Capacitance | $V_{C B}=10 \mathrm{~V}, I_{E}=0$, | $\mathrm{f}=1 \mathrm{MHz}$ | 8 | pF |
| $\mathrm{C}_{\text {ibo }}$ Common-Base Open-Circuit Input Capacitance | $V_{E B}=0.5 \mathrm{~V}, \mathrm{I}^{\prime} \mathrm{C}=0$, | $f=1 \mathrm{MHz}$ | 25 | pF |
| Re( $h_{i \theta}$ ) Real Part of Small-Signal <br> Common-Emitter Input Impedance | $V_{C E}=10 \mathrm{~V}, \quad I_{C}=20 \mathrm{~mA}$, | $f=300 \mathrm{MHz}$ | 60 | $\Omega$ |

NOTES: 3. These parameters must be measured using pulse techniques. $t_{w}=\mathbf{3 0 0} \mu \mathrm{s}$, duty cycie $<\mathbf{2 \%}$.
4. To obtain $f_{T}$, the $h_{f e} \mid$ response with frequency is extrapolated at the rate of -6 dB per octave from $\mathrm{f}=100 \mathrm{MHz}$ to the frequency at which $\left.\right|_{h_{\mathrm{fe}}} \mid=1$.

## switching characteristics at $25^{\circ} \mathrm{C}$ free-air temperature


tVoltage and current values shown are nominal; exact values very slightly with transistor parameters.

## PARAMETER MEASUREMENT INFORMATION



FIGURE 1-DELAY AND RISE TIMES
FIGURE 2-STORAGE AND FALL TIMES
NOTES: a. The input waveforms have the following characteristics: for figure $1, t_{f} \leqslant 2$ ns, $t w<200$ ns, duty cycle $<2 \%$ for figure 2 , $\mathrm{t}_{\mathrm{f}}<\mathrm{5ns}, \mathrm{t}_{\mathrm{w}} \approx 100 \mu \mathrm{~s}$, duty cycle $<17 \%$.
b. All waveforms are monitored on an oscilloscope with the following eharacteristics: $\mathrm{t}_{\mathrm{r}}<5 \mathrm{~ns}, \mathrm{~A}_{\mathrm{in}}>100 \mathrm{k} \Omega, \mathrm{C}_{\mathrm{in}}<12 \mathrm{pF}$.

## TWO TRANSISTORS IN ONE PACKAGE FOR DIFFERENTIAL AMPLIFIER APPLICATIONS

- Medium Power
- High Operating Voltage
*mechanical data

*absolute maximum ratings at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

|  | 2N2060 |  | $\begin{aligned} & \text { 2N2223 } \\ & \text { 2N2223A } \end{aligned}$ |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  | $\begin{aligned} & \text { EACH } \\ & \text { TRIODE } \end{aligned}$ | TOTAL DEVICE | $\begin{gathered} \text { EACH } \\ \text { TRIODE } \end{gathered}$ | TOTAL DEVICE | UNIT |
| Collector-Base Voltage | 100 |  | 100 |  | V |
| Collector-Emitter Voltage (See Note 1) | 80 |  | 80 |  | V |
| Collector-Emitter Voltage (See Note 2) | 60 |  | 60 |  | V |
| Emitter-Base Voltage | 7 |  | 7 |  | $V$ |
| Continuous Collector Current | 500 |  | 500 |  | mA |
| Continuous Device Dissipation at (or below) $25^{\circ} \mathrm{C}$ Free-Air Temperature (See Note 3) | . 0.5 | 0.6 | 0.5 | 0.6 | W |
| Continuous Device Dissipation at (or below) $25^{\circ} \mathrm{C}$ Case Temperature (See Notes 4 and 5) | 1.5 | 3 | 1.6 | 3 | W |
| Continuous Devica Dissipstion at $100^{\circ} \mathrm{C}$ Cese Temperature | 0.86 | 1.7 | 0.91 | 1.7 | W |
| Operating Collector Junction Temperature | 200 |  | 200 |  | C |
| Storage Temperature Ranga | $-65^{\circ} \mathrm{C}$ to $200^{\circ} \mathrm{C}$ |  |  |  |  |
| Lead Temperature 1/16 Inch from Case for 10 Seconds | $300^{\circ} \mathrm{C}$ |  |  |  |  |

NOTES: 1. Thase values apply when the base-mitter resistance ( $\boldsymbol{R}_{\mathrm{BE}}$ ) is equal to or lese than 10 ohms.
2. These values apply when the beee-amitter diode is open-circulted.
3. Derate linearly to $200^{\circ} \mathrm{C}$ free-alr tempernture at the rate of $2.86 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$ for each triode and $3.43 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$ for total device.
4. Derate 2 N 2060 linearly to $200^{\circ} \mathrm{C}$ casa temperature at the rate of $8.6 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$ for sach triode and $17.2 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$ for total device.
6. Derate $2 N 2223$ and 2N2223A lineariv to $200^{\circ} \mathrm{C}$ case temperature at the rate of $9.1 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$ for each triode and $17.2 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$ for total device.
6. The terminals of the triode not under test are open-circuited for the motasurement of thase charecteristics.
7. This parameter must be measured using pulse techniques. $t_{w}=300 \mu$, duty cycle $<\mathbf{1 \%}$.
8. The lower of the two $h_{\text {FE }}$ reeding is taken as $h_{F E}$.
9. This parameter is measured in an amplifier with reaponse down 3 dB at 25 Hz and 10 kHz and a high-frequency rolloff of 6 dB/octave.
*JEDEC registered data. This data shaet contains all epplicable registered date in effect at the time of publication.

## TYPES 2N2060, 2N2223, 2N2223A DUAL N-P-N SILICON TRANSISTORS

*electrical characteristics at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)
individual triode characteristics (see note 6)

| PARAMETER |  | TEST CONDITIONS | 2N2060 | $\begin{aligned} & \text { 2N2223 } \\ & \text { 2N2223A } \end{aligned}$ | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | MIN MAX | MIN MAX |  |
|  |  |  | $I_{C}=100 \mu A, I_{E}=0$ | 100 | 100 | $V$ |
| $V_{\text {(BR) }}{ }^{\text {(BRO }}$ | Collector-Base Breakdown Voltage | $I_{C}=30 \mathrm{~mA}, \mathrm{I}_{B}=0, \quad$ See Note 7 | 60 | 60 | V |
| $V_{\text {(BR)CEO }}$ | Collector-Emitter Breakdown Voltage | $I_{C}=30 \mathrm{~mA}, \mathrm{I}_{B}=0$, $I_{C}=100 \mathrm{~mA}, \mathrm{R}_{\mathrm{BE}}=10 \Omega$, See Note 7 | 80 | 80 | V |
| $V_{\text {(BR) }}$ | Collector-Emitter Breakdown Voltage | $\mathrm{C}=100 \mathrm{~mA}, \mathrm{R}_{\mathrm{BE}}=10 \Omega$, Ser $I_{E}=100 \mu \mathrm{~A}, I_{C}=0$ | 7 | 7 | V |
| $V_{\text {(BR)EBO }}$ | Emitter-Base Breakdown Voltage | $I_{E}=100 \mu \mathrm{~A}, \mathrm{C}=0$ $V_{C B}=80 \mathrm{~V}, \mathrm{I}_{\mathrm{E}}=0$ | 2 | 10 | nA |
| ${ }^{\prime} \mathrm{CBO}$ | Collector Cutoff Current | $\begin{array}{ll}V_{C B}=80 \mathrm{~V}, ~ & \\ V_{C B}=80 \mathrm{~V}, T_{E}=0, & T_{A}=150^{\circ} \mathrm{C}\end{array}$ | 10 | 15 | $\mu \mathrm{A}$ |
| IEbO | Emitter Cutoff Current | $V_{E B}=5 \mathrm{~V}, \mathrm{I}^{\prime}=0$ | 2 | 10 | nA |
| hFE | Static Forward Current Transfer Ratio | $V_{C E}=5 \mathrm{~V}, \quad \mathrm{I}^{\prime} \mathrm{C}=10 \mu \mathrm{~A}$ | $25 \quad 75$ | 15 |  |
|  |  | $V_{C E}=5 \mathrm{~V}, \mathrm{I}_{\mathrm{C}}=100 \mu \mathrm{~A}$ | $30 \quad 90$ | 25150 |  |
|  |  | $V_{C E}=5 \mathrm{~V}, \quad \mathrm{IC}=1 \mathrm{~mA}$ | $40 \quad 120$ |  |  |
|  |  | $V_{C E}=5 \mathrm{~V}, 1 \mathrm{C}=10 \mathrm{~mA}$, See Note 7 | $50 \quad 150$ | 50200 |  |
| $V_{B E}$ | Base-Emitter Voltage | $I_{B}=5 \mathrm{~mA}, \quad I_{C}=50 \mathrm{~mA}$ | 0.9 | 0.9 | $V$ |
| $\mathrm{V}_{\text {CE }}$ (sat) | Collector-Emitter Saturation Voltage | $I_{B}=5 \mathrm{~mA}, \quad I C=50 \mathrm{~mA}$ | 1.2 | 1.2 | V |
| $h_{\text {ib }}$ | Small-Signal Common-Base | $V_{C B}=5 \mathrm{~V}, \quad \mathrm{I}_{\mathrm{C}}=1 \mathrm{~mA}, \quad f=1 \mathrm{kHz}$ | $20 \quad 30$ | $20 \quad 30$ | $\Omega$ |
|  | Input Impedance |  |  |  |  |
| $h_{\text {rb }}$ | Small-Signal Common-Base |  |  | $10^{3 x}$ |  |
|  | Small-Signal Common-Base |  |  | 0.5 | $\mu \mathrm{mho}$ |
| hob | Output Admittance |  |  |  |  |
| $h_{\text {ie }}$ | Small-Signal Common-Emitter | $V_{C E}=5 \mathrm{~V}, \quad \mathrm{I} C=1 \mathrm{~mA}, f=1 \mathrm{kHz}$ | 10004000 |  | $\Omega$ |
|  | Input Impedance |  |  |  |  |
| $h_{\text {fe }}$ | Small-Signal Common-Emitter Forward Current Transfer Ratio |  | $50 \quad 150$ | 40200 |  |
| hoe | Small-Signal Common-Emitter |  | 16 |  | $\mu \mathrm{mho}$ |
|  | Output Admittance |  |  |  |  |
| $h_{\text {fe }} \mid$ | Small-Signal Common-Emitter Forward Current Transfer Ratio | $V_{C E}=10 \mathrm{~V}, \mathrm{I}^{\prime} \mathrm{C}=50 \mathrm{~mA}, f=20 \mathrm{MHz}$ | 3 | 2.5 |  |
|  | Common-Base Open-Circuit | $V_{C B}=10 \mathrm{~V}, \mathrm{I}_{\mathrm{E}}=0, \quad f=1 \mathrm{MHz}$ | 15 | 15 | pF |
| Cobo | Output Capacitance |  |  |  |  |
| $\mathrm{C}_{\text {ibo }}$ | Common-Base Open-Circuit Input Capacitance | $V_{E B}=0.5 \mathrm{~V}, \mathrm{I}^{\prime}=0, \quad f=1 \mathrm{MHz}$ | 85 | 85 | pF |

triode matching charactoristics

|  | PARAMETER | TEST CONDITIONS | $\begin{array}{\|l\|} \hline \text { 2N2060 } \\ \hline \text { MIN MAX } \\ \hline \end{array}$ | $\begin{array}{\|l\|} \hline \text { 2N2223 } \\ \hline \text { MIN MAX } \\ \hline \end{array}$ | 2NP223A MIN MAX | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| $\frac{h_{F E 1}}{h_{F E}}$ | Static Forward Current Gain Balance Ratio | $V_{C E}=5 \mathrm{~V}, \quad I^{\prime} \mathrm{C}=100 \mu \mathrm{~A}$, See Note 8 | 0.91 | 0.81 | 0.91 |  |
|  |  | $V_{C E}=5 \mathrm{~V}, \mathrm{I}^{\prime}=1 \mathrm{~mA}$, See Note 8 | 0.91 |  |  |  |
| $\left\|\mathrm{V}_{\mathrm{BE} 1}-\mathrm{V}_{\mathrm{BE} 2}\right\|$ | Base-Emitter-Voltage Differential | $V_{C E}=5 \mathrm{~V}, \mathrm{I}^{\prime} \mathrm{C}=100 \mu \mathrm{~A}$ | 5 | 15 | 5 | mV |
|  |  | $V_{C E}=5 \mathrm{~V}, \mathrm{I}_{\mathrm{C}}=1 \mathrm{~mA}$ | 5 |  |  |  |
| $\left\|\frac{\Delta\left(\mathrm{V}_{\mathrm{BE} 1}-\mathrm{V}_{\mathrm{BE} 2}\right.}{\Delta T_{\mathrm{A}}}\right\|$ | Base-Emitter-Voltage-Differential <br> Temperature Gradient | $\begin{aligned} & \text { VCE }=5 \mathrm{~V}, \quad I_{C}=100 \mu A, \\ & \text { From } T_{A}=-55^{\circ} C \text { to } T_{A}=125^{\circ} \mathrm{C} \end{aligned}$ | 10 | 25 | 25 | $\mu \vee /{ }^{\circ} \mathrm{C}$ |

## "operating characteristics at $25^{\circ} \mathrm{C}$ free-air temperature

individual triode characteristics (see note 6)

| PARAMETER | TEST CONDITIONS | 2N2060 | UNIT |  |
| :---: | :---: | :---: | :---: | :---: |
| $F$ | Spot Noise Figure | $V_{C E}=10 \mathrm{~V}, I_{C}=300 \mu A, R_{G}=510 \Omega, f=1 \mathrm{kHz}$ | 8 | $d B$ |
| $F$ | Averge Noise Figure | $V_{C E}=10 \mathrm{~V}, I_{C}=300 \mu A, R_{G}=1 \mathrm{k} \Omega$, Noise Bandwidth $=15.7 \mathrm{kHz}$, See Note 9 | 8 | $d B$ |

[^48]
## FOR MEDIUM-POWER SWITCHING AND AMPLIFIER APPLICATIONS

## - High Breakdown Voltage Combined with Very Low Saturation Voltage

- hFE-Guaranteed from $100 \mu$ a to 1 amp
mechanical data

absolute maximum ratings at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

|  | $\begin{array}{\|c\|} \hline \text { 2N2192 } \\ \text { 2N2192A } \\ \hline \end{array}$ | $\begin{array}{\|c\|} \hline \text { 2N2193 } \\ \text { 2N2193A } \\ \hline \end{array}$ | $\begin{array}{\|c\|} \hline \text { 2N2194 } \\ \text { 2N2194A } \\ \hline \end{array}$ | $\begin{array}{r} \text { 2N2243 } \\ \text { 2N2243A } \\ \hline \end{array}$ | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: |
| Collector-Base Voltage | $60^{*}$ | 80* | 60* | 120* | $v$ |
| Collector-Emitter Voltage (See Note 1) | 40* | 50* | 40* | $80^{*}$ | $v$ |
| Emitter-Base Voltage | 5* | 8* | 5* | 7* | $v$ |
| Collector Current | $1^{*}$ | $1^{*}$ | 1* | 1* | a |
| Total Device Dissipation at (or below) $25^{\circ} \mathrm{C}$ Free-Air Temperature (See Note 2) | 0.8* | 0.8* | 0.8* | 0.8* | w |
| Total Device Dissipation at (or below) $25^{\circ} \mathrm{C}$ Case Temperature (See Note 3) | $\begin{array}{r} 10^{\dagger} \\ 2.8^{*} \\ \hline \end{array}$ | $\begin{array}{r} 10^{\dagger} \\ 2.8^{*} \\ \hline \end{array}$ | $\begin{array}{r} 10^{\dagger} \\ 2.8^{*} \\ \hline \end{array}$ | $\begin{array}{r} 10^{\dagger} \\ 2.8^{*} \end{array}$ | w |
| Storage Temperature Range | $-65^{\circ} \mathrm{C}$ to $200^{\circ} \mathrm{C}{ }^{*}$ |  |  |  |  |
| Lead Temperature 1/16 Inch from Case for 10 Seconds | $300^{\circ} \mathrm{C}^{*}$ |  |  |  |  |

NOTES: 1. This value applies when the base-emitter diode is open-circuited.
2. Derate linearly to $200^{\circ} \mathrm{C}$ free-air temperature at the rate of $4.57 \mathrm{mw} /{ }^{\circ} \mathrm{C}$
 rating linearly to $200^{\circ} \mathrm{C}$ case temperature at the rate of $\mathbf{1 6 ~ \mathrm { mw }} /^{\circ} \mathrm{C}$.

[^49]
## TYPES 2N2243, 2N2243A <br> W-P-N SILICON TRANSISTORS

*electrical characteristics at $25^{\circ} \mathrm{C}$ free-air semperature (unless oftherwise moted)

| PARAMETER |  | TEST CONDITIONS | 2N2243 |  | 2N2243A |  | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | MIN | max | MIN | max |  |
| $V_{\text {IRP) }}$ cso | Collector-Base Brockdown Voltage |  | $I_{c}=100 \mu a_{1}, I_{E}=0$ | 120 |  | 120 |  | $v$ |
| $V_{\text {IRP\|CEO }}$ | Collactor-Emither Breokdown Voltoge | $I_{c}=25 \mathrm{ma}, \quad I_{s}=0, \quad$ See Mote 4 | 0 |  | 80 |  | $v$ |
| $V_{\text {(ratelio }}$ | Emitter-Bose Breakdown Valtage | $\mathrm{I}_{\mathrm{E}}=100 \mu \mathrm{a}, \mathrm{l}_{\mathrm{c}}=0$ | 7 |  | 7 |  | $\checkmark$ |
| $\mathrm{I}_{\text {coo }}$ | Collector Cutoff Current | $\mathrm{V}_{C B}=60 \mathrm{v}, \quad \mathrm{l}_{E}=0$ |  | 10 |  | 10 | $n 0$ |
|  |  | $V_{C B}=60 \mathrm{v}, \quad \mathrm{I}_{\mathrm{E}}=0, \quad \mathrm{~T}_{\mathrm{A}}=150^{\circ} \mathrm{C}$ |  | 15 |  | 15 | $\mu$ |
| IENO | Emitter Cutoff Current | $\mathrm{V}_{\mathrm{Et}}=5 \mathrm{v}, \quad \mathrm{Ic}_{\mathrm{c}}=0$ |  | 50 |  | 50 | no |
| $h_{\text {fe }}$ | Static Forward Current Tronsfer Ratio | $\mathrm{V}_{\mathrm{CE}}=10 \mathrm{v}, \quad \mathrm{I}_{\mathrm{C}}=100 \mu \mathrm{O}$ | 15 |  | 15 |  |  |
|  |  | $V_{C E}=10 \mathrm{v}, \quad \mathrm{Ic}_{\mathrm{c}}=10 \mathrm{ma}$ | 30 |  | 30 |  |  |
|  |  | $V_{C E}=10 \mathrm{v}, \quad I_{C}=10 \mathrm{ma}, \mathrm{T}_{\mathrm{A}}=-55^{\circ} \mathrm{C}$ | 20 |  | 20 |  |  |
|  |  | $V_{\text {ce }}=10 \mathrm{v}, \quad I_{c}=150 \mathrm{ma}$, See Note 4 | 40 | 120 | 40 | 120 |  |
|  |  | $V_{C E}=10 \mathrm{r}, \quad \mathrm{I}_{\mathrm{C}}=500 \mathrm{ma}$, See Note 4 | 15 |  | 15 |  |  |
|  |  | $V_{C E}=1 \mathrm{iv}, \quad \mathrm{I}_{\mathrm{c}}=150 \mathrm{ma}$, See Note 4 | 30 |  | 30 |  |  |
| $V_{\text {re }}$ | Bpse-Emitter Volitage | $\mathrm{I}_{\mathrm{B}}=15 \mathrm{ma}, \quad \mathrm{I}_{\mathrm{c}}=150 \mathrm{ma}$ |  | 1.3 |  | 1.3 | $v$ |
| $V_{\text {cEfati }}$ | Collector-Emitter Saturation Voltoge | $\mathrm{I}_{\mathrm{c}}=15 \mathrm{ma}, \quad \mathrm{lc}_{\mathrm{c}}=150 \mathrm{ma}$ |  | 0.35 |  | 0.25 | v |
| \| $\mathrm{h}_{\text {c }}$ \| | Small-Signal Common-Emitter Forward Curront Tronsfor Ratio | $V_{C E}=10 \mathrm{v}, \quad \mathrm{IC}_{\mathbf{C}}=50 \mathrm{ma}, \mathrm{t}=20 \mathrm{mc}$ | 2.5 |  | 2.5 |  |  |
| $C_{\infty}$ | Common-Base Open-Circuit Output Capocitance | $\mathrm{V}_{\mathrm{CL}}=10 \mathrm{r}, \quad \mathrm{l}_{\mathrm{E}}=0, \quad \mathrm{f}=1 \mathrm{mk}$ |  | 15 |  | 15 | 1 |

*switching characteristics at $\mathbf{2 5}{ }^{\circ} \mathrm{C}$ free-air temperature

| Parameter | TEST CONDITIONS | $\begin{aligned} & \text { 2N2243 } \\ & \text { 2N2243A } \end{aligned}$ | UNIT |
| :---: | :---: | :---: | :---: |
|  |  | MAX |  |
| $\tau_{\mathrm{b}} \quad$ Stored-Charge Ilme Constiant | See Figure 1 | 2.1 | $\mu \mathrm{sck}$ |

NOTE 4: These paremolors must De meesured using palso texiniques. PW $=300 \mu \mathrm{sec}$, Duty Cyelo $\leq 2 \%$.
*Indicefes JEDEC registored dala

## PARAMETER MEASUREMENT INFORMATION


*FICuRE I - STORED-CHARSE TIME CONSTANT - $T_{b}$

[^50]
## - Indicates JEDEC registered data.

# SILECT ${ }^{\dagger}$ TRANSISTOR $\ddagger$ FOR MEDIUM-POWER SWITCHING AND AMPLIFIER APPLICATIONS <br> - High V(BR)CBO ... 120 V <br> - hfe Guaranteed from $\mathbf{1 0 0} \mu \mathrm{A}$ to $\mathbf{5 0 0} \mathrm{mA}$ <br> - fT . . . 50 MHz Min <br> - Electrically Similar to 2N2243A 

## mechanical data

This transistor is encapsulated in a plastic compound specifically designed for this purpose, using a highly mechanized process developed by Texas Instruments. The case will withstand soldering temperatures without deformation. This device exhibits stable characteristics under high-humidity conditions and is capable of meeting MIL-STD-202C, Method 106B. The transistor is insensitive to light.


NOTES: A. Lead diameter is not controlled in this area.
B. Leads having maximum diameter ( 0.019 ) shall be within 0.007 of their true positions measured In the gaging plane 0.054 below the seating plane of the device relative to a maximum. diameter pack age.
C. All dimensions are in inches.
absolute maximum ratings at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)
Collector-Base Voltage ..... 120 V
Collector-Emitter Voltage (See Note 1) ..... 80 V
Emitter-Base Voltage ..... 7 V
Continuous Collector Current ..... 1 A
Continuous Device Dissipation at (or below) $25^{\circ} \mathrm{C}$ Free-Air Temperature (See Note 2) ..... 625 mW
Continuous Device Dissipation at (or below) $\mathbf{2 5 ^ { \circ }} \mathrm{C}$ Lead Temperature (See Note 3) ..... 1.25 W
Continuous Device Dissipation at (or below) $\mathbf{2 5}{ }^{\circ} \mathrm{C}$ Case-and-Lead Temperature (See Note 4) ..... 1.6 W
Storage Temperature Range ..... $-65^{\circ} \mathrm{C}$ to $150^{\circ} \mathrm{C}$
Lead Temperature 1/16 Inch from Case for 10 Seconds ..... $260^{\circ} \mathrm{C}$

NOTES: 1. This value applies when the base-amitter diode is open-circuited.
2. Derate lineariy to $150^{\circ} \mathrm{C}$ free-air temperature at the rate of $5 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$.
3. Darate linearly to $150^{\circ} \mathrm{C}$ lead temperature at the rate of $10 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$. Lead temperature is measured on the collector lead $1 / 16$ inch from the casa.
4. This rating applies with the entire case (including the leads) maintained at $25^{\circ} \mathrm{C}$. Derate linearly to $150^{\circ} \mathrm{C}$ case-and-lead temperature at the rate of $12.8 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$.

[^51]
## TYPE A5T2243 <br> N-P-N SILICON TRANSISTOR

electrical characteristics at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

| PARAMETER | TEST CONDITIONS | MIN MAX | UNIT |
| :---: | :---: | :---: | :---: |
| $\mathrm{V}_{\text {(BR) }}$ CBO Collector-Base Breakdown Voltage | $I_{C}=100 \mu A, \quad I_{E}=0$ | 120 | $V$ |
| $\mathrm{V}_{(B R) C E O}$ Collector-Emitter Breakdown Voltage | $\mathrm{I}_{C}=25 \mathrm{~mA}, \mathrm{I}_{B}=0, \quad$ See Note 5 | 80 | V |
| V(BR)EBO Emitter-Base Breakdown Voltage | $\mathrm{I}_{\mathrm{E}}=100 \mu \mathrm{~A}, \mathrm{I}_{\mathrm{C}}=0$ | 7 | $\checkmark$ |
| Collector Cutoff Current | $\mathrm{V}_{C B}=60 \mathrm{~V}, \mathrm{I}_{\mathrm{E}}=0$ | 10 | nA |
|  | $V_{C B}=60 \mathrm{~V}, \mathrm{I}^{2}=0, \quad \mathrm{TA}^{2}=100^{\circ} \mathrm{C}$ | 1 | $\mu \mathrm{A}$ |
| IEBO Emitter Cutoff Current | $\mathrm{V}_{\mathrm{EB}}=5 \mathrm{~V}, \quad \mathrm{I}^{\prime}=0$ | 50 | nA |
| Static Forward Current Transfer Ratio | $V_{C E}=10 \mathrm{~V}, \mathrm{I}^{\prime}=100 \mu \mathrm{~A}$ | 15 |  |
|  | $\mathrm{V}_{\text {CE }}=10 \mathrm{~V}, \mathrm{IC}=10 \mathrm{~mA}$ | 30 |  |
|  | $\mathrm{V}_{\text {CE }}=10 \mathrm{~V}, \mathrm{I} \mathrm{C}=150 \mathrm{~mA}$ | $40 \quad 120$ |  |
|  | $V_{C E}=10 \mathrm{~V}, 1 \mathrm{C}=500 \mathrm{~mA}$ See Note 5 | 15 |  |
|  | $V_{C E}=1 \mathrm{~V}, \quad I_{C}=150 \mathrm{~mA}$ | 30 |  |
| VBE Base-Emitter Voltage | $\mathrm{I}_{B}=15 \mathrm{~mA}, \quad I_{C}=150 \mathrm{~mA}$, See Note 5 | 1.3 | V |
| VCE(sat) Collector-Emitter Saturation Voltage | $\mathrm{I}_{\mathrm{B}}=15 \mathrm{~mA}, \mathrm{I}_{C}=150 \mathrm{~mA}$, See Note 5 | 0.25 | V |
| $\beta_{\text {fel }}$ Small-Signal Common-Emitter <br> Forward Current Transfer Ratio | $V_{C E}=10 \mathrm{~V}, \mathrm{I}^{\prime}=50 \mathrm{~mA}, \quad f=20 \mathrm{MHz}$ | 2.5 |  |
| Cobo Common-Base Open-Circuit <br> Output Capacitance | $V_{C B}=10 \mathrm{~V}, \mathrm{l} E=0, \quad \mathrm{f}=1 \mathrm{MHz}$ | 15 | pF |


switching characteristics at $25^{\circ} \mathrm{C}$ free-air temperature

| PARAMETER | TEST CONDITIONS | MIN | MAX | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: |
| $\tau_{\mathrm{b}}$ | Stored-Charge Time Constant | See Figure 1 | 2.1 | $\mu \mathrm{~s}$ |

PARAMETER MEASUREMENT INFORMATION


TEST CIRCUIT


VOLTAGE WAVEFORMS

NOTES: a. Waveforms are monitored on an oscilloscope with the following characteristics: $t_{r} \leqslant 14 \mathrm{~ns}, \mathrm{R}_{\mathrm{in}}=10 \mathrm{M} \Omega, \mathrm{C}_{\mathrm{in}}=11.5 \mathrm{pF}$. b. The relay is Clare HG 1005 (or equivelent).

FIGURE 1-STORED-CHARGE TIME CONSTANT- $\tau_{b}$

## FOR MEDIUM-POWER, GENERAL PURPOSE APPLICATIONS

*mechanical data
THE COLLECTOR IS IN ELECTRICAL CONTACT WITH THE CASE

## absolute maximum ratings at $\mathbf{2 5}{ }^{\circ} \mathrm{C}$ case temperature (unless otherwise noted)


*electrical characteristics at $25^{\circ} \mathrm{C}$ case temperature (unless otherwise noted)

| PARAMETER | TEST CONDITIONS | MIN MAX | UNIT |
| :---: | :---: | :---: | :---: |
| V(BR)CEO Collector-Emitter Breakdown Voltage | $\mathrm{I}_{\mathrm{C}}=100 \mathrm{~mA}, \mathrm{I}_{\mathrm{B}}=0, \quad$ See Note 5 | 45 | V |
| $\mathrm{V}_{\text {(BR) }}$ CER Collector-Emitter Breakdown Voltage | $\mathrm{I}_{\mathrm{C}}=100 \mathrm{~mA}, \mathrm{R}_{\mathrm{BE}}=10 \Omega$, See Note 5 | 60 | $V$ |
| $V_{\text {(BR)EBO }}$ Emitter-Base Breakdown Voltage | $\mathrm{IE}_{\mathrm{E}}=0.1 \mathrm{~mA}, \mathrm{IC}^{\prime}=0$ | 7 | V |
|  | $V_{C B}=60 \mathrm{~V}, \mathrm{I}_{\mathrm{E}}=0$ | 50 | nA |
| Icbo Collector Cutoff Current | $V_{C B}=60 \mathrm{~V}, \mathrm{I}_{\mathrm{E}}=0, \quad \mathrm{~T}_{\mathrm{C}}=150^{\circ} \mathrm{C}$ | 50 | $\mu \mathrm{A}$ |
| IEBO Emitter Cutoff Current | $V_{E B}=5 \mathrm{~V}, \quad I_{C}=0$ | 100 | nA |
|  | $V_{C E}=10 \mathrm{~V}, \mathrm{I}_{C}=1 \mathrm{~mA}$ | 30 |  |
| hFE $\quad$ Static Forward Current Tra | $\mathrm{V}_{C E}=10 \mathrm{~V}, \mathrm{IC}=150 \mathrm{~mA}$, See Note 5 | 50200 |  |
| $V_{\text {BE }} \quad$ Base-Emitter Voltage | $\mathrm{I}_{B}=15 \mathrm{~mA}, \mathrm{I}_{\mathrm{C}}=150 \mathrm{~mA}$, See Note 5 | 1.2 | V |
| $\mathrm{V}_{\text {CE }}(\mathrm{sat})$ Collector-Emitter Saturation Voltage | $I_{B}=15 \mathrm{~mA}, \quad I^{\prime}=150 \mathrm{~mA}$, See Note 5 | 0.9 | V |
| $\mathrm{h}_{\mathrm{fe}}$ Small-Signal Common-Emitter <br>  Forward Current Transfer Ratio | $V_{C E}=10 \mathrm{~V}, \mathrm{I}^{\prime}=5 \mathrm{~mA}, \quad f=1 \mathrm{kHz}$ | 50275 |  |
| \|hel $\quad$ Small-Signal Common-Emitter | $V_{C E}=10 \mathrm{~V}, \mathrm{IC}=50 \mathrm{~mA}, \quad f=20 \mathrm{MHz}$ | 5 |  |
| $\mathrm{f}_{\mathrm{T}} \quad$ Transition Frequency | $V_{C E}=10 \mathrm{~V}, I_{C}=50 \mathrm{~mA}$, See Note 6 | 100 | MHz |
| Cobo Common-Base Open-Circuit Output Capacitance | $V_{C B}=10 \mathrm{~V}, \mathrm{I}_{\mathrm{E}}=0, \quad f=1 \mathrm{MHz}$ | 15 | pF |
| $\mathrm{C}_{\text {ibo }}$ Common-Base Open-Circuit Input Capacitance | $V_{E B}=0.5 \mathrm{~V}, \mathrm{I}^{\prime}=0, \quad f=1 \mathrm{MHz}$ | 80 | pF |

NOTES: 1. This value applies when the base-emitter diode is open-circuited.
2. This value applles when the base-mittor resistance $\mathrm{R}_{\mathrm{BE}}<10 \Omega$.
3. Derate innarly to $200^{\circ} \mathrm{C}$ free-air temperature st the rate of $5.71 \mathrm{mw} /{ }^{\circ} \mathrm{C}$.
4. Derate the 10 -watt rating linearly to $200^{\circ} \mathrm{C}$ case temperature at the rate of $57.1 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$. Derate the 5 -watt (JEDEC registered) rating linearly to $200^{\circ} \mathrm{C}$ case temparature at the rate of $28.6 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$.
6. These parameters must be measured using pulse techniques. $\tau_{w}=300 \mu \mathrm{~s}$, duty cycle $<2 \%$.
6. To obtain $f_{T}$, the $h_{f e} \mid$ rasponse with frequency is extrapolated at the rate of $\mathbf{- 6} \mathbf{d B}$ per octave from $f=20 \mathrm{MHz}$ to the frequency at which $\left|h_{f e}\right|=1$.
*thermal characteristics

| Parameter |  | Max | UNIT |
| :---: | :---: | :---: | :---: |
| $\mathrm{P}_{\boldsymbol{\theta} \mathrm{JC}}$ | Junction-to-Case Thermal Resistance | 35 |  |
| $\mathrm{R}_{\boldsymbol{\theta} \mathrm{J} \text { A }}$ | Junction-to.Free-Air Thermal Resititance | 175 | CN |

*operating characteristics at $\mathbf{2 5}{ }^{\circ} \mathrm{C}$ case temperature

| PARAMETER |  | TEST CONDITIONS | MIN MAX | UNIT |
| :---: | :---: | :---: | :---: | :---: |
| $F$ | Spot Noise Figure | $\begin{aligned} & V_{C E}=10 \mathrm{~V}, \quad I_{C}=0.3 \mathrm{~mA}, \quad R_{G}=1 \mathrm{k} \Omega, \\ & f=1 \mathrm{kHz} \end{aligned}$ | 10 | dB |

*switching characteristics at $25^{\circ} \mathrm{C}$ case temperature

| PARAMETER | TEST CONDITIONS | MIN | MAX | UNIT |
| :---: | :---: | :---: | :---: | :---: |
| TT | Sotal Switching Time | Sigure 1 | 30 | ns |

PARAMETER MEASUREMENT INFORMATION


FIGURE 1-SWITCHING TIME MEASUREMENT CIRCUIT

NOTES: 7. The input waveform is supplied by a mercury relay pulse generator with the following characteristics: $\mathbf{t}_{\boldsymbol{r}} \leqslant 1 \mathbf{n s}$, $\mathbf{t}_{\boldsymbol{f}} \leqslant \mathbf{1} \mathbf{n s}$ $t_{w}=15 \mathrm{~ns}, Z_{\text {out }}=50 \Omega$. Adjust $R 1$ and the input puise ampiltude to obtain the specified voltage levels at Point $A$.
8. Waveforms are monitored on a sampling oscilloscope ( $\mathrm{t}_{\mathrm{r}} \leqslant 0.4 \mathrm{~ns}$ ) using a $2 \mathrm{k} \$ 2$ probe.

- JEDEC registered data


# DESIGNED FOR AUDIO AND GENERAL PURPOSE AMPLIFIER APPLICATIONS 

## *mechanical data


*absolute maximum ratings of $25^{\circ} \mathrm{C}$ free-air temperature (uniess otherwise noted)


MOTES: 1. This value applies when the baso-minitter resistence $\mathrm{R}_{\text {we }} \leq 10 \Omega$.
2. This value applies when the baso-mmitter diedo is open-circuliod.
3. Derate linearly to $175^{\circ} \mathrm{C}$ free-air temperature at the rate of $4 \mathrm{~mW} / \mathrm{deg}$.
4. Derate lineorly to $175^{\circ} \mathrm{C}$ cess thmperefure at the rite of $13.3 \mathrm{~mW} / \mathrm{dog}$.
*Indicutes JEDEC mistorvad deta.

## *electrical characteristics at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

| PARAMETER |  | TEST CONDITIONS |  | MIN | MAX | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| $V_{\text {rapaceo }}$ | Collector-Base Breakdown Voltage | $\mathrm{I}_{\mathrm{C}}=-100 \mu \mathrm{~h}, \mathrm{I}_{\mathrm{E}}=0$ |  | -50 |  | $V$ |
| V ${ }_{\text {liericeo }}$ | Collector-Emitter Braekdown Voltage | $\mathrm{I}_{\mathrm{c}}=-100 \mathrm{~mA}, \mathrm{I}_{\mathrm{B}}=0$ | Seo Note 5 | -35 |  | $V$ |
| $V_{\text {frajer }}$ | Collector-Emitter Breakdown Voltage | $\mathrm{I}_{\mathrm{C}}=-100 \mathrm{~mA}, \mathrm{R}_{\text {RE }}=10 \Omega$, | See Note 5 | -50 |  | $V$ |
|  | Emitter-Base Breakdown Voltage | $\mathrm{I}_{\mathrm{E}}=-100 \mu \mathrm{~A}, \mathrm{I}_{\mathrm{C}}=0$ |  | -5 |  | $V$ |
| Icao | Collector Cutoff Current | $\mathrm{V}_{\mathrm{CB}}=-30 \mathrm{~V}, \quad \mathrm{I}_{\mathrm{E}}=0$ |  |  | -1 | $\mu \mathrm{A}$ |
|  |  | $V_{C B}=-30 V_{1}, I_{E}=0$, | $\mathrm{T}_{\mathrm{A}}=150^{\circ} \mathrm{C}$ |  | -100 | $\mu \mathrm{A}$ |
| IEso | Emitter Cutoff Current | $V_{E B}=-2 V_{1} \quad I_{C}=0$ |  |  | -100 | $\mu \mathrm{A}$ |
| hre | Static Forward Curent Transfer Rotio | $V_{C E}=-10 \mathrm{~V}_{1} \quad \mathrm{I}_{\mathrm{C}}=-5 \mathrm{~mA}$, | Soe Note 5 | 75 |  |  |
|  |  | $V_{\text {CE }}=-10 \mathrm{~V}, \quad i_{C}=-150 \mathrm{~mA}$, | See Note 5 | 75 | 200 |  |
| $V_{\text {EE }}$ | Base-Emitter Voltage | $\mathrm{I}_{\mathrm{B}}=-15 \mathrm{~mA}, \quad \mathrm{I}_{\mathrm{C}}=-150 \mathrm{~mA}$, | See Mote 5 |  | -1.3 | $v$ |
| $\mathrm{V}_{\text {CE }}$ | Collector-Emitter Saturation Voltoge | $\mathrm{I}_{\mathrm{B}}=-15 \mathrm{~mA}, \quad \mathrm{I}_{\mathrm{c}}=-150 \mathrm{~mA}$, | See Note 5 |  | -1.5 | $V$ |
| $\mathrm{h}_{\mathrm{ib}}$ | Small-Signal Common-Base Input Impedance | $V_{C B}=-5 \mathrm{~V}_{\text {, }} \quad \mathrm{I}_{\mathrm{C}}=-1 \mathrm{~mA}$ | $1=1 \mathrm{kHz}$ | 25 | 35 | $\boldsymbol{\Omega}$ |
|  |  | $V_{C B}=-10 V^{\prime}, I_{C}=-5 \mathrm{~mA}$, | $\mathrm{t}=1 \mathrm{kHz}$ |  | 10 | $\boldsymbol{\Omega}$ |
| $\mathrm{h}_{6}$ | Small-Signal Common-Emitter Forward Current Transter Ratio | $V_{C E}=-5 \mathrm{~V}_{1} \quad \mathrm{I}_{\mathrm{C}}=-1 \mathrm{~mA}$, | $1=1 \mathrm{kHz}$ | 75 | 300 |  |
|  |  | $V_{C E}=-10 \mathrm{~V}, \quad \mathrm{I}_{\mathrm{C}}=-5 \mathrm{~mA}$, | $\mathrm{f}=1 \mathrm{kHz}$ | 75 |  |  |
| $h_{\text {rb }}$ | Small-Signol Common-Bose Reverse Voltage Tronsfer Ratio | $V_{C E}=-5 \mathrm{~V}_{\text {, }} \quad \mathrm{I}_{\mathrm{C}}=-1 \mathrm{~mA}$, | $f=1 \mathrm{kHz}$ |  | $8 \times 10^{-4}$ |  |
|  |  | $V_{\text {CB }}=-10 \mathrm{~V}, \quad \mathrm{I}_{\mathrm{C}}=-5 \mathrm{~mA}$, | $i=1 \mathrm{kHz}$ |  | $8 \times 10^{-4}$ |  |
| $h_{\text {ob }}$ | Small-Signal Common-Base Output Admiftence | $V_{C B}=-5 \mathrm{~V}, \quad \mathrm{I}_{\mathrm{C}}=-1 \mathrm{~mA}$, | $f=1 \mathrm{kHz}$ |  | 1 | $\mu \mathrm{mho}$ |
|  |  | $V_{C B}=-10 \mathrm{~V}, \quad \mathrm{I}_{\mathrm{C}}=-5 \mathrm{~mA}$, | $f=1 \mathrm{kHz}$ |  | 5 | $\mu \mathrm{md}$ |
| \|hiol | Small-Signol Common-Emitter Forward Current Tronsfer Rotio | $V_{C E}=-10 \mathrm{~V}, \quad \mathrm{I}_{\mathrm{C}}=-50 \mathrm{~mA}$, | $f=20 \mathrm{MHz}$ | 3 |  |  |
| Cobo | Common-Base Open-Girvit Output Copacitance | $V_{C I}=-10 \mathrm{~V}, \quad \mathrm{I}_{\mathrm{E}}=0$, | $f=140 \mathrm{kHz}$ |  | 45 | pF |
| $C_{\text {ibo }}$ | Common-Base Open-Circuit Input Capacitance | $V_{E \pm}=-0.5 \mathrm{~V}, \quad \mathrm{I}_{\mathbf{c}}=0$, | $f=140 \mathrm{kHz}$ |  | 80 | pF |

mote 5: These peramelers must be measured usiang pulse techniquos. $\mathrm{t}_{\mathrm{p}}=\mathbf{3 0 0} \mu \mathrm{s}$, duly cycle $\leq 1 \%$.
*indicates JEBEC regisfored dato

## AUDIO- TO HIGH-FREQUENCY SMALL-SIGNAL AMPLIFIERS <br> 2N2386A offers the following improvements resulting from process innovation: <br> - $\left|\mathrm{Y}_{\mathrm{is}}\right|$ Min Raised from 1 mmho to 2.2 mmho <br> - Ciss Max Lowered from 50 pF to 10 pF

*mechanical data

*absolute maximum ratings at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

*electrical characteristics at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

| PARAMETER |  | TEST CONDITIONS | 2N2386 | 2N2386A | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | MIN MAX | MIN MAX |  |
|  | Drain-Gate Breakdown Voltage (Soe Mote 3) |  | $l_{0}=-10 \mu A_{1} I_{s}=0$ | -20 | -20 | V |
| Igss | Gate Reverse Current | $V_{G S}=10 \mathrm{~V}, V_{\text {DS }}=0$ | 10 | 10 | nA |
|  |  | $V_{G S}=10 \mathrm{~V}, V_{\text {DS }}=0, T_{A}=100^{\circ} \mathrm{C}$ | 1 | 1 | $\mu \mathrm{A}$ |
| IDIom | Drain Cutoff Current | $V_{\text {DS }}=-12 \mathrm{~V}, \mathrm{~V}_{\text {GS }}=8 \mathrm{~V}$ | -10 | -0.01 | $\mu \mathrm{A}$ |
| loss | Zero-Gato-Voltage Drain Current | $V_{D S}=-10 V_{,} V_{S S}=0$ |  | -1-15 | mA |
| \| $y_{i s}$ \| | Small-Signal Common-Source Input Admittance | $\mathrm{V}_{\mathrm{DS}}=-10 \mathrm{~V}, \mathrm{~V}_{\mathrm{GS}}=0, \mathrm{f}=1 \mathrm{kHz}$ | 0.3 | 0.1 | $\mu \mathrm{mh}$ |
| $\left\|\boldsymbol{y}_{\boldsymbol{t}}\right\|$ | Small-Signal Common-Source Forward Transfer Admittance | $V_{\text {DS }}=-10 \mathrm{~V}, \mathrm{~V}_{\mathrm{GS}}=0,1=1 \mathrm{kHz}$ | 1 | 2.25 | mmho |
| $\mathrm{C}_{\text {is }}$ | Common-Source Shor-Circuit Input Capocitance | $V_{D S}=-10 \mathrm{~V}, \mathrm{~V}_{S S}=0,1=0.1 \mathrm{MHz}$ to $1 \mathrm{MHz}_{2}$ | 50 | 10 | pf |

NOTES: 1. Derate linearly to $175^{\circ} \mathrm{C}$ frea-air temperature of the rate of $3.3 \mathrm{~mW} /$ deg.
2. Derate linearly to $175^{\circ} \mathrm{C}$ case tomperature at the rate of $10 \mathrm{~mW} / \mathrm{deg}$.
 Vollage for other velues of $\left.\mathbf{V}_{\mathbf{G S}}\right)$ may be colculated from: $\left|\mathbf{V}_{\text {(Gi) }) \text { DSV }}\right| \cong\left|\mathbf{V}_{\text {(GR)DGO}}\right|-\left|\mathbf{V}_{\mathbf{G S}}\right|$.

[^52]> FOR EXTREMELY LOW-LEVEL, LOW-NOISE, HIGH-GAIN, AMPLIFER APPLICATIONS Formerly T1420 and TI 421
> - Guaranteed $h_{\text {fe }}$ at $10 \mu \mathrm{a}, \mathrm{T}_{\mathrm{A}}=-55^{\circ} \mathrm{C}$ and $+25^{\circ} \mathrm{C}$
> - Guarantoed Low-Noise Characteristics at $10 \mu \mathrm{a}$
> - Usable at Colloctor Currents as Low as $1 \mu a$
> - Electrically Similar to 2N929 and 2N930
> - Compatible Package for Interfacing with Integratod Circuits and Thin-Film Modules

## mechanical dofa

The transistors are in a hermetically sealed welded package meeting the JEDEC TO-50 outline.

*absolute maximum ratings at $\mathbf{2 5}{ }^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)


MOTES: 1 . This valve applies whan the base-amittor diedo is apen-sirevited.
2. Dersite linearly to $175^{\circ} \mathrm{C}$ hree-air tempermura at the rete of $2 \mathrm{~mm} / \mathrm{C}^{\circ}$.
3. Derets ligently to $175^{\circ} \mathrm{C}$ cese tomperature at the mine of $6.66 \mathrm{~mm} / \mathrm{C}^{\circ}$.
*Indicetes JEDEC magisterod date.
*electrical characteristics at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

| PARAMETER |  | TEST CONDITIONS | 2N2387 |  | 2N2388 |  | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | MIN | MAX | MIN | MAX |  |
| $V_{\text {( }}^{\text {(ry]ce }}$ O | Coliector-Emitter Breakdown Voltage |  | $I_{c}=10 \mathrm{ma}, I_{B}=0, \quad$ See Note 4 | 45 |  | 45 |  | $v$ |
| $V_{\text {(Br) }}$ | Emitter-Base Breakdown Vołtage | $l_{E}=10 \mathrm{na}, \mathrm{I}_{C}=0$ | 5 |  | 5 |  | $v$ |
| Icmo | Collector Cutoff Current | $V_{C B}=45 \mathrm{v}, \mathrm{l}_{\mathrm{E}}=0$ |  | 10 |  | 10 | no |
| Ices | Collector Cutoff Current | $V_{\text {CE }}=45 \mathrm{v}, \mathrm{V}_{\text {®E }}=0$ |  | 10 |  | 10 | na |
|  |  | $V_{C E}=45 \mathrm{v}, \mathrm{V}_{\text {侑 }}=0, \quad \mathrm{~T}_{\mathrm{A}}=170^{\circ} \mathrm{C}$ |  | 10 |  | 10 | $\mu \mathrm{m}$ |
| $\mathrm{I}_{\text {ceo }}$ | Collector Cutoff Curront | $V_{C E}=5 \mathrm{v}, \quad \mathrm{l}_{\mathrm{E}}=0$ |  | 2 |  | 2 | na |
| $\mathrm{I}_{\text {ESO }}$ | Emitter Cutoff Current | $v_{E E}=5 \mathrm{v}, \quad \mathrm{I}_{\mathrm{C}}=0$ |  | 10 |  | 10 | no |
| $h_{\text {fe }}$ | Static Forward Current Transter Ratio | $V_{C E}=5 v_{1}, \quad I_{C}=10 \mu \mathrm{a}$ | 40 | 120 | 100 | 300 |  |
|  |  | $\mathrm{V}_{C E}=5 \mathrm{v}, \quad \mathrm{IC}_{C}=10 \mu \mathrm{a}, \quad \mathrm{T}_{\mathrm{A}}=-55^{\circ} \mathrm{C}$ | 10 |  | 20 |  |  |
|  |  | $V_{C E}=5 \mathrm{v}, \quad \mathrm{I}_{\mathrm{C}}=500 \mu \mathrm{a}$ | 60 |  | 150 |  |  |
|  |  | $V_{\text {CE }}=5 \mathrm{v}, \quad \mathrm{I}_{\mathrm{C}}=10 \mathrm{ma}$, See Mote 4 |  | 350 |  | 600 |  |
| $V_{\text {IE }}$ | Base Emitter Voltage | $\mathrm{I}_{\mathrm{g}}=0.5 \mathrm{ma}, \mathrm{ic}_{\mathrm{c}}=10 \mathrm{ma}$, See Note 4 | 0.6 | 1.0 | 0.6 | 1.0 | $v$ |
| $\mathrm{V}_{\text {CE }(2+1)}$ | Colliector-Emitter Saturation Voltage | $\mathrm{I}_{\mathrm{B}}=0.5 \mathrm{ma}, \mathrm{I}_{\mathrm{C}}=10 \mathrm{ma}$, See Note 4 |  | 1.0 |  | 1.0 | $v$ |
| $h_{\text {ib }}$ | Smali-Signol Common-Base Input Impedance | $V_{c t}=5 \mathrm{v},$$l_{E}=-1 \mathrm{mo},$$f=\mathbf{I k c}$ | 25 | 32 | 25 | 32 | $\Omega$ |
| $\mathrm{hrb}^{\text {b }}$ | Small-Signal Common-Base Reverse Voltage Iransier Ratio |  | 0 | 6x10-4 | 0 | $6 \times 10^{-4}$ |  |
| $\mathrm{h}_{\text {ob }}$ | Small-Signal Common-Base Output Admittance |  | 0 | 1 | 0 | 1 | $\mu \mathrm{mho}$ |
| $\mathrm{h}_{6}$ | Smail-Signal Common-Emitter Forward Current Transfer Ratio | $V_{\text {ce }}=5 \mathrm{v}, \quad \mathrm{I}_{\mathrm{C}}=1 \mathrm{ma}, \quad \mathrm{t}=1 \mathrm{lkc}$ | 60 | 350 | 150 | 600 |  |
| \| $\mathrm{h}_{\text {fol }}$ \| | Small-Signal Common-Emifter Forward Current Iranster Ratio | $V_{C E}=5 \mathrm{v}, \quad \mathrm{I}_{\mathrm{C}}=500 \mu \mathrm{a}, \mathrm{f}=30 \mathrm{Mc}$ | 1 |  | 1 |  |  |
| $C_{\text {bob }}$ | Common-Base Open-Circuil Output Capacitance | $V_{C B}=5 \mathrm{r}, \quad \mathrm{I}_{\mathrm{E}}=0, \quad f=1 \mathrm{Mc}$ |  | 8 |  | 8 | pf |

*operating characteristics at $25^{\circ} \mathrm{C}$ free-air temperature

| PARAMETER |  | TEST CONDITIONS | 2N2387 | 2N2388 | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | MAX | MaX |  |
| $\overline{\text { NF }}$ | Average Noise Figure |  | $V_{C B}=5 \mathrm{v}, \quad I_{E}=-10 \mu a_{,}, R_{G}=10 \mathrm{k} \Omega$ <br> Noise Bandwidth 10 cps to 15.7 kc | 4 | 3 | db |

Note: 4. These parameters must be measurod using pulse techniquos. PW =300 $\mu$ soc, Duty cyclo $\leq 2 \%$.

* Indicatas Jedec registered data.


## FOR GENERAL PURPOSE AMPLIFER AND SWITCHING APPLLCATIONS

## FROM < 0.1 ma to $>150 \mathrm{ma}$, de to 30 Mc Formerly TI 424 and TI 425

- Electrically Similer to 2N1613 and 2N1711
- Compartible Package for Interfacing with Integrated Circuits and Thim-Film Modules
mechanical defe
The transistors are in a hermetically sealed welded package meeting the JEDEC TO-50 outline.

*absolute maximum ratings at $25^{\circ} \mathrm{C}$ free-air tomperature (unless otherwise noted)
Collector-Base Voltage . . . . . . . . . . . . . . . . . . . . . . . . . 75 r

Collector-Emitter Voltage (See Note 1) . . . . . . . . . . . . . . . . . . . . 50 r
Emitter-Base Voltage . . . . . . . . . . . . . . . . . . . . . . . . . . 7 v
Collector Current . . . . . . . . . . . . . . . . . . . . . . . . . . 500 ma
Continuous Device Dissipation at (or below) $25^{\circ} \mathrm{C}$ Free-Air Temperature (See Note 2) . . . . 450 mw
Continuous Device Dissipation at (or below) $25^{\circ} \mathrm{C}$ Case Temperature (See Note 3) . . . . . . 1.5 w
Operating Collector Junction Temperature . . . . . . . . . . . . . . . . . . . $200^{\circ} \mathrm{C}$
Storage Tomperature Range . . . . . . . . . . . . . . . . . . . $-65^{\circ} \mathrm{C}$ to $+200^{\circ} \mathrm{C}$
Lead Temperature $K_{t}$ Inch from Case For 10 Seconds . . . . . . . . . . . . . . . $230^{\circ} \mathrm{C}$
*electrical characteristics of $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

| PARAMETER | TEST CONDITIONS | 2N2389 | 2N2390 | UNIT |
| :---: | :---: | :---: | :---: | :---: |
|  |  | MIN MAX | MIN MAX |  |
| Vieniceo Collecter-lase Irockdoum Yoltege | $\mathrm{I}_{\mathrm{c}}=100 \mu 0, \mathrm{I}_{5}=0$ | 75 | 75 | $V$ |
|  | $\mathrm{I}_{\mathrm{C}}=100$ me, R $\mathrm{R}_{\text {ce }}=10 \mathrm{D}, \mathrm{Seo}$ Mete 4 | 50 | 50 | $v$ |
|  | $\mathrm{I}_{\mathrm{E}}=100 \mu \mathrm{~m}, \mathrm{I}_{\mathbf{C}}=0$ | 7 | 7 | $v$ |
| ICoO Ciloctor Cuteff Corrent | $\mathbf{Y}_{\mathbf{C E}}=60 \mathrm{v}_{\mathrm{E}} \mathrm{I}_{\mathrm{E}}=0$ | 10 | 10 | Hat |
|  | $V_{C B}=60$ v, $I_{5}=0, \quad T_{A}=150^{\circ} \mathrm{C}$ | 10 | 10 | $\boldsymbol{\mu}$ |
| Ifto Emilfer Cerofi Cwrmal | $y_{\text {fe }}=5$ v, $\mathrm{I}_{\mathrm{C}}=0$ | 10 | 5 | na |
| Stetic Fowwerd Curnat$\mathrm{H}_{\text {Re }} \quad$ Trensfor llathe | $V_{C E}=10 v_{0} I_{C}=10 \mu \mathrm{~m}$ |  | 21 |  |
|  | $v_{C s}=10 v_{0} I_{C}=100 \mu$ | 24 | 35 |  |
|  |  | 35 | 75 |  |
|  | $Y_{C E}=10 v_{1} \mathrm{I}_{\mathrm{C}}=10 \mathrm{me}, \mathrm{T}_{\mathbf{A}}=-55^{\circ} \mathrm{C}$, | 20 | 35 |  |
|  | $Y_{C E}=10 r_{\text {c }} \mathrm{I}_{\mathrm{C}}=150$ me, Sue Moto 4 | 40124 | $100 \quad 300$ |  |
|  |  | 20 | 40 |  |
| $\Psi_{\text {ES }}$ | $\mathrm{I}_{\mathrm{E}}=15 \mathrm{me}, \mathrm{l}_{\mathrm{c}}=150 \mathrm{~mm}, \mathrm{sen}$ Note 4 | 0.41 .3 | 0.61 .3 | $v$ |
| $V_{\text {Cespati }}$ Collocter-Emititer Seluration Velteg | $\mathrm{I}_{\mathrm{E}}=15 \mathrm{me}, \mathrm{I}_{\mathrm{C}}=150 \mathrm{ma}, \mathrm{Sen}$ loto 4 | 1.5 | 1.5 | $\checkmark$ |


 *Imicetos JEDEC maistorad dato. Duty Cycis $\leq \mathbf{2 \%}$.

## TYPES 2N2389, 2N2390

## N-P-N SILICON TRANSISTORS

*electrical characteristies at $25^{\circ} \mathrm{C}$ free-alr tomperature

| PARAMETER |  | TEST CONDITIONS | 2N2389 |  | 2N2390 |  | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | MIN | MAX | MIN | MAX |  |
| $h_{16}$ | Small-Stignal Commen-losi Input Impolance |  | $v_{C 1}=5 \mathrm{v}, \mathrm{L}_{\text {c }}=-1 \mathrm{~mm}, \mathrm{f}=1 \mathrm{kc}$ | 24 | 34 | 4 | 24 | $\square$ |
|  |  |  | 1 | 1 | 4 | 1 | 8 |
| $h^{\text {rb }}$ | Small-signal Commen-Stas Reverse Veltege Tremstor Relle | $v_{C B}=5 v_{1} l_{\text {a }}=-1 \mathrm{ma}_{1} /=1 \mathrm{kc}$ |  | $3 \times 10^{-4}$ |  | $5 \times 10^{-4}$ |  |
|  |  | $\mathrm{v}_{\mathrm{c}_{3}}=10 \mathrm{v}, \mathrm{I}_{1}=-5 \mathrm{me}, f=1 \mathrm{kc}$ |  | $3 \times 10^{-4}$ |  | $5 \times 10^{-4}$ |  |
| $h_{\text {ab }}$ | Small-Slenal Commen-Leso Output Rdmilitence |  | 0.1 | 0.5 | 0.1 | 0.5 | $\mu \mathrm{mms}$ |
|  |  | $V_{c i}=10 \mathrm{v}, 1 \mathrm{~s}=-5 \mathrm{~mm}, \mathrm{t}=1 \mathrm{kc}$ | 0.1 | 1.0 | 0.1 | 1.0 | $\mu$ mint |
| 46 | Small-Signal Commen-Emiftar Forwerd Curmat Trenstor Ratio | $v_{c s}=5 \mathrm{v}, \mathrm{l}_{\mathrm{c}}=1 \mathrm{me}, f=1 \mathrm{kc}$ | 30 | 100 | 50 | 200 |  |
|  |  | $\mathrm{V}_{\mathrm{c}}=10 \mathrm{v}, \mathrm{l}_{\mathrm{c}}=5 \mathrm{ma}, \quad \mathrm{i}=1 \mathrm{kc}$ | 35 | 150 | 70 | 300 |  |
| $\left\|h_{\text {gol }}\right\|$ | Small-Signall Commen-Emither Fowwerd Curreant Irampor Ratio | $v_{C B}=10 \mathrm{v}, \mathrm{c}_{\mathrm{C}}=20 \mathrm{ma}, \quad \mathrm{f}=20 \mathrm{me}$ | 3.0 |  | 3.5 |  |  |
| $C_{\text {cobo }}$ | Commen-loss Opna-Cirvult Output Copucitance | $v_{c i}=10 \mathrm{v}, \mathrm{l}_{\mathbf{E}}=0, \quad \mathrm{f}=1 \mathrm{mc}_{\mathbf{c}}$ |  | 25 |  | 25 | P |
| Clbo | Commen-Eese Open-Circulf Input Copecitence | $\boldsymbol{v}_{\mathbf{E} \text { : }}=0.5 \mathrm{v}, \mathrm{I}_{\mathbf{C}}=0, \quad 1=1 \mathrm{mc}$ |  | 00 |  | 60 | pf |

*operating characteristics at $25^{\circ} \mathrm{C}$ free-air temperature

| PARAMETER |  | TEST CONDITIONS | 2N2389 |  | 2N2890 |  | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | TYP | MAX | TYP | MAX |  |
| WF | Spot Meist Pigure |  | $\begin{aligned} & y_{c t}=10 v_{r} l_{c}=300 \mu \mathrm{l} \\ & \mathbf{R}_{\mathrm{g}}=510 \mathrm{Q}, 1=1 \mathrm{kc} \end{aligned}$ |  | 12 | 5 | * | d |

"switching charactorisfics at $\mathbf{2 5}^{\mathbf{\circ}} \mathrm{C}$ free-air tomperature

| PARAMETER |  | TEST CONDITIONS | 2N2389 |  | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | TYP | MAX |  |
| $t_{T}$ | Tofal Swliching Time |  | Sen Figure 1 | 20 | 31 | mas |

*PARAMETER MEASUREMENT INFORMATION

flgure 1- mombaturateo switehimg time measurement circuit
 and the Input pulse amplitude to ottaln the apnetiled veltage lovels at filnt $A$.

-Indicates JEDEE registered dale (typleal' data axelvided).

# FOR GENERAL PURPOSE AMPLIFIER AND SWITCHING APPLICATIONS Formerly T1428 and T1429 

- Eloctrically Similer to 2 Ni 131 and 2 N 1132
- Compatible Package For Interfacing With Integrated Circuits and Thin-Film Modules


## mechanical dafa

The transistors are in a hermetically sealed welded package meeting the JEDEC TO-50 outline.

*absolute maximum ratings at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

[^53]
## P-N-P SILICON TRANSISTORS

*eloctrical characteristics at $25^{\circ} \mathrm{C}$ free-air temperature (unloss otherwise noted)


Nete 4. These parameters must be measured wsiag pulse fechniques. $\mathrm{PW}=\mathbf{3 0 0} \mu \mathrm{sec}$, Duty Cycle $\leq \mathbf{2} \%$.

[^54]THERMAL CHARACTERISTICS


# FOR GENERAL PURPOSE AMPLIFIER AND SWITCHING APPLICATIONS Formerly TI 432, TI 433 <br> - Electrically Similar To 2N696 and 2N697 <br> - Compatible Package For Inferfacing with Integrated Circuits and Thin-Film Modules 

mechanical data
These transistors are in a hermetically sealed welded package meating the JEDEC TO-50 outline.

*absolute maximum ratings at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)
Collector-Base Voltage . . . . . . . . . . . . . . . . . . . . . . . . . 60 r
Collector-Emitter Voltage (See Note 1) . . . . . . . . . . . . . . . . . . . . 40 r
Emitter-Base Voltage . . . . . . . . . . . . . . . . . . . . . . . . . . 5 v
Collector Current . . . . . . . . . . . . . . . . . . . . . . . . . . 300 ma
Continuous Device Dissipation at (or below) $25^{\circ} \mathrm{C}$ Free-Air Temperature (See Note 2) . . . . 450 mw
Continuous Device Dissipation at (or below) $25^{\circ} \mathrm{C}$ Case Temperature (See Note 3) . . . . . . 1.5 w
Operating Collector Junction Temperature . . . . . . . . . . . . . . . . . . . $200^{\circ} \mathrm{C}$
Storage Temperature Range . . . . . . . . . . . . . . . . . . . $-65^{\circ} \mathrm{C}$ to $+200^{\circ} \mathrm{C}$
Lead Temperature $K_{1}$ Inch from Case for 10 Seconds . . . . . . . . . . . . . . . $230^{\circ} \mathrm{C}$

WOTES: 1. This value appliss when baso-amition thode is open-ciccited.
2. Derete linearly to $200^{\circ} \mathrm{C}$ froo-air tomperature of the rate of $2.57 \mathrm{~mm} / \mathrm{C}^{\circ}$.
3. Darate linearly to $200^{\circ} \mathrm{C}$ case temparatere at the rate of $8.57 \mathrm{~mm} / \mathrm{C}^{\circ}$.

* Indicates JEDEC ragistered dato.


## TYPES 2N2395, 2N2396

N-P-N SILICON TRANSISTORS
*electrical characteristics at $25^{\circ} \mathrm{C}$ free-air tomperature (unless otherwise noted)

mote 4. These paramelors must be mossured asing pulso tochniquos. PW $=300 \mu s \mathrm{sc}$, Daty Cycle $\leq \mathbf{2 \%}$.

## THERMAL CHARACTERISTICS



[^55]
# FOR LOW-LEVEL, HIGH-SPEED CHOPPER APPLCATIONS IN INVERTED CONNECTION 

- Low Offsef Voltage ... $0.4 \mathrm{mV} \operatorname{Max}$ (2N2432A)
- Low Ita... 2 nA Max
- High Reted $\mathbf{V}_{\text {cco }}$ for Inverted Connection


## also useful for low-livel amplifier applications <br> - $h_{\text {fe }} \ldots 30 \mathrm{Min}$ at $10 \mu \mathrm{~A}$

*mechanical data

tII gwaranted minimum. The JEDEC registered miaisem leed demeter for the T0-46 is 0.012.
*absolute maximum ratings af $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)


MOTES: I. This value appliss betwoen 0 and 10 mA collector curront when the omititer-bese diede is epon-circuited.
2. This value appiles between 0 end $100 \mu \mathrm{~h}$ mither curroat when the colloctor-base diede is epem-circulted.
3. Derate linearly to $175^{\circ} \mathrm{C}$ freo-air tamperature at bite rate of $2 \mathrm{~mW} / \mathrm{deg}$.
4. Derate linearly to $175^{\circ} \mathrm{C}$ case semperatere at the rete of $4 \mathrm{~mW} / \mathrm{deg}$.
*Iaticatos JEDEC ragistared deta.
USES CHIP N18
*electrical characteristics at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

| PARAMETER |  | TEST CONDITIONS |  | $\begin{array}{\|l\|} \hline \text { 2N2432 } \\ \text { 2N4138 } \\ \hline \text { MIN MAX } \\ \hline \end{array}$ | $\begin{array}{\|l\|} \hline \text { 2N2432A } \\ \hline \text { MIN MAX } \\ \hline \end{array}$ | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | Collector-Base Breakdown Voltage | $I_{C}=100 \mu A, I_{E}=0$ |  | 30 | 45 | V |
| $\mathbf{V}_{\text {(tr) }}$ (CEO | Collector-Emitter Breakdown Voltage | $\mathrm{I}_{\mathrm{C}}=10 \mathrm{~mA}, \mathrm{I}_{\mathrm{B}}=0$, | See Note 5 | 30 | 45 | V |
| $\bar{V}_{\text {(R) }}$ SCCO | Emitter-Collector Breakdown Voltage | $\mathrm{I}_{\mathrm{E}}=100 \mu \mathrm{~A}, \mathrm{I}_{\mathrm{B}}=0$ |  | 15 | 18 | V |
| ICmo | Collector Cutoff Current | $V_{C B}=25 \mathrm{~V}, \mathrm{I}_{\mathrm{E}}=0$ |  | 10 |  | nA |
|  |  | $\mathrm{V}_{\mathrm{CB}}=40 \mathrm{~V}, \mathrm{I}_{\mathrm{E}}=0$ |  |  | 10 | nA |
| Ices | Collector Cutoff Current | $\mathrm{V}_{\text {CE }}=25 \mathrm{~V}, \mathrm{~V}_{\text {BE }}=0$ |  | 10 |  | nA |
|  |  | $\mathrm{V}_{\text {CE }}=25 \mathrm{~V}, \mathrm{~V}_{\text {BE }}=0$, | $\mathrm{T}_{\mathrm{A}}=125^{\circ} \mathrm{C}$ | 250 |  | nA |
|  |  | $Y_{C E}=40 \mathrm{~V}, V_{\text {BE }}=0$ |  |  | 10 | nA |
|  |  | $\mathrm{V}_{\text {CE }}=40 \mathrm{~V}, \mathrm{~V}_{\text {EE }}=0$, | $\mathrm{T}_{\mathrm{A}}=125^{\circ} \mathrm{C}$ |  | 250 | nA |
| IEBO | Emitter Cutoff Current | $V_{E B}=15 \mathrm{~V}, \mathrm{I}_{\mathrm{C}}=0$ |  | 2 | 2 | nA |
| Jecs | Emitter Cutoff Current | $\mathrm{V}_{E C}=15 \mathrm{~V}, \mathrm{~V}_{\mathrm{BC}}=0$ |  | 2 | 2 | nA |
|  |  | $\mathrm{V}_{\mathrm{EC}}=15 \mathrm{~V}, \mathrm{~V}_{\mathrm{BC}}=0$, | $\mathrm{T}_{\mathrm{A}}=125^{\circ} \mathrm{C}$ | 200 | 200 | nA |
| $h_{\text {fe }}$ | Static Forward Current Transier Ratio | $V_{C E}=5 \mathrm{~V}, \quad \mathrm{I}_{\mathrm{C}}=10 \mu \mathrm{~A}$ |  | 30 | 30 |  |
|  |  | $\mathrm{V}_{\text {CE }}=5 \mathrm{~V}, \quad \mathrm{I}_{\mathrm{C}}=1 \mathrm{~mA}$ |  | 50 | 50 |  |
| $h_{\text {retimu }}$ | Static Forward Current Transfer Ratio (Inverted Connection) | $\mathrm{V}_{\mathrm{EC}}=5 \mathrm{~V}, \quad \mathrm{f}_{\mathrm{E}}=0.2 \mathrm{~mA}$ |  | 2 | 3 |  |
| $\mathbf{V}_{\text {CEf } \text { sat) }}$ | Collector-Emitter Saturation Vollage | $\mathrm{I}_{\mathrm{B}}=0.5 \mathrm{~mA}, \mathrm{I}_{\mathrm{C}}=10 \mathrm{~mA}$ |  | 0.15 | 0.15 | V |
| $V_{E C \text { [ }}^{\text {cos] }}$ ] | Offsel Voltage (Inverted Connection) | $\mathrm{I}_{\mathrm{B}}=200 \mu \mathrm{~A}, \mathrm{~T}_{\mathrm{E}}=0$, | See Figure 1 | 0.5 | 0.4 | mV |
|  |  | $\mathrm{I}_{\mathrm{I}}=1 \mathrm{~mA}, \mathrm{I}_{\mathrm{E}}=0$, | See Figure 1 | 1 | 0.7 | $\mathrm{m} V$ |
| Poclon) | Small-Signal Emilter-Colletfor On-State Resistance | $\begin{array}{ll} \mathrm{l}_{\mathrm{B}}=1 \mathrm{~mA}, & \mathrm{l}_{\mathrm{E}}=0, \\ & f=1 \mathrm{kHz}, \end{array}$ | $\mathrm{I}_{0}=100 \mu \mathrm{~A}$ <br> See Figure 2 | 20 | 15 | $\Omega$ |
| \|hel | Small-Signal Common-Emitter Forward Current Transfer Ratio | $V_{C E}=5 \mathrm{~V}, \quad \mathrm{I}_{\mathrm{C}}=1 \mathrm{~mA}$, | $f=20 \mathrm{MHz}$ | 1 | 1 |  |
| Cobo | Common-Base Open-Circuit Output Capacitunce | $V_{C B}=0, \quad t_{E}=0$, | $\mathrm{f}=140 \mathrm{kHz}$ | 12 | 12 | pF |
| $\mathrm{C}_{\mathrm{cb}}$ | Collector-Base Capacitance | $\mathrm{V}_{\mathrm{CB}}=0, \quad \mathrm{I}_{\mathrm{E}}=0$, | $\begin{aligned} & \quad i=1 \text { MHz, } \\ & \text { See Note } 6 \\ & \hline \end{aligned}$ | 12 | 12 | pF |
| $\mathrm{C}_{\text {ibo }}$ | Common-Base Open-Cirtuit Input Capacitance | $V_{E B}=0, \quad I_{C}=0$, | $\mathrm{f}=140 \mathrm{kHz}$ | 12 | 12 | pF |
| $C_{0 b}$ | Emilter-Base Capacitance | $\mathrm{V}_{\mathrm{EB}}=0, \quad \mathrm{l}_{\mathrm{C}}=0$, | $\mathrm{f}=1 \mathrm{MHz},$ <br> See Note 6 | 12 | 12 | pF |

HOTES: 5. This parameter must be measured using pulse techniques. $i_{p}=300 \mu$ s, duty cycle $\leq 2 \%$.
6. $\mathrm{C}_{\mathrm{cb}}$ and $\mathrm{C}_{\mathrm{eb}}$ ore measured using thre-terminal measurement techniques with the third electrode (emitter or collector respectively) guarded.

## PARAMETER MEASUREMENT INFORMATION



FIGURE 1
measurement circuit for offset voltage

figure 2
MEASUREMENT CIRCUIT FOR EMITTER-
COLLECTOR ON-STATE RESISTANCE

MOTE a: The voltmater must have high anough impedance that halving the value of the voltmeler impedance does not change the measured voiue.
*Indicates JEDES registered datu.

# TWO TRANSISTORS IN ONE PACKAGE RECOMMENDED FOR 

- Differential Amplifiers
- Low-Level, Low-Noise Audio Amplifiers
- Low-Level Flip-Flops


## *mechanical data


"absolute maximum ratings at $\mathbf{2 5 ^ { \circ }} \mathbf{C}$ free-air temperature (unless otherwise noted)
EACH
TOTAL

NOTES: 1. This value applies when the bese-emitter diode is open-circuited.
2. Derate linaarly to $200^{\circ} \mathrm{C}$ free-alr temperature at the rates 0 $1.14 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$ for each triode and $1.71 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$ for total device.
3. Derate Inearly to $200^{\circ} \mathrm{C}$ case temperature at the rates $0 \mathrm{of} 3.43 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$ for each triode and $6.86 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$ for total device.
*JEDEC reglatered deth. This date mheet contains all applicable registered data in affect at the time of publication.

## TYPE 2N2453

## DUAL N-P-N SILICON TRANSISTOR

## "electrical characteristics at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

 Individual triode characteristion (tee note 4)| PARAMETER | TEST CONDITIONS | MIN MAX | UNIT |
| :---: | :---: | :---: | :---: |
| V(BR)C8O Collector-Base Breakdown Voltage | $I_{C}=10 \mu A, \quad I_{E}=0$ | 60 | $V$ |
| V(BR)CEO Collactor-Emitter Breakdown Voltage | $\mathrm{I}_{\mathrm{C}}=10 \mathrm{~mA}, \mathrm{I}_{\mathrm{B}}=0, \quad$ See Note 5 | 30 | $V$ |
| V(BR)EBO Emitter-Base Breakdown Voltage | $I_{E}=0.1 \mu A_{1} I_{C}=0$ | 7 | V |
| ICBO Collector Cutoff Current | $V_{C B}=80 \mathrm{~V}, \mathrm{IE}^{\text {e }} 0$ | 5 | nA |
|  | $V_{C B}=80 V_{\text {, }} I_{E}=0, \quad T_{A}=160{ }^{\circ} \mathrm{C}$ | 10 | $\mu \bar{A}$ |
| IE8O Emitter Cutoff Current | VEB $=5 \mathrm{~V}$, $\mathrm{IC}^{\text {c }}=0$ | 2 | nA |
| Static Forward Current Transfar Ratio | $\mathrm{I}_{\mathrm{C}}=10 \mu \mathrm{~A}, \mathrm{~V}_{\text {CE }}=6 \mathrm{~V}$ | 80 |  |
|  | $1_{C}=10 \mu A, V_{C E}=5 \mathrm{~V}, \mathrm{TA}^{\prime}=-65^{\circ} \mathrm{C}$ | 40 |  |
|  | $I_{C}=1 \mathrm{~mA}, \quad V_{C E}=5 \mathrm{~V}$ | $150 \quad 600$ |  |
|  | $I_{C}=1 \mathrm{~mA}, \mathrm{~V}_{\text {CE }}=5 \mathrm{~V}, \mathrm{~T}_{\mathrm{A}}=-55^{\circ} \mathrm{C}$ | 75 |  |
| VBE Base-Emitter Voltage | $I_{C}=6 \mathrm{~mA}, \quad I_{B}=0.6 \mathrm{~mA}$ | 0.8 | $V$ |
| VCE(sat) Collector-Emitter Saturation Voltaga | $I_{C}=5 \mathrm{~mA}, \quad I_{B}=0.6 \mathrm{~mA}$ | 1 | V |
| $\mathrm{h}_{\mathrm{ib}} \quad$ Small-Signal Common-Base Input Impedance | $V_{C B}=5 \mathrm{~V}, \quad \mathrm{l}=1 \mathrm{~mA}, \quad \mathrm{f}=1 \mathrm{kHz}$ | $20 \quad 30$ | $\Omega$ |
| $h_{r b}$ Smali-Signal Common-Bate <br> Reverse Voltage Transfer Ratio  |  | $\begin{gathered} 5 x \\ 10^{-4} \end{gathered}$ |  |
| hob Small-Signal Common-Base Output Admittance |  | 0.2 | $\mu \mathrm{mho}$ |
| $\mathrm{h}_{\text {ie }} \quad$ Small-Signal Common-Emitter Input Impedance | $V_{C E}=5 \mathrm{~V}, \quad \mathrm{IC}=1 \mathrm{~mA}, \quad f=1 \mathrm{kHz}$ | 6 | kn |
| $\mathrm{h}_{\mathrm{f}}$ Small-Signal Common-Emitter <br> Forward Current Transfer Retio |  | 160600 |  |
| $h_{r e}$ Small-Signal Common-Emitter <br> Reverse Voltage Transfer Ratio |  | $\begin{gathered} 6 \times \\ 10^{-4} \end{gathered}$ |  |
| hoe Small-Signal Common-Emitter Output Admittance |  | $5 \quad 30$ | $\mu \mathrm{mho}$ |
| $h_{\text {fel }} \|$Small-Signal Common-Emitter <br> Forward Current Transfer Ratio | $V_{C E}=10 \mathrm{~V}, \mathrm{IC}=5 \mathrm{~mA}, \quad f=30 \mathrm{MHz}$ | 2 |  |
| Cobo Common-Base Open-Circuit Output Capacitance | $V_{C B}=10 \mathrm{~V}, \mathrm{I}_{\mathrm{E}}=0, \quad f=140 \mathrm{kHz}$ | 8 | pF |
| Cibo Common-Base Open-Circuit Input Capacitance | $\mathrm{VEB}^{\text {a }}=0.5 \mathrm{~V}, \mathrm{I}_{\mathrm{C}}=0, \quad f=140 \mathrm{kHz}$ | 10 | PF |

triode matching characteristics

|  | PARAMETER | TEST CONDITION8 | MIN | MAX | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: |
| $\frac{h F E 1}{h F E 2}$ | Static Forward-Current-Gain Balance Ratio | $V_{C E}=5 \mathrm{~V}, \mathrm{I}_{\mathrm{C}}=1 \mathrm{~mA}, \mathrm{Sen}$ Note 6 | 0.8 | 1 |  |
|  |  | $\begin{aligned} & V_{C E}=5 V, \quad I^{\prime}=1 \mathrm{~mA}, \quad \text { Sae Note } \mathrm{E}_{1} \\ & T_{A}=-58^{\circ} \mathrm{C} \text { to } 128^{\circ} \mathrm{C} \end{aligned}$ | 0.85 | 1 |  |
|  | Base-Emitter-Voltage Differential | $V_{C E}=5 V_{1} \quad 1 C=10 \mu A$ |  | 3 | mV |
|  |  | $\mathrm{V}_{\text {CE }}=8 \mathrm{~V}, \mathrm{IC}_{\mathrm{C}}=1 \mathrm{~mA}$ |  | 5 | mV |
| $\left\|\frac{\Delta \mid V_{B E 1}-V_{B E 2}}{\Delta T_{A}}\right\|$ | Baso-Emitter-Voltago-Differential Temperature Gradient | $\begin{aligned} & V_{C E}=8 V, \quad \text { C } C=10 \mu A, \\ & \Delta T_{A}=\left[25^{\circ} \mathrm{C}-\left(-55^{\circ}\right)\right] \text { and }\left(125^{\circ} \mathrm{C}-25^{\circ} \mathrm{C}\right) \end{aligned}$ |  | 10 | $\mu \vee /{ }^{\circ} \mathrm{C}$ |

"operating characteristics at $25^{\circ} \mathrm{C}$ free-air temperature
individual triode charraoteristices (ese notu 4)

|  | PARAMETER | TEET CONDITIONS | MIN | MAX | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: |
| $F$ | Spot Nolsa Floure | $\begin{aligned} & V C E=5 \mathrm{~V}, \quad I C=10 \mu \mathrm{~A}, \quad R_{\mathrm{G}}=10 \mathrm{k} \Omega, \\ & f=1 \mathrm{kHz} \end{aligned}$ |  | 7 | dB |

NOTES: 4. The terminale of the trlode not under tast are open-clrculted for the measurament of thase characteriates.
5. This parcmeters must be moaured using pulat technequet, $t_{w}=300 \mu$, dutv cycle $\leq 2 \%$.
6. The lower of the two $h_{F E}$ readinge le taken asfel.
*JEDEC reglaterad dita

FOR LOW-LIVEL, LOW-NOISE, HIGH-GANN, AMPLIFIER APPLLCATIONS<br>- Gearemtoed Low-Noise Characteristics af $100 \mathrm{~Hz}, 1 \mathrm{kHz}$, and 10 kHz<br>- High Vimenco . . 60 V Min<br>- D.C Bota Guarantood at $\mathrm{I}_{\mathrm{C}}=1 \mu \mathrm{~A}$ (2N2484)

## *mechemical deta


*absolute maximum retings ef $25^{\circ} \mathrm{C}$ free-air temperature (uniess otherwise noted)


2. Derate Invarly to $280^{\circ} \mathrm{C}$ how-ifr tomproture of the rete of $2,06 \mathrm{~mW} / \mathrm{dog}$.

-Iadleater JEasC mighered dela

## TYPES 2N2483, 2N2484 <br> N-P-N SILICON TRANSISTORS

*electrical characteristics at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

\begin{tabular}{|c|c|c|c|c|c|c|c|}
\hline \multicolumn{2}{|r|}{\multirow[b]{2}{*}{PARAMETER}} \& \multirow[b]{2}{*}{TEST CONDITIONS} \& \multicolumn{2}{|c|}{2N2483} \& \multicolumn{2}{|c|}{2N2484} \& \multirow[t]{2}{*}{UNIT} <br>
\hline \& \& \& MIN \& MaX \& MIN \& MAX \& <br>
\hline  \& Collector-Base Breakdown Voltage \& $I_{c}=10 \mu \mathrm{~A}, ~ I_{\mathrm{E}}=0$ \& 60 \& \& 60 \& \& V <br>
\hline $V_{\text {(m) }{ }^{\text {cee }} \text { ( }}$ \& Collector-Emitter Breakdown Volfage \& $\mathrm{I}_{\mathrm{c}}=10 \mathrm{~mA}, \mathrm{I}_{\mathrm{E}}=0, \quad$ See Note 4 \& 60 \& \& 60 \& \& V <br>
\hline  \& Emifter-Base Broakdown Voltoge \& $\mathrm{I}_{\mathrm{E}}=10 \mu \mathrm{~A}, \mathrm{ic}_{\mathrm{C}}=0$ \& 6 \& \& 6 \& \& V <br>
\hline \multirow[b]{2}{*}{lcso} \& \multirow[b]{2}{*}{Collector Cutolf Current} \& $V_{C I}=45 \mathrm{~V}, I_{E}=0$ \& \& 10 \& \& 10 \& nA <br>
\hline \& \& $V_{C B}=45 \mathrm{~V}, \mathrm{I}_{\mathrm{E}}=0, \quad \mathrm{~T}_{A}=150^{\circ} \mathrm{C}$ \& \& 10 \& \& 10 \& $\mu \mathrm{A}$ <br>
\hline $\mathrm{I}_{\mathrm{EBO}}$ \& Emitter Cutoff Current \& $V_{E I}=5 \mathrm{~V}, \quad I_{C}=0$ \& \& 10 \& \& 10 \& ni <br>
\hline \multirow{7}{*}{hre} \& \multirow{7}{*}{Slatic Forward Current Transfer Ratio} \& $V_{\text {CE }}=5 \mathrm{~V}, \quad \mathrm{I}_{\mathrm{C}}=1 \mu \mathrm{~A}$ \& \& \& 30 \& \& <br>
\hline \& \& $V_{C E}=5 \mathrm{~V}, \quad \mathrm{I}_{\mathrm{C}}=10 \mu \mathrm{~A}$ \& 40 \& 120 \& 100 \& 500 \& <br>
\hline \& \& $V_{C E}=5 \mathrm{~V}, \quad \mathrm{I}_{\mathrm{C}}=10 \mu \mathrm{~A}, \quad \mathrm{I}_{\mathrm{A}}=-55^{\circ} \mathrm{C}$ \& 10 \& \& 20 \& \& <br>
\hline \& \& $V_{\text {CE }}=5 \mathrm{~V}, \quad \mathrm{I}_{\mathrm{C}}=100 \mu \mathrm{~A}$ \& 75 \& \& 175 \& \& <br>
\hline \& \& $V_{\text {CE }}=5 \mathrm{~V}, \quad \mathrm{I}_{\mathrm{C}}=500 \mu \mathrm{~A}$ \& 100 \& \& 200 \& \& <br>
\hline \& \& $V_{C E}=5 \mathrm{~V}, \quad \mathrm{I}_{\mathrm{C}}=1 \mathrm{~mA}$ \& 175 \& \& 250 \& \& <br>
\hline \& \& $V_{C E}=5 \mathrm{~V}, \quad \mathrm{I}_{\mathrm{C}}=10 \mathrm{~mA}$, Soe Note 4 \& \& 500 \& \& 600 \& <br>
\hline $V_{\text {IE }}$ \& Base-Emitter Voltage \& $V_{C E}=5 \mathrm{~V}, \quad \mathrm{I}_{\mathrm{C}}=100 \mu \mathrm{~A}$ \& 0.5 \& 0.7 \& 0.5 \& 0.7 \& $v$ <br>
\hline $V_{\text {celsat }}$ \& Collector-Emitter Saturation Volitage \& $\mathrm{I}_{\mathrm{L}}=100 \mu \mathrm{~A}, \mathrm{I}_{\mathrm{c}}=1 \mathrm{~mA}$ \& \& 0.35 \& \& 0.35 \& $v$ <br>
\hline $\mathrm{h}_{\text {it }}$ \& Small-Signal Common-Emiltor Input Impodance \& \multirow{4}{*}{$V_{\text {CE }}=5 \mathrm{~V}$,

$\quad \mathrm{IC}_{\mathrm{c}}=1 \mathrm{~mA}$,} \& 1.5 \& 13 \& 3.5 \& 24 \& k $\Omega$ <br>
\hline $\mathrm{h}_{6}$ \& Small-Signal Commen-Emiltor Forward Current Tronstor Ratio \& \& 80 \& 450 \& 150 \& 900 \& <br>
\hline hre \& Small-Signal Common-Emittor Reverse Voliage Transfer Ratio \& \& \& $8 \times 10^{-4}$ \& \& $8 \times 10^{-4}$ \& <br>
\hline $h_{\infty}$ \& Small-Signal Common-Emittor Output Admiltance \& \& \& 30 \& \& 40 \& $\mu \mathrm{mho}$ <br>
\hline \multirow[t]{2}{*}{| $\mathrm{h}_{\text {ol }} \mid$} \& \multirow[t]{2}{*}{Small-Signal Common-Emitter Forward Current Trunstior Ratio} \& $V_{\text {CE }}=5 \mathrm{~V}_{1} \quad \mathrm{I}_{\mathrm{C}}=50 \mu \mathrm{~h}, \quad 1=5 \mathrm{mHz}$ \& 2.4 \& \& 3 \& \& <br>
\hline \& \& $V_{C E}=5 \mathrm{~V}, \mathrm{I}_{\mathrm{C}}=500 \mu \mathrm{~A}_{1} \mathrm{f}=30 \mathrm{MHz}$ \& 2 \& \& 2 \& \& <br>
\hline $C_{\text {cob }}$ \& Common-Base Open-Circult Output Capacitance \& $V_{C B}=5 \mathrm{~V}, \quad \mathrm{l}_{\mathrm{E}}=0, \quad \mathrm{f}=140 \mathrm{kHz}$ \& \& 6 \& \& 6 \& pf <br>
\hline $C_{i b o}$ \& Common-Base Open-Circult Input Capactance \& $V_{E B}=0.5 \mathrm{~V}, \mathrm{l}_{\mathrm{C}}=0, \quad f=140 \mathrm{kHz}$ \& \& 6 \& \& 6 \& pF <br>
\hline
\end{tabular}

*operating characteristics af $\mathbf{2 5}^{\circ} \mathrm{C}$ free-air temperature

| PARAMETER |  | TEST CONDITIONS | 2N2483 | 2N2484 | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | MaX | MAX |  |
| $\overline{\text { MF }}$ | Average Noise flgure |  | $\begin{array}{ll} V_{c E}=5 \mathrm{~V}, \quad I_{c}=10 \mu A_{1} & R_{G}=10 \mathrm{k} \mathrm{\Omega}, \\ \text { Nolse Bandwidh }=15.7 \mathrm{kHz}, & \text { See Mote } 5 \end{array}$ | 4 | 3 | dB |
| NF | Spot Noise Figure | $\begin{array}{ll} V_{C E}=5 \mathrm{~V}, & I_{C}=10 \mu \mathrm{~A}, \quad R_{6}=10 \mathrm{k} \Omega, \\ I=100 \mathrm{~Hz}, & \text { Nolss Bandwiddh }=20 \mathrm{~Hz} \\ \hline \end{array}$ | 15 | 10 | dB |
|  |  | $\begin{array}{ll} V_{C I}=5 \mathrm{~V}, & I_{c}=10 \mu \mathrm{~A}, \quad R_{e}=10 \mathrm{k} \Omega, \\ f=1 \mathrm{kHz}, & \text { Noiss Dondwidth }=200 \mathrm{~Hz} \end{array}$ | 4 | 3 | $d 8$ |
|  |  | $\begin{array}{ll} V_{C E}=5 \mathrm{~V}, & I_{c}=10 \mu \mathrm{~A}, \\ R_{e}=10 \mathrm{k} \Omega, \\ & =10 \mathrm{kHz}, \end{array}$ | 3 | 2 | dB |

wotes: 4. These paramaters mest be massurad union pulse trehniques. $t_{p}=300 \mu s$, duty qeio $\leq 1 \%$.

*Indieates JEDEC ragistered data

# TYPES 2N2497 THRU 2N2500 P-CHANNEL SILICON JUNCTION FIELD-EFFECT TRANSISTORS 

BULLETIN NO. DL-S 683519, MAY 1963-REVISED MAY 1968

## FOR SMALL-SIGNAL, LOW-NOISE APPLICATIONS

- Guaranteed 10 cps Noise Figure (2N2500)
- High Input Impedance ( $>5$ megohms at 1 kc )
*mechanical data

*absolute maximum ratings at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)
Continuous Forward Gate Current .
-10 ma
Total Device Dissipation at (or below) $25^{\circ} \mathrm{C}$ Free-Air Temperature (See Note 1) . . . . 0.5 w
Total Device Dissipation at (or below) $25^{\circ} \mathrm{C}$ Case Temperature (See Note 2) . . . . . . 1.5 w
Storage Temperature Range
*electrical characteristics at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

| Parameter | TEST CONDITIONS | 2N2497 | 2N2498 | 2N2499 | 2N2500 | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | MIN MAX | MIN MAX | MIN MAX | MIN MAX |  |
| $\begin{array}{\|cc\|} \hline V_{\text {(DR)DGO }} & \begin{array}{c} \text { Drain-Gote Breakdown } \\ \text { Voltage } \end{array} \text { (See Note 3) } \end{array}$ | $\mathrm{I}_{\mathrm{D}}=-10 \mu \mathrm{c}, \mathrm{I}_{\mathbf{s}}=0$ | -20 | - 20 | - 20 | - 20 | $v$ |
| IGSS Gote Cutoff Current | $\mathbf{v}_{\text {GS }}=10 v^{\prime}, \quad v_{\text {DS }}=0$ | 0.01 | 0.01 | 0.01 | 0.01 | $\mu$ |
| IGSS Gate Cutoff Current | $\begin{array}{ll} V_{G S}=10 \mathrm{v}, & \begin{array}{l} Y_{D S}=0 \\ T_{A}=150^{\circ} \mathrm{C} \end{array} \end{array}$ | 10 | 10 | 10 | 10 | $\mu$ |
| I DSS Lero-Gate-Voltoge Brain Current | $v_{\text {DS }}=-10 \mathrm{v}, \mathrm{V}_{G S}=0$ | $-1 \quad-3$ | -2 -6 | -5 -15 | $-1 \quad-6$ | ma |
| ${ }^{\text {Diofl }}$ Pinch-0Hf Drain Current | $\mathbf{V}_{\text {dS }}=-15 \mathrm{r}, \mathrm{V}_{\text {GS }}$ : Soe Note 4 | -10 | -10 | - 10 | -10 | $\mu$ |
| IDS Static Drain-Source Resistance | $\mathrm{I}_{\mathrm{D}}=-100 \mu \mathrm{a}, V_{G S}=0$ | 1000 | 800 | 600 |  | ohm |
| $\left\|y_{i s}\right\| \quad$Smoll-Signal Common-Source <br> Input Admittance | $V_{D S}=-10 v, \quad I_{D}:$ See Nofa 5$i=1 \mathrm{kc}$ | 0.2 | 0.2 | 0.2 | 0.2 | $\mu \mathrm{mbo}$ |
| $\left\|y_{f_{s}}\right\| \quad$Small-Signal Common-Souce <br> Forward Transfer Admittence |  | 10002000 | 15003000 | 2000 4000 | 10002200 | $\mu \mathrm{mho}$ |
| $\left\|\boldsymbol{y}_{\mathrm{rs}}\right\| \quad$Small-Signal Common-Source <br> Reverse Transter Admittonce |  | 0.1 | 0.1 | 0.1 | 0.1 | $\mu \mathrm{mh}$ |
| $\left\|y_{o s}\right\|$Small-Signal Common-Sourco <br> Output Admiftance |  | 20 | 40 | 100 | 20 | $\mu \mathrm{mho}$ |
| $\left\|\mathbf{y}_{\mathrm{fs}}\right\| \quad$Smali-Signal Common-Sourte <br> Forward I Jonsfer Admittence | $y_{D S}=-10 r_{1} \quad I_{0}: \text { Soe Hole } 5$ $f=10 \mathrm{mc}$ | 900 | 1350 | 1800 | 900 | $\mu \mathrm{mho}$ |
| $\boldsymbol{c}_{\text {iss }} \quad$Common-Source Short-Circuit <br> Input Capacitance | $\begin{array}{ll} v_{\mathrm{GS}}=0, & v_{\mathrm{DS}}=-10 \mathrm{v} \end{array}$ | 32 | 32 | 32 | 32 | pf |

*operating characteristics at $\mathbf{2 5}{ }^{\circ} \mathrm{C}$ free-air temperature
 (the Drain-Source Breakdown Voltage for $\left.V_{G S}=0\right)$. $V_{\text {(BR) }}$ DSV (the Drain-Source Breakdown Voltage for other values of $\mathrm{V}_{\mathbf{G S}}$ ) may be calculated from:
$\left|V_{(B R) D S V}\right| \approx\left|V_{(B R) D G O}\right|-\left|V_{G S}\right|$.
*Indicates JEDEC registeted dafa.

## DESIGNED FOR MEDIUM-POWER SWITCHING AND GENERAL PURPOSE AMPLIFIER APPLICATIONS

- Total Switching Time . . . 80 nsec max at 150 ma
- High fT . . . $\mathbf{2 5 0} \mathbf{~ M c ~ m i n ~ a t ~} \mathbf{2 0} \mathbf{v , 2 0} \mathbf{~ m a}$
- hFE Guaranteed from 1 ma to 500 ma


## *mechanical data

Device types 2N2537 and 2N2538 are in JEDEC TO-5 packages.
Device types 2N2539 and 2N2540 are in JEDEC TO-18 packages.

*ebsolute maximum ratings at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)


WOTES: 1 . This volue applies when the bess-emittor resistance $\left(R_{\text {Be }}\right)$ is equal to of less then 10 ohms.
2. This value applies when the bese-mititor diede is apen-circuitod.
3. Derate 2W2537 and zN2538 linearly to $200^{\circ} \mathrm{C}$ free-air temperature al the rate of $4.57 \mathrm{~mm} / \mathrm{t}^{\circ}$.
4. Derate 2 2 2539 and 2 N 2540 lineorly to $200^{\circ} \mathrm{C}$ trov-air temperature at the rate of $2.86 \mathrm{~mm} / \mathrm{C}^{\circ}$.

6. Derute 2 N 2539 and 2 N 2540 linserly to $200^{\circ} \mathrm{C}$ cose temperature of the rote of $10.3 \mathrm{mw} / \mathrm{C}^{\circ}$.

[^56]*electrical characteristics at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)


NOTE 7: These paremotors mest be measured using palse tochniques. PW $\leq 300 \mu$ sec, Duty cycle $\leq \mathbf{7 \%}$.
*Indicates JEDEC registered data

## TYPES 2N2537 THRU 2N2540 <br> N-P-N SILICON TRANSISTORS

*switching characteristics af $25^{\circ} \mathrm{C}$ free-air temperature

| Parameter |  | TEST CONDITIONS | $\xrightarrow{\text { TO.5 } \rightarrow}$ | $\begin{aligned} & \text { 2N2537 } \\ & \hline \text { 2N2539 } \end{aligned}$ |  | $\begin{aligned} & \hline \text { 2N2538 } \\ & \hline \text { 2N2540 } \end{aligned}$ |  | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  |  |  |  |  |
|  |  | MIN |  | MAX | MIN | MAX |  |
| $\mathrm{t}_{\text {on }}$ | Turn-on Time |  | $\begin{aligned} & I_{C}=150 \mathrm{ma}, I_{B(1]}=15 \mathrm{ma}, I_{Q(2)}=-15 \mathrm{ma} \\ & v_{\mathrm{BE}[0 \mathrm{ff}}=-1 \mathrm{v}, V_{C C}=7 \mathrm{v},(\text { See Figure } 1) \end{aligned}$ |  |  | 40 |  | 40 | nser |
| toff | Tum-off Time |  |  |  | 40 |  | 40 | nser |
| $i_{1}$ | Storage Time | $I_{C}=I_{\text {E(1) }}=-I_{\text {P(2) }}=20 \mathrm{ma}$, (See Figure 2) |  |  | 20 |  | 20 | nsec |
| $\mathrm{Q}_{T}$ | Totol Control Charge | $\mathrm{I}_{\mathrm{c}}=150 \mathrm{ma}, \mathrm{I}_{\text {(1) }}=15 \mathrm{ma}$, (See Figure 3) |  |  | 750 |  | 750 | pcb |
| $\mathrm{T}_{\mathrm{A}}$ | Active-hegion Time Constant | $V_{c c}=15.2 \mathrm{v}, \mathrm{I}_{\mathrm{c}}=150 \mathrm{ma}, \mathrm{I}_{8(1)}=15 \mathrm{ma}$, (See Figure 4) |  |  | 2.0 |  | 2.0 | nsec |

## PARAMETER MEASUREMENT INFORMATION


*FIGURE 1 - TURN-ON AND TURN-OFF TIMES

*figure 2 - storage time

# TYPES 2N2537 THRU 2N2540 <br> N-P-N SILICON TRANSISTORS 

## PARAMETER MEASUREMENT INFORMATION



(See Notes a and b) VOLTAGE WAVEFORMS

Note: $\quad Q_{Y} \leq 750^{\circ}$ peb when $V_{1} \leq 50 \mathrm{mv}$ and $\mathrm{t}_{\mathrm{f}} \leq 10$ nsec.

* FIGURE 3 - TOTAL COnTHOL CHAREE


TEST CIRCUIT

(See Notes a and b)
VOLTAGE WAVEFORMS

Note: In this circuit, $\tau_{A}=\frac{t_{r}}{10}$
-FIOURE 4 - ACTIVE-REOION TIME CONSTANT


| FIGURE | $1{ }^{1}$ | $1{ }^{*}$ | M ${ }^{\text {P }}$ | $\mathbf{I}_{\text {out }}{ }^{*}$ |
| :---: | :---: | :---: | :---: | :---: |
| 1 | $\leq 2$ mact | $\leq 2 \mathrm{max}$ | $1 \mu \mathrm{sec}$ | 508 |
| 2 | $\leq 2$ пsя | $\leq 2$ mate |  | $50 \Omega$ |
| 3 |  | $\leq 2$ nsoc |  |  |
| 4 | $\leq 2$ mac | $\leq 2 \mathrm{moc}$ |  | $50 \Omega$ |

NOTE it: Wevolerms are menitered on oscilloseopss with the heliewing charectorisiks:

| FIGURE | $t_{\text {P* }}$ | ${ }_{1 / 4}{ }^{*}$ | $c_{\text {in }}$ |
| :---: | :---: | :---: | :---: |
| 1 | $\leq 1$ nsoe | 10 Mn | $\leq 5 \mathrm{pt}$ |
| 2 | $\leq 5$ nser | 10 ma | $\leq 10 \mathrm{pf}$ |
| 3 | $\leq 1$ nsor | 10 Mn | $\leq 5 \mathrm{pt}$ |
| 4 | $\leq 5$ nsoc | 10 ma | $\leq 10 \mathrm{pf}$ |

[^57]
## TYPE 2N2586 <br> N-P-N SILICON TRANSISTOR

## FOR EXTREMELY LOW-LEVEL, LOW-NOISE, AMPLIFIER APPLICATIONS

- Guaranteed Very-Low-Current hfe . . . 80 min at $1 \mu \mathrm{~A}$
- Guaranteed Low-Temperature hFE . . . 40 min at $10 \mu \mathrm{~A},-65^{\circ} \mathrm{C}$
- Complete Noise Characterization at $1 \mu \mathrm{~A}$ and $10 \mu \mathrm{~A}$


## *mechanical dafa


*absolute maximum ratings at $25^{\circ} \mathrm{C}$ free-air temperature (unless etherwise noted)






[^58]
## TYPES 2N2588 <br> N-P-N SILICON TRANSISTOR

*eloctrical charectorisfles of $25^{\circ} \mathrm{C}$ tree-air temperature (unless otherwise noted)

| PaRMMITHE | TIST CONDITIONS | MIN MAX | UNIT |
| :---: | :---: | :---: | :---: |
| $V_{\text {(m, cso }}$ Collector-dase Brackdown Volmaje | $l_{c}=10 \mu \mathrm{a}, \mathrm{l}_{\mathrm{E}}=0$ | 60 | $v$ |
|  | $\mathrm{l}_{c}=10 \mathrm{ma}, l_{1}=0(500 \mathrm{Moto} 4)$ | 45 | $v$ |
| $V_{\text {(marico }}$ Emittor-Base Brandomo Voltoen | $l_{1}=10 \mu \mathrm{a}, l_{c}=0$ | 6 | $v$ |
| Iewo Collector Cutoff Current | $V_{\text {cta }}=45 \mathrm{v}, \mathrm{l}_{\mathrm{t}}=0$ | 2 | no |
| Lero Collecter Cutoff Current | $V_{C t}=5 v_{1} \quad I_{B}=0$ | 2 | no |
| Collecter Cutoff Curront | $V_{c t}=45 \mathrm{v}, V_{m i}=0$ | 2 | na |
|  | $V_{c t}=45 \mathrm{v}, V_{\mathrm{w}}=0, \quad \mathrm{~T}_{\mathrm{A}}=170^{\circ} \mathrm{C}$ | 10 | $\mu$ |
| Ineo. Emitter Cutoff Curront | $v_{\text {et }}=5 v_{1} \quad l_{c}=0$ | 2 | no |
| Static ferword Curmot Trunster Ratio | $v_{c t}=5 v_{\text {g }} \quad l_{c}=1 \mu \mathrm{~m}$ | 80 |  |
|  | $V_{\text {ct }}=5 v_{1}, k_{c}=10 \mu \mathrm{a}$ | $120 \quad 360$ |  |
|  | $V_{\mathrm{Ct}}=5 \mathrm{v}, \quad \mathrm{lc}_{\mathrm{c}}=10 \mu \mathrm{a}, \mathrm{T}_{\mathrm{A}}=-55^{\circ} \mathrm{C}$ | 40 |  |
|  | $V_{c t}=5 \mathrm{v}, \quad l_{c}=500 \mu \mathrm{a}$ | 150 |  |
|  | $V_{c t}=5 \mathrm{v}, \mathrm{lc}_{\mathrm{c}}=10 \mathrm{mo}(500$ Note 4) | 600 |  |
| Ver Baso-Emitter Voltues | $\mathrm{l}_{\mathrm{a}}=0.5 \mathrm{ma}, \mathrm{l}_{\mathrm{c}}=10 \mathrm{mo}$ | 0.70 .9 | $v$ |
| $V_{\text {cquat) }}$ Collioctor-Emitior Soturation Voltreye | $\mathrm{l}_{\mathrm{L}}=0.5 \mathrm{mo}, \mathrm{l}_{\mathrm{c}}=10 \mathrm{~mm}$ | 0.5 | $v$ |
| his $\begin{aligned} & \text { Small-Signal Commen-Emittor } \\ & \text { Input Impedance }\end{aligned}$ Input Impedance | $V_{C E}=5 \mathrm{v}, \quad \mathbf{l}_{\mathbf{c}}=1 \mathrm{mos}, \quad 1=1 \mathrm{kc}$ | 4.518 | kohn |
| $h_{\infty} \quad \begin{aligned} & \text { Small-Signal Common-Emittor } \\ & \text { Output Admittance }\end{aligned}$ | $V_{c t}=5 \mathrm{v}, \mathrm{l}_{\mathrm{c}}=1 \mathrm{ma}, \quad 1=1 \mathrm{kc}$ | 100 | $\mu \mathrm{mho}$ |
| $h_{\text {ho }} \quad \begin{aligned} & \text { Small-Slegnal Common-Emithor } \\ & \text { Forward Currant Tramsfor Ratio }\end{aligned}$ | $V_{\text {ct }}=5 \mathrm{v}, \quad \mathrm{lc}_{\mathrm{c}}=1 \mathrm{ma}, \quad 1=1 \mathrm{kc}$ | 150600 |  |
| \|hol Small-Simnal Common-Emithor | $V_{\mathrm{ct}}=5 \mathrm{v}, \quad \mathrm{l}_{\mathrm{c}}=500 \mu \mathrm{l}, 1=30 \mathrm{~mm}$ | 1.5 |  |
| $\mathrm{C}_{\mathrm{ab}} \quad$ Common-dase Open-Uravit Output Capaditance | $V_{c t}=5 \mathrm{~V}, \quad \mathrm{~h}=0, \quad \mathrm{f}=1 \mathrm{mc}$ | 7.0 | pf |

*operating charactoristies at $25^{\circ} \mathrm{C}$ tree-ailr temperature

| paramitith | Tlist CONDITIONS | MAX | UNIT |
| :---: | :---: | :---: | :---: |
| MF Spol Nolst Flgure | $V_{\text {est }}=5 \mathrm{v}, \mathrm{l}_{\mathrm{c}}=10 \mu_{0}, \mathrm{~m}_{0}=10 \mathrm{k} \Omega_{\text {, }} \mathrm{I}=10 \mathrm{kc}$ | 2.0 | db |
|  | $V_{\text {cit }}=5 \mathrm{v}, \mathrm{t}_{\mathrm{c}}=10 \mu \mathrm{a}, \mathrm{R}_{\mathrm{c}}=10 \mathrm{k} \Omega, 1=1 \mathrm{kc}$ | 3.0 | dit |
|  | $V_{c t}=5 \mathrm{v}, \mathrm{l}_{\mathrm{c}}=1 \mu \mathrm{l}, \mathrm{R}_{\mathrm{c}}=1 \mathrm{~m}$, $f=10 \mathrm{kc}$ | 2.0 | dh |
|  | $V_{\text {ct }}=5 \mathrm{y}, \mathrm{l}_{\mathrm{c}}=1 \mu \mathrm{c}, \mathrm{R}_{0}=1 \mathrm{~m} \Omega, \mathrm{l}=1 \mathrm{kc}$ | 3.5 | did |

## - Jadiceten JEDEC registerval date

## TYPES 2N2604, 2N2605 <br> P-N-P SILICON TRANSISTORS

BULLETIN NO. DL.S 7311966, MARCH 1973

## FOR LOW-LEVEL, LOW-NOISE, HIGH-GAIN AMPLIFIER APPLICATIONS

- For Complementary Use with 2N929, 2N930, 2N2483, 2N2484, and 2N2586
- Guaranteed hFE at $10 \mu \mathrm{~A},-55^{\circ} \mathrm{C}$ and $25^{\circ} \mathrm{C}$
- Low Noise Charactaristics
- Usable at Collector Currents as Low as $1 \mu \mathrm{~A}$


## *mechanical data

THE COLLECTOR IS IN ELECTRICAL CONTACT WITH THE CASE


ALL JEDEC TO-46 DIMENSIONS AND NOTES ARE APPLICABLE
${ }^{\boldsymbol{T}} \mathrm{T}$ I guaranteed minimum. The JEDEC ragisterad minimum lasd diameter for the TO-46 is 0.012 .
*absolute maximum ratings at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)


NOTES: 1. This value applien betwaen 0 and 10 mA collector eurrent when the base-emltter diode le open-circulted.
2. Derate IInearly to $200^{\circ} \mathrm{C}$ free-air temparature at the rate of $2.28 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$.

## TYPES 2N2604, 2N2605 P-N-P SILICON TRANSISTORS

*electrical characteristics at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

| PARAMETER |  | TEST CONDITIONS | 2N2604 | 2N2605 | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | MIN MAX | MIN MAX |  |
| $V_{\text {(BR) }}$ CBO | Collector-Base Breakdown Voltage |  | $\mathrm{I}^{\prime} \mathrm{C}=-10 \mu \mathrm{~A}, \quad \mathrm{I} E=0$ | -60 | -60 | V |
| $V_{\text {(BR) }}$ CEO | Collector-Emitter Breakdown Voltage | $\mathrm{I}_{\mathrm{C}}=-10 \mathrm{~mA}, \mathrm{I}_{\mathrm{B}}=0, \quad$ See Note 3 | -45 | -45 | V |
| $V_{\text {(BR)EBO }}$ | Emitter-Base Breakdown Voltage | $\mathrm{I}_{\mathrm{E}}=-10 \mu \mathrm{~A}, \quad \mathrm{I}^{2}=0$ | -6 | -6 | V |
| 1 CBO | Collector Cutoff Current | $\mathrm{V}_{C B}=-45 \mathrm{~V}, \mathrm{I}_{\mathrm{E}}=0$ | -10 | -10 | nA |
| ICES | Collector Cutoff Current | $V_{C E}=-45 \mathrm{~V}, \mathrm{~V}_{\mathrm{BE}}=0$ | -10 | -10 | nA |
|  |  | $\mathrm{V}_{\text {CE }}=-45 \mathrm{~V}, \mathrm{~V}_{\mathrm{BE}}=0, \quad \mathrm{~T}_{\mathrm{A}}=170^{\circ} \mathrm{C}$ | -10 | -10 | $\mu \mathrm{A}$ |
| IEBO | Emitter Cutoff Current | $V_{E B}=-5 V, I^{\prime}=0$ | -2 | -2 | nA |
| $h_{\text {FE }}$ | Static Forward Current Transfer Ratio | $V_{C E}=-5 \mathrm{~V}, 1 \mathrm{C}=-10 \mu \mathrm{~A}$ | $40 \quad 120$ | $100 \quad 300$ |  |
|  |  | $V_{C E}=-5 \mathrm{~V}, \mathrm{I}^{\prime}=-10 \mu \mathrm{~A}, \mathrm{~T}_{\mathrm{A}}=-55^{\circ} \mathrm{C}$ | 10 | 20 |  |
|  |  | $\mathrm{V}_{C E}=-5 \mathrm{~V}, \mathrm{I}^{\prime} \mathrm{C}=-500 \mu \mathrm{~A}$ | 60 | 150 |  |
|  |  | $\mathrm{V}_{\mathrm{CE}}=-5 \mathrm{~V}, \mathrm{I}^{\prime}=-10 \mathrm{~mA}$, See Note 3 | 350 | 600 |  |
| $V_{\text {BE }}$ | Base-Emitter Voltage | $\mathrm{I}_{\mathrm{B}}=-0.5 \mathrm{~mA}, \mathrm{I}^{\prime} \mathrm{C}=-10 \mathrm{~mA}$, See Note 3 | -0.7 -0.9 | -0.7 -0.9 | V |
| VCE(sat) | Collector-Emitter Saturation Voltage | $\mathrm{I}_{\mathrm{B}}=-0.5 \mathrm{~mA}, \mathrm{I}_{C}=-10 \mathrm{~mA}$, See Note 3 | -0.5 | -0.5 | V |
| $\mathbf{h i b}_{\text {b }}$ | Small-Signal Common-Base Input Impedance | $V_{C B}=-5 \mathrm{~V}, \mathrm{I}_{\mathrm{E}}=1 \mathrm{~mA}, \quad \mathrm{f}=1 \mathrm{kHz}$ | $25 \quad 35$ | $25 \quad 35$ | $\Omega$ |
| $h_{\text {rb }}$ | Small-Signal Common-Base Reverse Voltage Transfer Ratio |  | $\begin{array}{r} 10 x \\ 10^{-4} \end{array}$ | $\begin{array}{r} 10 \times \\ 10^{-4} \end{array}$ |  |
| $h_{\text {ob }}$ | Small-Signal Common-Base Output Admittance |  | 1 | 1 | $\mu \mathrm{mho}$ |
| $\mathrm{h}_{\mathrm{fe}}$ | Small-Signal Common-Emitter Forward Current Transfer Ratio |  | $60 \quad 350$ | 150600 |  |
| Hfe! | Small-Signal Common-Emitter <br> Forward Current Transfer Ratio | $V_{C E}=-5 \mathrm{~V}, \quad 1 \mathrm{C}=-500 \mu \mathrm{~A}, \mathrm{f}=30 \mathrm{MHz}$ | 1 | 1 |  |
| Cobo | Common-Base Open-Circuit Output Capacitance | $V_{C B}=-5 V, l_{E}=0 . \quad f=1 \mathrm{MHz}$ | 6 | 6 | pF |
| $h_{\text {ie }}($ real $)$ | Real Part of Small-Signal Common-Emitter Input Impedance | $V_{C E}=-5 V, \quad I_{C}=-1 \mathrm{~mA}, \quad f=100 \mathrm{MHz}$ | 200 | 200 | $\Omega$ |

*operating characteristics at $25^{\circ} \mathrm{C}$ free-air temperature

| PARAMETER |  | TEST CONDITIONS | 2N2604 | 2N2605 | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | MIN MAX | MIN MAX |  |
| F | Average Noise Figure |  | $V_{C E}=-5 \mathrm{~V}, \quad I_{C}=-10 \mu \mathrm{~A}, \quad \mathrm{R}_{\mathrm{G}}=10 \mathrm{k} \Omega$, <br> Noise Bandwidth $=15.7 \mathrm{kHz}$, See Note 4 | 4 | 3 | dB |

NOTES: 3. These parameters must be measured using puise techniques. $t_{w}=\mathbf{3 0 0} \mu \mathrm{s}$, duty cycte $\leqslant \mathbf{2 \%}$.
4. Average Noise Figure is measured in en amplitier with response down 3 dB at 10 Hz and 10 kHz and a high-frequency roll-off of $6 \mathrm{~dB} /$ octave.

[^59]
# SILECT ${ }^{\dagger}$ TRANSISTORS $\ddagger$ <br> FOR LOW-LEVEL, LOW-NOISE, HIGH-GAIN AMPLIFIER APPLICATIONS 

- Minimum hfe at $10 \mu \mathrm{~A}$. . 100 (A5T2605)
- Low Average Noise Figure . . . 3 dB, Max (A5T2605)
- Usable at Collector Currents as Low as $1 \mu \mathrm{~A}$


## mechanical data

These transistors are encapsulated in a plastic compound specifically designed for this purpose, using a highly mechanized process developed by Texas Instruments. The case will withstand soldering temperatures without deformation. These devices exhibit stable characteristics under high-humidity conditions and are capable of meeting MIL-STD-202C, Method 106B. The transistors are insensitive to light.

absolute maximum ratings at $\mathbf{2 5}{ }^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)


NOTES: 1. This value applies betwesn $O$ and 10 mA collector current when the base-emitter diode is open-circuited.
2. Derate linearly to $150^{\circ} \mathrm{C}$ free-air temperature at the rate of $5 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$.
†Trademark of Texas Instruments
$\ddagger$ U.S. Patent No. 3,439,238

## TYPES A5T2604, A5T2605 P-N-P SILICON TRANSISTORS

electrical characteristics at $\mathbf{2 5}{ }^{\circ} \mathbf{C}$ free-air temperature (unless otherwise noted)

| PARAMETER |  | TEST CONDITIONS | A5T2604 | A5T2605 | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | MIN MAX | MIN MAX |  |
| $V_{\text {(BR) }}$ CBO | Collector-Base Breakdown Voltage |  | $\mathrm{I}_{\mathrm{C}}=-10 \mu \mathrm{~A}, \quad \mathrm{I}_{\mathrm{E}}=0$ | -60 | -60 | V |
| $V_{\text {(BR) }}$ CEO | Collector-Emitter Breakdown Voltage | $\mathrm{I}_{\mathrm{C}}=\mathbf{- 1 0 m A}, \mathrm{I}_{\mathrm{B}}=0, \quad$ See Note 3 | -45 | -45 | V |
| $V_{\text {(BR)EBO }}$ | Emitter-Base Breakdown Voltage | $\mathrm{I}_{\mathrm{E}}=-10 \mu \mathrm{~A}, \mathrm{I}^{2}=0$ | -6 | -6 | V |
| ICBO | Collector Cutoff Current | $\mathrm{V}_{\mathrm{CB}}=-45 \mathrm{~V}, \mathrm{I}_{\mathrm{E}}=0$ | -10 | -10 | nA |
| ICES | Collector Cutoff Current | $\mathrm{V}_{\text {CE }}=-45 \mathrm{~V}, \mathrm{~V}_{\text {BE }}=0$ | -10 | -10 | nA |
|  |  | $V_{C E}=-45 \mathrm{~V}, \mathrm{~V}_{\mathrm{BE}}=0, \quad \mathrm{~T}_{\mathrm{A}}=85^{\circ} \mathrm{C}$ | -200 | -200 |  |
| IEBO | Emitter Cutoff Current | $\mathrm{VEB}=-5 \mathrm{~V}, \mathrm{IC}=0$ | -2 | -2 | nA |
| hfe | Static Forward Current Transfer Ratio | $V_{C E}=-5 \mathrm{~V}, \mathrm{I}^{\prime}=-10 \mu \mathrm{~A}$ | $40 \quad 120$ | $100 \quad 300$ |  |
|  |  | $V_{C E}=-5 \mathrm{~V}, \mathrm{I}^{\prime}=-500 \mu \mathrm{~A}$ | 60 | 150 |  |
|  |  | $V_{C E}=-5 \mathrm{~V}, \mathrm{I}^{\prime}=-10 \mathrm{~mA}$, See Note 3 | 350 | 600 |  |
| VBE | Base-Emitter Voltage | $\mathrm{I}_{\mathrm{B}}=-0.5 \mathrm{~mA}, \mathrm{I}^{\prime} \mathrm{C}=-10 \mathrm{~mA}$, See Note 3 | -0.7 -0.9 | -0.7 | V |
| VCE(sat) | Collector-Emitter Saturation Voltage | $\mathrm{I}_{B}=-0.5 \mathrm{~mA}, \mathrm{I}^{\prime}=-10 \mathrm{~mA}$, See Note 3 | -0.5 | -0.5 | V |
| $h_{i b}$ | Small-Signal Common-Base Input Impedance | $V_{C B}=-5 \mathrm{~V}, \quad \mathrm{l}_{\mathrm{E}}=1 \mathrm{~mA}, \quad f=1 \mathrm{kHz}$ | 2535 | $25 \quad 35$ | $\Omega$ |
| $h_{r b}$ | Small-Signal Common-Base <br> Reverse Voltage Transfer Ratio |  | $\begin{array}{r} 10^{-x} \\ 10^{-4} \end{array}$ | $\begin{array}{r} 10 \times \\ 10^{-4} \end{array}$ |  |
| hob | Small-Signal Common-Base Output Admittence |  | 1 | 1 | $\mu \mathrm{mho}$ |
| $h_{\text {fe }}$ | Small-Signal Common-Emitter Forward Current Transfer Ratio |  | 60350 | 150600 |  |
| \|hfel | Small-Signal Common-Emitter Forward Current Transfer Ratio | $V_{C E}=-5 \mathrm{~V}, \quad \mathrm{I}^{\prime}=-500 \mu \mathrm{~A}, \mathrm{f}=30 \mathrm{MHz}$ | 1 | 1 |  |
| Cobo | Common-Base Open-Circuit Output Capacitance | $V_{C B}=-5 V, \quad l_{E}=0, \quad f=1 \mathrm{MHz}$ | 6 | 6 | pF |
| $h_{\text {ie(real }}$ ) | Real Part of Small-Signal Common-Emitter Input Impedance | $V_{C E}=-5 \mathrm{~V}, \quad 1 \mathrm{C}=-1 \mathrm{~mA}, \quad f=100 \mathrm{MHz}$ | 200 | 200 | $\Omega$ |

operating characteristics at $\mathbf{2 5}{ }^{\circ} \mathrm{C}$ free-air temperature

| PARAMETER |  | TEST CONDITIONS | A5T2604 | AST2605 | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | MIN MAX | MIN MAX |  |
| $\overline{\mathrm{F}}$ | Average Noise Figure |  | $\begin{array}{ll} V_{C E}=-5 \mathrm{~V}, \quad \mathrm{I}_{\mathrm{C}}=-10 \mu \mathrm{~A}, & \mathrm{R}_{\mathrm{G}}=10 \mathrm{k} \Omega, \\ \text { Noise Bandwidth }=15.7 \mathrm{kHz}, & \text { See Note } 4 \end{array}$ | 4 | 3 | dB |

NOTES: 3. These parameters must be measured using pulse techniques. $t_{w}=300 \mu s$, duty cycle $\leqslant 2 \%$.
4. Average Noise Figure is measured in an amplifier with response down 3 dB at 10 Hz and 10 kHz and a high-frequency roll-off of $6 \mathrm{~dB} /$ octave.

## FOR SMALL-SIGNAL, LOW-NOISE APPLICATIONS

\author{

- High Input Impedance
}
*mechanical data

absolute maximum ratings at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

$$
\begin{aligned}
& \text { Continuous Forward Gate Current } \\
& -10 \mathrm{~mA} \\
& \text { *Continuous Device Dissipation at (or below) } 25^{\circ} \mathrm{C} \text { Free-Air Temperature (See Note 1) } \\
& 300 \mathrm{~mW} \\
& \text { *Storage Temperature Range } \\
& \text { Lead Temperature } \mathbf{1 / 1 6} \text { inch from Case for } 10 \text { Seconds } \\
& 300^{\circ} \mathrm{C}
\end{aligned}
$$

electrical characteristics at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

operating characteristics at $25^{\circ} \mathbf{C}$ free-air temperature

| PARAMETER |  | TEST CONDITIONS |  |  | BOTH |  | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | MIN | MAX |  |
| *NF | Common-Source Spot Noise Figure |  |  |  | $V_{D S}=-5 \mathrm{~V}, \quad V_{G S}=0$, | $\mathrm{f}=1 \mathrm{kHz}$, | $\mathrm{R}_{\mathrm{G}}=1 \mathrm{M} \Omega$ |  | 3 | dB |

NOTE 1: Derate linearly to $175^{\circ} \mathrm{C}$ free-air temperature at the rate of $2 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$.
*JEDEC registered data. This data sheet contains all applicable registered data in effect at the time of publication.

## TWO TRANSISTORS IN ONE PACKAGE RECOMMENDED FOR

- Differential Amplifiers
- High-Gain, Low-Noise Audio Amplifiers
- Transducer Signal-Conditioner Amplifiers
- Low-Level Flip.Flops
"mechanical data

*absolute maximum ratings at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)


NOTES: 1. This volue applies when the emitter-base diode is open-circuited.
2. For each triode derate linearly to $175^{\circ} \mathrm{C}$ frea-air temperature at the rate of $2 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$.
3. For each triode derate linearly to $175^{\circ} \mathrm{C}$ case temperature at the rate of $4 \mathrm{mw} /{ }^{\circ} \mathrm{C}$.
-JEDEC registered date. This data sheat contains all applicable registered data in effect et the time of publication.

## TYPES 2N2639 THRU 2N2644 dUAL N-P-N SILICON TRANSISTORS

*electrical characteristics at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)
individual triode characteristics (see note 4)

| PARAMETER | TEST CONDITIONS |  |  | $\begin{aligned} & 2 \mathrm{~N}_{2} 659 \\ & 2 N 2640 \\ & 2 N 2641 \end{aligned}$ | $\begin{aligned} & \text { 2N2645 } \\ & 2 N 2643 \\ & \text { 2NR264 } \end{aligned}$ | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  | MIN MAX | MIN MAX |  |
| V(RR)CEO Collector-Emitter Breakdown Voltage | $I^{\prime} \mathrm{C}=10 \mathrm{~mA}$, | $I_{B}=0$, | Ser Note 5 | 45 | 45 | V |
| ICBO Collector Cutoff Current | $V_{C B}=45 \mathrm{~V}$, | $\mathrm{J}_{5}=0$ |  | 10 | 10 | nA |
|  | $V_{C B}=45 \mathrm{~V}$, | $\mathrm{I}_{\mathrm{E}}=0$, | $\mathrm{T}_{\mathrm{A}}=150^{\circ} \mathrm{C}$ | 10 | 10 | $\mu \mathrm{A}$ |
| $I_{\text {CEO }}$ Collector Cutoff Current | $V_{C E}=5 \mathrm{~V}$, | $\mathrm{I}_{\mathrm{B}}=0$ |  | 10 | 10 | nA |
| IEBO Emitter Cutoff Current | $V_{E B}=5 V_{\text {d }}$ | $1^{1} C=0$ |  | 10 | 10 | nA |
| hfe Static Forward Current Transfer Ratio | $V_{C E}=5 V_{\text {, }}$ | $I_{C}=10 \mu A$ |  | $50 \quad 300$ | $100 \quad 300$ |  |
|  | $V_{C E}=5 \mathrm{~V}$, | $I^{\prime} C=10 \mu A$, | $T_{A}=-55^{\circ} \mathrm{C}$ | 10 | 20 |  |
|  | $V_{C E}=5 V_{1}$ | $\mathrm{I}_{\mathrm{C}}=100 \mu \mathrm{~A}$ |  | 55 | 110 |  |
|  | $V_{C E}=5 \mathrm{~V}_{1}$ | $I_{C}=1 \mathrm{~mA}$ |  | 65 | 130 |  |
| VBE Base-Emitter Voltage | $\mathrm{I}_{\mathrm{B}}=0.5 \mathrm{~mA}$, | $I_{C}=10 \mathrm{~mA}$, |  | 0.6 | $0.6 \quad 1$ | V |
| $\mathrm{V}_{\text {CE }}(\mathrm{sat}) \quad$ Collector-Emitter Saturation Voltage | ${ }^{1} B=0.5 \mathrm{~mA}$, | $I_{C}=10 \mathrm{~mA}$ |  | 1 | 1 | V |
| $\mathrm{h}_{\text {ib }} \quad$ Small-Signal Common-Base Input Impedance | $V_{C B}=5 \mathrm{~V}$, | ${ }^{\prime} \mathrm{E}=-1 \mathrm{~mA}$, | $f=1 \mathrm{kHz}$ | $25 \quad 32$ | $25 \quad 32$ | $\Omega$ |
| $\mathrm{h}_{\mathrm{rb}}$ Small-Signal Common-Base <br> Reverse Voltage Transfer Ratio  |  |  |  | $\begin{gathered} 6 \times \\ 10^{-4} \\ \hline \end{gathered}$ | $\begin{gathered} 6 \times \\ 10^{-4} \\ \hline \end{gathered}$ |  |
| $\mathrm{h}_{\text {ob }} \quad$ Small-Signal Common-Base Output Admittance |  |  |  | 1 | 1 | $\mu \mathrm{mho}$ |
| $h_{f e}$ Small-Signal Common-Emitter <br> Forward Current Transfer Ratio | $V_{C E}=5 \mathrm{~V}$, | $I_{C}=1 \mathrm{~mA}$, | $f=1 \mathrm{kHz}$ | 65600 | 130600 |  |
| $\left\|h_{\mathrm{fe}}\right\| \quad$Small-Signal Common-Emitter <br> Forward Current Transfer Ratio | $V C E=5 V$, | $\mathrm{IC}=1 \mathrm{~mA}$, | $f=20 \mathrm{MHz}$ | 4 | 4 | dB |
| Cobo Common-Base Open-Circuit Output Capscitance | $V_{C B}=5 V$, | $t E=0$, | $f=1 \mathrm{MHz}$ | 8 | 8 | pF |

triode matching characteristics

| PARAMETER |  | TEST CONDITIONS |  |  | $\begin{aligned} & \text { 2N2639 } \\ & \text { 2N2642 } \\ & \hline \end{aligned}$ |  | $\begin{aligned} & \text { 2N2640 } \\ & \text { 2N2643 } \\ & \hline \end{aligned}$ |  | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | MIN | MAX | MIN | MAX |  |
| $\frac{h_{F E 1}}{h_{F E 2}}$ | Static Forward-Current-Gain Balance Ratio |  |  |  | $V_{C E}=5 \mathrm{~V}$. | ${ }^{1} \mathrm{C}=10 \mu \mathrm{~A}$, | See Note 6 | 0.9 | 1 | 0.8 | 1 |  |
| \| $\mathrm{V}_{\text {BE1 }}-\mathrm{V}_{\text {BE2 }} \mid$ | Base-Emitter-Voltage Differential | $V_{C E}=5 \mathrm{~V}$, | $I^{\prime} C=10 \mu A$ |  |  | 5 |  | 10 | mV |
| $\left\|\frac{\Delta\left(V_{B E 1}-V_{B E 2}\right)}{\Delta T_{A}}\right\|$ | Base-Emitter-Voltage-Differential Temperature Gradient | $\begin{aligned} & V_{C E}=5 \mathrm{~V}, \\ & \Delta T_{A}=125^{\circ} \end{aligned}$ | $\begin{aligned} & I^{I}=10 \mu A \\ & \left.\left(-55^{\circ} \mathrm{C}\right)\right] \end{aligned}$ | $\left.25^{\circ} \mathrm{C}-25^{\circ} \mathrm{C}\right]$ |  | 10 |  | 20 | $\mu \mathrm{V} /{ }^{\circ} \mathrm{C}$ |

## *operating characteristics at $25^{\circ} \mathrm{C}$ free-air temperature

individual triode characteristice (see note 4)


NOTES: 4. The terminals of the triode not under test are open-circulted for the measurement of these charseteristes.
8. This paramoter must be measured using pulse technlques. $\imath_{w}=\mathbf{3 0 0} \mu_{\mathbf{s}}$, dutv cyele $\mathbf{6} \mathbf{2 \%}$.
6. The lower of the two $h_{F E}$ resdings is taken as $h_{F E 1}$,
7. Averape Noise Flgure is messured in an amplifier with response down 3 dB at 10 Hz and 10 kHz and a high-fraquancy rolloff of © dB/octave.

- JEDEC registered date


## PLANAR UNIJUNCTION TRANSISTORS SPECIFICALLY CHARACTERIZED FOR A WIDE RANGE OF MILITARY AND INDUSTRIAL APPLICATIONS

- Planar Process Ensures Low Leakage, Low Drive-Current Requirement, and Improved Reliability


## *mechanical data

Package outline is the same as JEDEC TO-18 except for lead position. All TO-18 registration notes also apply to this outline.

*absolute maximum ratings at $25^{\circ} \mathrm{C}$ free-air temperature (uniess otherwise noted)


## TYPES 2N2646, 2 N2647 <br> P-N PLANAR SILICON UNLUUNCTION TRANSISTORS

*electrical characteristics at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

| PARAMETER |  | TEST CONDITIONS | 2N2846 |  | 2 N 2647 |  | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | MIN | MAX | MIN | MAX |  |
| 'BB | Static Interbase Resistance |  | $V_{B 2 B 1}=3 V, \quad V_{E}=0$ | 4.7 | 9.1 | 4.7 | 9.1 | $k \Omega$ |
| $\alpha_{\mathrm{r} B \mathrm{~B}}$ | Interbase Resistance Temperature Coofficient | $V_{B 2 B 1}=3 V$, $I_{E}=0$, <br> $T_{A}=-55^{\circ} \mathrm{C}$ to $125^{\circ} \mathrm{C}$, See Note 4 | 0.1 | 0.9 | 0.1 | 0.9 | $\% /^{\circ} \mathrm{C}$ |
| $\eta$ | Intrinsic Standoff Ratio | $\mathrm{V}_{\mathrm{B2B1}}=10 \mathrm{~V}$, See Figure 1 | 0.56 | 0.75 | 0.68 | 0.82 |  |
| IEB2O | Emitter Reverse Current | $\mathrm{V}_{\mathrm{EB2}}=-30 \mathrm{~V}, \quad \mathrm{I}_{\mathrm{B} 1}=0$ |  | -12 |  | -0.2 | $\mu \mathbf{A}$ |
| Ip | Peak-Point Emitter Current | $\mathrm{V}_{\mathrm{B2B1}}=25 \mathrm{~V}$ |  | 5 |  | 2 | $\mu \mathrm{A}$ |
| IV | Valley-Point Emitter Current | $\mathrm{V}_{\mathrm{B2B1}}=20 \mathrm{~V}$ | 4 |  | 8 | 18 | mA |
| VOB1 | Baso-Ona Peak Pulse Voltage | See Figure 2 | 3 |  | 6 |  | V |

NOTE 4: Temperature coefficient $\alpha_{\mathrm{rBg}}$ is determined by the following formula:

$$
\alpha_{\mathrm{rBB}}=\left[\frac{\left(\mathrm{r}_{\mathrm{BB}} 125^{\circ} \mathrm{C}\right)-\left(\mathrm{r}_{\mathrm{BB}}{ }^{\oplus}-55^{\circ} \mathrm{C}\right)}{\mathrm{r}_{\mathrm{BB}}{ }^{\circ} 5^{\circ} \mathrm{C}}\right] \frac{100 \%}{180 \%} .
$$

To obtain $r_{B B}$ for a given temperature $T_{A(2)}$, use the following formula:
$r_{B B(2)}=\quad\left[r_{B B}\left(25^{\circ} \mathrm{C}\right]\left[1+\left(\alpha_{\mathrm{rBg}} / 100 \%\right)\left(T_{A(2)}-25^{\circ} \mathrm{C}\right)\right]\right.$.

## *PARAMETER MEASUREMENT INFORMATION



D1: Sllieon dlode with the following characteristics:
$V_{F}=0.672 \mathrm{Vat} \mathrm{I}_{\mathrm{F}}=0.5 \mathrm{~mA}$
$\mathrm{I}_{\mathrm{R}} \leqslant 2 \mathrm{nA}$ at $\mathrm{V}_{\mathrm{R}}=20 \mathrm{~V}$.
$\eta$-Intrinsic Standoff Ratio-This parameter is defined by the equation: $V_{P}=\eta V_{B B}+V_{F}$, where $V_{F}$ is about 0.67 volts at $25^{\circ} \mathrm{C}$ and decreases with tempersture at about 2 millivolts ${ }^{\circ} \mathrm{C}$.

A circuit which may be used to measure $\eta$ is shown in this figure. In this circult, R1, C1, and the unijunction transistor form a relaxation oscillator. The remainder of the circuit serves as a peak-voltage detector with the diode D1 sutomatically subtracting the voltage $V_{F}$. To use the circuit, the calibrated potentiometer R3 is adjusted to null the metor M. The potentiometer le then read directly for $\eta$. e.9., $6 \mathrm{k} \Omega$ represents $\eta=0.6$.


FIGURE 2-VOB1 TEST CIRCUIT

FIGURE 1- $\eta$ TEST CIRCUIT

EMITTER-BASE-ONE VOLTAGE
vs EMITTER CURRENT


FIGURE 3-GENERAL STATIC EMITTER CHARACTERISTIC CURVE

[^60]
## TWO P-N-P TRANSISTORS IN ONE PACKAGE RECOMMENDED FOR

## - Differential Amplifiers

- Low-Noise, Low-Level Amplifiers
- Low-Level Flip-Fiops
- Complementary Use With 2N2639 Through 2N2644 Dual N-P-N Transistors
*meachanical data

*absolute maximum ratings at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)


1. This value applies when the base-amitter diode is open-circuited.
2. For sach triode derate linearly to $175^{\circ} \mathrm{C}$ free-air temperature at the rate of $1.67 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$.
3. For each triode derate linearly to $175^{\circ} \mathrm{C}$ case temperature at the rate of $3.33 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$.
-JEDEC registered data. This data sheat contains all applicable registered data in effect at the time of publication.

## TYPES 2N2802 THRU 2N2807 <br> DUAL P-N-P PLANAR SILICON TRANSISTORS

*electrical characteristics at $\mathbf{2 5}{ }^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)
individual triode characteristics (see note 4)

| PARAMETER | TEST CONDITIONS | $\begin{aligned} & \text { 2N2802 } \\ & \text { 2N2803 } \\ & \text { 2N2804 } \end{aligned}$ |  | UNIT |
| :---: | :---: | :---: | :---: | :---: |
|  |  | MIN . MAX | MIN MAX |  |
| V(BR)CEO Collector-Emitter Breakdown Voltage | $\mathrm{I}_{\mathrm{C}}=-10 \mathrm{~mA}, \mathrm{I}_{\mathrm{B}}=0, \quad$ See Note 5 | -20 | -20 | V |
| Collector Cutoff Current | $\mathrm{V}_{C B}=-25 \mathrm{~V}, \mathrm{I}_{\mathrm{E}}=0$ | -10 | -10 | nA |
|  | $V_{C B}=-25 V, I_{E}=0, \quad T_{A}=150^{\circ} \mathrm{C}$ | -10 | -10 | $\mu \mathrm{A}$ |
| IEbo Emitter Cutoff Current | $V_{E B}=-5 \mathrm{~V}, \mathrm{I}_{\mathrm{C}}=0$ | -10 | -10 | nA |
| Static Forward Current Transfer Ratio | $V_{C E}=-5 \mathrm{~V}, \mathrm{I}_{\mathrm{C}}=-10 \mu \mathrm{~A}$ | 15 | 30 |  |
|  | $\mathrm{V}_{\text {CE }}=-5 \mathrm{~V}, \mathrm{I}_{\mathrm{C}}=-100 \mu \mathrm{~A}$ | $20 \quad 120$ | $40 \quad 120$ |  |
|  | $\mathrm{V}_{\text {CE }}=-5 \mathrm{~V}, \mathrm{I}_{\mathrm{C}}=-100 \mu \mathrm{~A}, \mathrm{~T}_{\mathrm{A}}=-55^{\circ} \mathrm{C}$ | 10 | 20 |  |
|  | $\mathrm{V}_{\text {CE }}=-5 \mathrm{~V}$. $1_{C}=-1 \mathrm{~mA}$ | 20 | 40 |  |
| $\mathrm{V}_{\text {BE }}$ Base-Emitter Voltage | $\mathrm{I}_{\mathrm{B}}=-1 \mathrm{~mA}, \mathrm{I}_{\mathrm{C}}=-10 \mathrm{~mA}$ | -0.7-0.9 | -0.7-0.9 | V |
| VCE(sat) Collector-Emitter Saturation Voltage | $\mathrm{I}_{\mathrm{B}}=-1 \mathrm{~mA}, \mathrm{I}_{\mathrm{C}}=-10 \mathrm{~mA}$ | -0.5 | -0.5 | V |
| $\mathrm{h}_{\text {ib }}$ Small-Signal Common-Base Input Impedance | $V_{C B}=-5 \mathrm{~V}, \mathrm{l}_{E}=1 \mathrm{~mA}, \quad f=1 \mathrm{kHz}$ | $25 \quad 32$ | $25 \quad 32$ | $\Omega$ |
| $h_{r b}$ Small-Signal Common-Base <br> Reverse Voltage Transfer Ratio  |  | $\begin{aligned} & 12 \times \\ & 10^{-4} \end{aligned}$ | $\begin{aligned} & 12 x \\ & 10^{-4} \end{aligned}$ |  |
| hob Small-Signal Common-Base Output Admittance |  | 1 | 1 | $\mu \mathrm{mho}$ |
| $\mathbf{h}_{\mathrm{fe}}$ Small-Signal Common-Emitter <br> Forward Current Transfer Ratio  | $\mathrm{V}_{C E}=-5 \mathrm{~V}, \quad \mathrm{I}_{\mathrm{C}}=-1 \mathrm{~mA}, \quad f=1 \mathrm{kHz}$ | $20 \quad 200$ | $40 \quad 200$ |  |
| Thel Small-Signal Common-Emitter | $V_{C E}=-5 \mathrm{~V}, \quad \mathrm{IC}=-1 \mathrm{~mA}, \quad f=20 \mathrm{MHz}$ | 3 | 3 |  |
| Cobo Common-Base Open-Circuit Output Capacitance | $\mathrm{V}_{\mathrm{CB}}=-5 \mathrm{~V}, \mathrm{I}_{\mathrm{E}}=0, \quad \mathrm{f}=1 \mathrm{MHz}$ | 8 | 8 | pF |

triode matching characteristics

| PARAMETER |  | TEST CONDITIONS | $\begin{aligned} & \text { 2N2802 } \\ & \text { 2N2905 } \\ & \hline \end{aligned}$ |  | $\begin{aligned} & \text { 2N2803 } \\ & \text { 2N2806 } \\ & \hline \end{aligned}$ |  | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | MIN | MAX | MIN | MAX |  |
| $\frac{\text { hFE1 }}{}$ | Static Forward-Current-Gain Balance Ratio |  | $V_{C E}=-5 \mathrm{~V}, \mathrm{I} C=-100 \mu \mathrm{~A}$, See Note 6 | 0.9 | 1 | 0.8 | 1 |  |
| $\left\|\mathrm{V}_{\text {BE1 }}-\mathrm{V}_{\text {BE2 }}\right\|$ | Base-Emitter-Voltage Differential | $\mathrm{V}_{\text {CE }}=-5 \mathrm{~V}, \mathrm{I}_{\text {C }}=-100 \mu \mathrm{~A}$ |  | 5 |  | 10 | mV |
| $\left\|\frac{\Delta\left(\mathrm{V}_{\mathrm{BE} 1}-\mathrm{V}_{\mathrm{BE} 2}\right)}{\Delta T_{A}}\right\|$ | Base-Emitter-Voltage-Differential Temperature Gradient | $\begin{aligned} & V_{C E}=-5 V, I_{C}=-100 \mu \mathrm{~A}, \\ & \Delta T_{A}=\left[25^{\circ} \mathrm{C}-\left(-55^{\circ} \mathrm{C}\right)\right] \text { and }\left[125^{\circ} \mathrm{C}-25^{\circ} \mathrm{C}\right] \end{aligned}$ | 10 |  | 20 |  | $\mu \vee /{ }^{\circ} \mathrm{C}$ |

*operating characteristics at $25^{\circ} \mathrm{C}$ free-air temperature
individual triode characteristics (see note 4)

| PARAMETER |  | TEST CONDITIONS | $\begin{aligned} & \text { ALL } \\ & \text { TYPES } \end{aligned}$ | UNIT |
| :---: | :---: | :---: | :---: | :---: |
|  |  | MAX |  |
| $\bar{F}$ | Average Noise Figure |  | $\begin{array}{ll} V_{C B}=-5 V, \quad I_{E}=10 \mu A, & R_{G}=10 \mathrm{k} \Omega, \\ \text { Noise Bandwidth }=15.7 \mathrm{kHz}, & \text { See Note } 7 \end{array}$ | 4 | dB |

NOTES: 4. The terminals of the triode not under test are open-circuited for the measurament of these characteristics.
5. This parameter must be measured using pulse techniques. $\mathbf{t}_{\mathbf{w}}=\mathbf{3 0 0} \mu \mathrm{s}$, duty cycle $\leqslant \mathbf{2 \%}$.
6. The lower of the two hFE readings is taken as $h_{F E 1}$.
7. Average Noise Figure is measured in an amplifier with low-frequency response down 3 dB at 10 Hz and 10 kHz and a high-frequency rolloff of $\mathbf{6 ~ d B} /$ octave.

[^61]BULLETIN NO. DL-S 645051, AUGUST 1964

## DESIGNED FOR HIGH-SPEED SWITCHING APPLICATIONS <br> - Guaranteed $\mathrm{V}_{\mathrm{ctsant}} \ldots 0.5 \mathrm{v}$ Max at 100 ma <br> - High $\mathrm{f}_{1}$... 400 Mc Min

*mechanical data

*absolute maximum ratings at $25^{\circ} \mathbf{C}$ free-air temperature (unless otherwise noted)

*electrical characteristics at $\mathbf{2 5}{ }^{\circ} \mathbf{C}$ free-air temperature (unless otherwise noted)

| PARAMETER |  | TEST CONDITIONS |  | 2N2894 | 2N3012 | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | MIN MAX | MIN MAX |  |
| $V_{\text {(m) }}$ cmo | Collactor-Ease Irrakdewn Yoliage |  |  | $\mathrm{I}_{\mathrm{C}}=-10 \mu \mathrm{n}, \quad \mathrm{I}_{\mathrm{E}}=0$ |  | -12 | -12 | $V$ |
| $V_{\text {(la)Ceo }}$ | Collfecter-Emitter Breakdown Voitage | $\mathrm{I}_{\mathrm{C}}=-10 \mathrm{mc}, \quad \mathrm{t}_{\mathrm{B}}=0$, | Soe Mote 4 | -12 | -12 | $\checkmark$ |
| $V_{\text {( }}^{\text {P }}$ ) CES | Colloerter-Emittor Broakdown Voltago | $\mathrm{I}_{\mathrm{C}}=-10 \mu \mathrm{a}, \quad \mathrm{V}_{\mathrm{ge}}=0$ |  | $-12$ | $-12$ | $\checkmark$ |
| $Y_{\text {(en) }}^{\text {cee }}$ | Emittor-Lase Breakdown Veltage | $\mathrm{I}_{\mathrm{E}}=-100 \mu \mathrm{a}, \mathrm{I}_{\mathrm{C}}=0$ |  | - | -4 | $\checkmark$ |
| $\mathrm{I}_{\mathrm{CnO}}$ | Collector Cuteff Curme | $v_{C B}=-6 \mathrm{v}, \quad \mathrm{I}_{\mathrm{E}}=0$, | $\mathrm{T}_{\mathrm{A}}=125^{\circ} \mathrm{C}$ | -10 |  | $\mu$ |
| 'ces | Colloctior Cotoff Curront | $v_{\text {CE }}=-6 \mathrm{v}, \quad \mathrm{V}_{\text {BE }}=0$ |  | $-80$ | $-80$ | na |
|  |  | $v_{C E}=-6 v_{1}, \quad v_{\text {EE }}=0$, | $\mathrm{T}_{\mathbf{A}}=\mathbf{8 5}{ }^{\circ} \mathrm{C}$ |  | -5 | $\mu \mathrm{o}$ |
| $\mathrm{I}_{1}$ | Base Curront | $\mathbf{v}_{\text {CE }}=-6 \mathrm{v} \quad \mathrm{v}_{\text {BE }}=0$ |  | 80 | 30 | no |
| $h_{\text {FE }}$ | Static Forward Curment Trensfer Ratio | $\mathrm{V}_{C E}=-0.3 \mathrm{v}, \mathrm{l}_{\mathrm{C}}=-10 \mathrm{ma}$, | See Note 4 | 30 | 25 |  |
|  |  | $\mathbf{v}_{C E}=-0.5 \mathrm{v}, \quad \mathrm{I}_{\mathrm{C}}=-30 \mathrm{mo}$, | Soe Mote 4 | $40 \quad 150$ | $30 \quad 120$ |  |
|  |  | $\mathrm{v}_{\text {CE }}=-1 \mathrm{v}, \quad \mathrm{t}_{C}=-100 \mathrm{ma}$, | Soe Mets 4 | 25 | 20 |  |
|  |  | $\begin{array}{ll} v_{C E}=-0.5 \mathrm{v}, & \mathrm{I}_{\mathrm{C}}=-30 \mathrm{me}, \\ T_{A}=-55^{\circ} \mathrm{C}, & \text { Ser Nete } 4 \end{array}$ |  | 17 |  |  |
| $v_{\text {CEIsat] }}$ | Collester-Emitter Saturation Vollage | $\mathrm{I}_{1}=-1 \mathrm{ma}, \quad \mathrm{I}_{\mathrm{c}}=-10 \mathrm{ma}$, | Soe Note 4 | -0.15 | -0.15 | $v$ |
|  |  | $\mathrm{I}_{8}=-3 \mathrm{ma}, \quad \mathrm{I}_{C}=-30 \mathrm{ma}$, | See Mote 4 | -0.20 | -0.20 | $v$ |
|  |  | $\mathrm{I}_{\mathrm{B}}=-10 \mathrm{ma}, \quad \mathrm{I}_{C}=-100 \mathrm{ma}$, | See Mote 4 | -0.50 | -0.50 | $v$ |
|  |  | $\begin{array}{ll} \mathrm{I}_{\mathrm{B}}=-3 \mathrm{ma}, & \mathrm{I}_{\mathrm{C}}=-30 \mathrm{mo}, \\ T_{\mathrm{A}}=85^{\circ} \mathrm{C}, & \text { See Hoto } 4 \end{array}$ |  |  | -0.40 | $v$ |
| $\mathbf{V E F}_{\text {E }}$ | Base-Emittar Voltage | $\mathrm{Im}^{\prime}=-1 \mathrm{ma}, \quad \mathrm{I}_{\mathrm{C}}=-10 \mathrm{ma}$, | See Mote 4 | -0.78-0.98 | -0.78 -0.98 | v |
|  |  | $\mathrm{I}_{8}=-3 \mathrm{ma}, \quad \mathrm{I}_{C}=-30 \mathrm{ma}$, | Soe Mote 4 | -0.85 -1.2 | $\begin{array}{lll}-0.85 & -1.2\end{array}$ | $v$ |
|  |  | $\mathrm{I}_{\mathrm{a}}=-10 \mathrm{ma}, \mathrm{I}_{\mathrm{C}}=-100 \mathrm{ma}$, | See Mote 4 | -1.7 | -1.7 | $v$ |

NOTES: 1. This value applies between $10 \mu 0$ and 10 ma collector corrent whan the base-amitter diode is open-tircuited.
2. Derale lineariy to $200^{\circ} \mathrm{C}$ free-air temperature at the rate of $2.06 \mathrm{mw} / \mathrm{C}^{\circ}$.
3. Derate linearly to $200^{\circ} \mathrm{C}$ case temperoture of the rale of $6.85 \mathrm{~mm} / C^{\circ}$.
4. This parameter must be measured using pulse techniques. $\mathbf{P W}=300 \mu \mathrm{sec}$, Duty Cycle $=1 \%$.
*indicates JEDEC registered data.

## TYPES 2N2894, 2N3012 <br> P-N-P SILICON TRANSISTORS

*electrical characteristics at $\mathbf{2 5}{ }^{\circ} \mathrm{C}$ free-air temperature

| PARAMETER |  | TEST CONDITIONS |  | 2N2894 |  | 2N3012 |  | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | MIN | MAX | MIN | MAX |  |
| $\left\|\mathrm{hfa}_{\text {fa }}\right\|$ | Small-Signal Common-Emitter Forward Current Iransfar Ratio |  |  | $\mathbf{v}_{\mathbf{C E}}=-10 \mathrm{v}, \mathrm{I}_{\mathbf{C}}=-3$ | $f=100 \mathrm{Mc}$ | 4 |  | 4 |  |  |
| $C_{\text {abo }}$ | Common-Bose Opan-Circuit Output Capacitance | $v_{C B}=-5 v_{,} I_{E}=0$, | $f=140 \mathrm{kc}$ |  | 6 |  | 6 | pf |
| $c_{\text {ibo }}$ | Common-Easa Open-Circuit Input Capacitence | $v_{\text {E }}=-0.5 \mathrm{v}, \mathrm{I}_{\mathrm{c}}=0$, | $f=140 \mathrm{kt}$ |  | 6 |  | 6 | pt |

*switching characteristics at $\mathbf{2 5}{ }^{\mathbf{}} \mathbf{C}$ free-air temperature

|  | PARAMETER | TEST CONDITIONS ${ }^{\dagger}$ | $\begin{gathered} \hline \text { 2N2894 } \\ \hline \text { MAX } \end{gathered}$ | $\frac{\text { 2N3012 }}{\text { MAX }}$ | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: |
| ${ }^{\text {on }}$ | Turn-On Time | $\begin{aligned} & I_{C}=-30 \mathrm{ma}, \quad I_{\text {B }\{1]}=-1.5 \mathrm{ma}, \quad V_{\mathrm{BE}(\mathrm{off}}=3 \mathrm{v}, \\ & \mathbf{R}_{\mathrm{L}}=62 \Omega, \text { see Figure }, \end{aligned}$ | 60 | 60 | nsec |
| ${ }^{\dagger}$ off | Turn-Off Tima | $\begin{aligned} & I_{C}=-30 \mathrm{ma}, \mathrm{I}_{\mathrm{B}(1)}=-1.5 \mathrm{ma}, I_{B 21}=1.5 \mathrm{ma}, \\ & R_{\mathrm{L}}=62 \Omega, \text { See figure } \end{aligned}$ | 90 | 75 | nsec |

tvoltage and current values shown are neminal; exact values vory slighty with transistor parameters.
*PARAMETER MEASUREMENT INFORMATION


FIGURE 1 - TURN-ON AND TURN-OFF TIMES

NOTES: $\mathbf{a}$. The ingut woveforms are supplied by ogenerator with the following tharacteristics: $l_{\text {out }}=50 \Omega, \mathrm{t}_{\mathrm{r}} \leq 1 \mathrm{nsec}, \mathrm{PW}>200$ nsec.
b. Woveforms are monitored on an oscilloscope with the fellowing characteristics: $\mathbf{I}_{\mathrm{f}} \leq 1 \mathrm{nsec}, \mathrm{R}_{\mathrm{in}} \geq 100 \mathrm{k} \Omega$.
*Indicatas JEDEC registered data.

## DESIGNED FOR HIGH-SPEED, MEDIUM-POWER SWITCHING AND GENERAL PURPOSE AMPLIFIER APPLICATIONS

- High Breakdown Voltage Combined with Very Low Saturation Voltage
- hFE Guaranteed from $\mathbf{1 0 0} \mu \mathrm{A}$ to $\mathbf{5 0 0} \mathrm{mA}$
- 2N2904, 2N2906 for Complementary Use with 2N2218, 2N2221
- 2N2905, 2N2907 for Complementary Use with 2N2219, 2N2222


## *mechanical data

Device types 2N2904, 2N2904A, 2N2905, and 2N2905A are in JEDEC TO-5 packages.
Device types 2N2906, 2N2906A, 2N2907, and 2N2907A are in JEDEC TO-18 packages.

*absolute maximum ratings at $\mathbf{2 5}{ }^{\circ} \mathbf{C}$ free-air tamperature (unless otherwise noted)

|  | $\begin{array}{\|l\|} \hline \text { 2N2904 } \\ \text { 2N2905 } \end{array}$ | $\begin{array}{\|l\|} \hline \text { 2N2904A } \\ \text { 2N2905A } \\ \hline \end{array}$ | $\begin{array}{\|l\|} \hline \text { 2N2906 } \\ \text { 2N2907 } \\ \hline \end{array}$ | $\begin{array}{\|l\|} \hline \text { 2N2906A } \\ \text { 2N2907A } \\ \hline \end{array}$ | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: |
| Collector-Base Voltage | -60 | -60 | -60 | -60 | V |
| Collector-Emitter Voltage (See Note 1) | -40 | -60 | -40 | -60 | V |
| Emitter-Base Voltage | -5 | -5 | -5 | -5 | V |
| Continuous Collector Current | -0.6 | -0.6 | -0.6 | -0.6 | A |
| Continuous Device Dissipation at (or below) $25^{\circ} \mathrm{C}$ Free-Air Temperature (See Notes 2 and 3) | 0.6 | 0.6 | 0.4 | 0.4 | W |
| Continuous Device Dissipation at (or below) $25^{\circ} \mathrm{C}$ Case Temperature (See Notes 4 and 5) | 3 | 3 | 1.8 | 1.8 | W |
| Storage Temperature Range | -65 to 200 |  |  |  | ${ }^{5} \mathrm{C}$ |
| Lead Temperature 1/16 Inch from Case for 10 Seconds | 230 |  |  |  | C |

NOTES: 1. These values apply between 0 and 100 mA collector current when the base-emitter diode is open-circuited.
2. Derate 2 N2904, 2N2904A, 2N2905, and $2 N 2905 A$ linearly to $200^{\circ} \mathrm{C}$ free-air temperature at the rate of $3.43 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$.
3. Derate 2N2906, 2N2906A, 2N2907, and 2N2907A linearly to $200^{\circ} \mathrm{C}$ free-air temperature at the rate of $2.28 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$.
4. Derate $2 N 2904,2 N 2904 A, 2 N 2905$, and $2 N 2905 A$ linearly to $200^{\circ} \mathrm{C}$ case temperature at the rate of $17.3 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$.
E. Derate $2 N 2908,2 N 2908 A, 2 N 2907$, and $2 N 2907 A$ linearly to $200^{\circ} \mathrm{C}$ case temperature at the rate of $10.3 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$.
-JEDEC registered data. This data sheet contains all applicable registered data in effect at the time of publication.

## TYPES 2N2904 THRU 2N2907, 2N2904A THRU 2N2907A P-N-P SILICON TRANSISTORS

*electrical characteristics at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

| PARAMETER |  | TEST CONDITIONS TO-18 $\rightarrow$ | $\frac{2 N 2904}{2 N 2906}$ |  | $\frac{2 N 2904 A}{2 N 2906 A}$ |  | $\begin{aligned} & \text { 2N2008 } \\ & \hline \text { 2N2907 } \end{aligned}$ |  | $\begin{aligned} & \text { 2N200BA } \\ & \text { 2N2907A } \end{aligned}$ |  | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  |  |  |  |  |  |  |  |
|  |  | MIN | MAX | MIN | MAX | MIN. | MAX | MIN | MAX |  |
| $V_{\text {(BR) }}$ CBO | Collector-Base Breakdown Voltage |  | $I_{C}=-10 \mu A, \quad I E=0$ | -60 |  | -60 |  | -60 |  | -60 |  | V |
| $V(B R) C E O$ | Collector-Emitter Breakdown Voltage | $\begin{aligned} I_{C}=-10 \mathrm{~mA}, & I_{\mathrm{B}}=0, \\ & \text { Seo Note } 6 \end{aligned}$ | $-40$ |  | -60 |  | -40 |  | -60 |  | V |
| $V(B R) E B O$ | Emitter-Base <br> Breakdown Voltage | $I_{E}=-10 \mu A, \quad I^{\prime}=0$ | -5 |  | -5 |  | -6 |  | -5 |  | $V$ |
| ICBO | Collector Cutoff Current | $V_{C B}=-50 \mathrm{~V}, \mathrm{TE}=0$ |  | -20 |  | -10 |  | -20 |  | -10 | nA |
|  |  | $\begin{aligned} & V_{C B}=-50 \mathrm{~V}, \mathrm{I}_{E}=0, \\ & T_{A}=160^{\circ} \mathrm{C} \end{aligned}$ | -20 |  | -10 |  | -20 |  | -10 |  | $\mu \mathrm{A}$ |
| ICEV | Collector Cutoff Current | $V_{C E}=-30 \mathrm{~V}, V_{B E}=0.5 \mathrm{~V}$ |  | -50 |  | -50 |  | -60 |  | -50 | nA |
| IBEV | Base Cutoff Current | $V_{C E}=-30 \mathrm{~V}, V_{B E}=0.5 \mathrm{~V}$ |  | 50 |  | 50 |  | 50 |  | 50 | nA |
| hFE | Static Forward Current Transfer Ratio | $V_{C E}=-10 \mathrm{~V}, \mathrm{I}^{\prime}=-100 \mu \mathrm{~A}$ | 20 |  | 40 |  | 35 |  | 75 |  |  |
|  |  | $V_{C E}=-10 \mathrm{~V}, \mathrm{I}_{\mathrm{C}}=-1 \mathrm{~mA}$ | 25 |  | 40 |  | 50 |  | 100 |  |  |
|  |  | $V_{C E}=-10 \mathrm{~V},{ }^{\prime} \mathrm{C}=-10 \mathrm{~mA}$ | 35 |  | 40 |  | 75 |  | 100 |  |  |
|  |  | $\begin{aligned} & \hline V_{C E}=-10 \mathrm{~V}, \text { lC }=-150 \mathrm{~mA}, \\ & \text { See Note } 6 \\ & \hline \end{aligned}$ | 40 | 120 | 40 | 120 | 100 | 300 | 100 | 300 |  |
|  |  | $\begin{gathered} V_{C E}=-10 \mathrm{~V}, \mathrm{I}_{\mathrm{C}}=-600 \mathrm{~mA}, \\ \text { See Note } 6 \end{gathered}$ | 20 |  | 40 |  | 30 |  | 50 |  |  |
| VBE | Base-Emitter Voltage | $\begin{aligned} I_{B}=-15 \mathrm{~mA}, & I_{C}=-150 \mathrm{~mA}, \\ & \text { See Note } 6 \end{aligned}$ |  | -1.3 |  | -1.3 |  | -1.3 |  | -1.3 | V |
|  |  | $\begin{aligned} & I_{B}=-50 m A, I_{C}=-500 m A \\ & \text { See Note } 6 \end{aligned}$ |  | -2.6 |  | -2.6 |  | -2.6 |  | -2.6 |  |
| $V_{C E}$ (sat) | Collector-Emitter Saturation Voltage | $\begin{aligned} I_{B}=-15 \mathrm{~mA}, & I_{C}=-150 \mathrm{~mA}, \\ & \text { See Note } 6 \end{aligned}$ |  | -0.4 |  | -0.4 |  | -0.4 |  | -0.4 | V |
|  |  | $\begin{aligned} & I_{B}=-50 m A, I_{C}=-500 \mathrm{~mA}, \\ & \\ & \text { See Note } 6 \end{aligned}$ |  | -1.6 |  | -1.6 |  | -1.6 |  | -1.6 |  |
| \|hfol | Small-Signal <br> Common-Emitter <br> Forward Current <br> Transfer Ratio | $\begin{array}{r} V_{C E}=-20 \mathrm{~V}, \\ I_{C}=-50 \mathrm{~mA} \\ f=100 \mathrm{MHz} \end{array}$ | 2 |  | 2 |  | 2 |  | 2 |  |  |
| Cobo | Common-Base Open-Circuit Output Capacitence | $\begin{aligned} & V_{C B}=-10 \mathrm{~V}, I_{E}=0 \\ & f=100 \mathrm{kHz} \end{aligned}$ | 8 |  | 8 |  | 8 |  | 8 |  | pF |
| Cibo | Common-Base Open-Circuit Input Capacitance | $\begin{aligned} V_{E B}=-2 V, & I_{C}=0 \\ & f=100 \mathrm{kHz} \end{aligned}$ | 30 |  | 30 |  | 30 |  | 30 |  | pF |

NOTE 6: These parameters must be measured using pulse techniques. $t_{w}=\mathbf{3 0 0} \mu \mathrm{s}$, dutv cycie $\leqslant \mathbf{2 \%}$.
*JEDEC ragistarad data

## TYPES 2N2s04 THRU 2N2s07, 2N2904A THRU 2N2907A P-N-P SILICON TRANSISTORS

*switching charecteristics at $\mathbf{2 5}{ }^{\circ} \mathrm{C}$ free-air temperature

| PARAMETER | TEST CONDITIONS ${ }^{+}$ | max | UNIT |
| :---: | :---: | :---: | :---: |
| $t_{\text {d }}$ Delay Time | $\begin{cases}V_{C C}=-30 \mathrm{~V}, & I_{C}=-150 \mathrm{~mA}, \\ V_{B E}(\mathrm{I}(1)(1)=-15 \mathrm{~mA}, \\ =0, & \text { See Figure } 1\end{cases}$ | 10 | ns |
| $4_{4}$ R Rise Time |  | 40 | ns |
| ton Turn-On Time |  | 45 | ns |
| $\mathrm{t}_{8}$ Storage Time | $V_{C C}=-8 \mathrm{~V}, \quad I_{C}=-150 \mathrm{~mA}, I_{B(1)}=-13 \mathrm{~mA},$$I_{B(2)}=17 \mathrm{~mA}, \quad \text { See Figure } 2$ | 80 | ns |
| tf Fall Time |  | 30 | ns |
| toff Turn-Off Time |  | 100 | n8 |

${ }^{\dagger}$ Voitage and currant values thown are nominal; exact values vary alightly with transistor parameters.

figure 2

NOTES: A. The input waveforms are supplied by generator with the following characteristies: $Z_{\text {out }}=80 \Omega, t_{r}<2 \mathrm{ne}, \mathrm{t}_{\mathrm{f}}<\mathbf{2 n s}$ $t_{w}=200 \mathrm{~ns}$, PRA $=160 \mathrm{~Hz}$.
B. Waveforms are monitored on an oscllloseope with the following charactoristict: $\mathrm{t}_{\mathrm{t}} \leqslant \mathrm{E} \mathrm{ns}, \mathrm{R}_{\text {in }}=10 \mathrm{M} \boldsymbol{\Omega}$.
-JEDEC regiatered data

## TWO GENERAL PURPOSE TRANSISTORS IN ONE PACKAGE

- Each Triode Electrically Similar to 2N2904, 2N2904A, 2N2905, 2N2905A Transistors
- For Complementary Use with D2T2218, D2T2218A, D2T2219, D2T2219A Dual N-P-N Transistors
mechanical data

absolute maximum ratings at $\mathbf{2 5}{ }^{\circ} \mathbf{C}$ free-air temperature (unless otherwise noted)

|  |  | D2T2904 | D2T2904A | UNIT |
| :---: | :---: | :---: | :---: | :---: |
|  |  | D2T2905 | D2T2905A |  |
| Collector-Base Voltage |  | -60 | -60 | $\bar{V}$ |
| Collector-Emitter Voltage (See Note 1) |  | -40 | -60 | V |
| Emitter-Base Voltage |  | -5 | -5 | $V$ |
| Continuous Collector Current |  | -600 |  | mA |
| Continuous Device Dissipation at (or below) $25^{\circ} \mathrm{C}$ Free-Air Temperature (See Note 2) | Each Triode | 400 |  | mW |
|  | Total Device |  |  |  |
| Continuous Device Dissipation at (or below) $25^{\circ} \mathrm{C}$ Case Temperature (See Note 3 | Each Triode |  |  | W |
|  | Total Device |  |  |  |
| Storage Temperature Range |  | -65 | 200 | C |
| Lead Temperature 1/16 Inch from Case for 10 Seconds |  | 300 |  | C |

NOTES: 1. These values apply between 0 and 100 mA collector current when the base-emitter diode is open-circuited.
2. Derate linearly to $200^{\circ} \mathrm{C}$ free-air temperature at the rates of $2.28 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$ for each triode and $3.43 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$ for the total device.
3. Derate linearly to $200^{\circ} \mathrm{C}$ case temperature at the rates of $5.7 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$ for each triode and $\mathbf{1 1 . 4} \mathbf{~ m W} /{ }^{\circ} \mathrm{C}$ for the total device.

## TYPES D2T2904, D2T2904A, D2T2905, D2T2905A DUAL P-N-P SILICON TRANSISTORS

electrical characteristics at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

| PARAMETER |  | TEST CONDITIONS | D2T2904 |  | D2T2904A |  | D2T2905 |  | D2T2905A |  | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | MIN | MAX | MIN | MAX | MIN | MAX | MIN | MAX |  |
| $V_{\text {(BR) }}$ CbO | Collector-Base Breakdown Voltage |  | $I^{\prime} C=-10 \mu A, \quad I^{\prime}=0$ | -60 |  | -60 |  | -60 |  | -60 |  | V |
| $V_{(B R) C E O}$ | Collector-Emitter Breakdown Voltage | $\begin{aligned} \mathrm{I}^{\prime} \mathrm{C}=-10 \mathrm{~mA}, & \mathrm{I}_{\mathrm{B}}=0, \\ & \text { See Note } 4 \end{aligned}$ | -40 |  | -60 |  | -40 |  | -60 |  | V |
| $V_{\text {(BR)EBO }}$ | Emitter-Base <br> Breakdown Voltage | ${ }^{\prime} \mathrm{E}=-10 \mu \mathrm{~A}, \quad I^{\prime} \mathrm{C}=0$ | -5 |  | -5 |  | -5 |  | -5 |  | V |
| ICBO | Collector Cutoff Current | $\mathrm{V}_{C B}=-50 \mathrm{~V}, \mathrm{I}_{\mathrm{E}}=0$ |  | -20 |  | -10 |  | -20 |  | -10 | nA |
|  |  | $\begin{aligned} & \mathrm{V}_{\mathrm{CB}}=-50 \mathrm{~V}, \mathrm{I}_{\mathrm{E}}=0, \\ & \mathrm{~T}_{\mathrm{A}}=150^{\circ} \mathrm{C} \end{aligned}$ |  | -20 |  | -10 |  | -20 |  | -10 | $\mu \mathrm{A}$ |
| ICEV | Collector Cutoff Current | $V_{C E}=-30 \mathrm{~V}, \mathrm{~V}_{\text {BE }}=0.5 \mathrm{~V}$ |  | -50 |  | -50 |  | -50 |  | -50 | nA |
| IBEV | Base Cutoff Current | $\mathrm{V}_{\text {CE }}=-30 \mathrm{~V}, \mathrm{~V}_{\text {BE }}=0.5 \mathrm{~V}$ |  | 50 |  | 50 |  | 50 |  | 50 | nA |
| hFE | Static Forward Current Transfer Ratio | $\mathrm{V}_{\text {CE }}=-10 \mathrm{~V}, \mathrm{I}_{\mathrm{C}}=-100 \mu \mathrm{~A}$ | 20 |  | 40 |  | 35 |  | 75 |  |  |
|  |  | $\mathrm{V}_{\text {CE }}=-10 \mathrm{~V}, \mathrm{I}^{\prime}=-1 \mathrm{~mA}$ | 25 |  | 40 |  | 50 |  | 100 |  |  |
|  |  | $\mathrm{V}_{\mathrm{CE}}=-10 \mathrm{~V}, \mathrm{I}_{\mathrm{C}}=-10 \mathrm{~mA}$ | 35 |  | 40 |  | 75 |  | 100 |  |  |
|  |  | $\begin{aligned} & V_{C E}=-10 \mathrm{~V},{ }^{\mathrm{I}} \mathrm{C}=-150 \mathrm{~mA}, \\ & \text { See Note } 4 \end{aligned}$ | 40 | 120 | 40 | 120 | 100 | 300 | 100 | 300 |  |
|  |  | $\begin{aligned} V_{C E}=-10 \mathrm{~V}, & \mathrm{I}_{\mathrm{C}}=-500 \mathrm{~mA}, \\ & \text { See Note } 4 \end{aligned}$ | 20 |  | 40 |  | 30 |  | 50 |  |  |
| $V_{B E}$ | Base-Emitter Voltage | $\begin{aligned} \mathrm{I}_{\mathrm{B}}=-15 \mathrm{~mA}, & \mathrm{I}_{\mathrm{C}}=-150 \mathrm{~mA}, \\ & \text { See Note } 4 \end{aligned}$ |  | -1.3 |  | -1.3 |  | -1.3 |  | -1.3 | V |
|  |  | $\begin{aligned} & I_{B}=-50 \mathrm{~mA}, I_{C}=-500 \mathrm{~mA}, \\ & \text { See Note } 4 \end{aligned}$ |  | -2.6 |  | -2.6 |  | -2.6 |  | -2.6 |  |
| VCE(sat) | Collector-Emitter Saturation Voltage | $\begin{aligned} &{ }^{\prime} B=-15 \mathrm{~mA}, \mathrm{I}_{\mathrm{C}}=-150 \mathrm{~mA}, \\ & \text { See Note } 4 \end{aligned}$ |  | -0.4 |  | -0.4 |  | -0.4 |  | -0.4 | $v$ |
|  |  | $\begin{aligned} & \mathrm{I}_{\mathrm{B}}=-50 \mathrm{~mA}, \mathrm{I}_{\mathrm{C}}=-500 \mathrm{~mA}, \\ & \text { See Note } 4 \end{aligned}$ |  | -1.6 |  | -1.6 |  | -1.6 |  | -1.6 |  |
| Hfel | Small-Signal <br> Common-Emitter <br> Forward Current <br> Transfer Ratio | $\begin{aligned} V_{C E}=-10 \mathrm{~V}, & \mathrm{I}_{\mathrm{C}}=-30 \mathrm{~mA}, \\ & f=100 \mathrm{MHz} \end{aligned}$ | 2 |  | 2 |  | 2 |  | 2 |  |  |
| $C_{\text {obo }}$ | Common-Base <br> Open-Circuit <br> Output Capacitance | $\begin{aligned} V_{C B}=-10 \mathrm{~V}, & l_{E}=0 \\ & f=1 \mathrm{MHz} \end{aligned}$ |  | 8 |  | 8 |  | 8 |  | 8 | pF |
| $C_{\text {ibo }}$ | Common-Base <br> Open-Circuit <br> Input Capacitance | $\begin{aligned} V_{E B}=-2 V . & \mathrm{C}=0, \\ & f=9 \mathrm{MHZ} \end{aligned}$ |  | 30 |  | 30 |  | 30 |  | 30 | pF |

NOTE 4: These parameters must be measured using pulse techniques. $t_{w}=\mathbf{3 0 0} \mu_{\mathrm{s}}$, duty cycle $\leqslant \mathbf{2 \%}$.

## TYPES D2T2904, D2T2904A, D2T2905, D2T2905A <br> DUAL P-N-P SILICON TRANSISTORS

switching characteristics at $25^{\circ} \mathrm{C}$ free-air temperature

| PARAMETER | TEST CONDITIONS ${ }^{\dagger}$ | MAX | UNIT |
| :---: | :---: | :---: | :---: |
| td Delay Time | $\begin{array}{ll} V_{C C}=-30 \mathrm{~V}, & I_{C}=-150 \mathrm{~mA}, \\ \mathrm{I}_{\mathrm{B}}(1)=-15 \mathrm{~mA}, \\ V_{\mathrm{BE}(\mathrm{off})}=0, & \text { See Figure } 1 \end{array}$ | 10 | ns |
| $t_{r}$ R Rise Time |  | 40 | ns |
| $t_{\text {on }}$ Turn-On Time |  | 45 | ns |
| $t_{\text {s }} \quad$ Storage Time | $\begin{array}{ll} V_{C C}=-30 \mathrm{~V}, & I_{C}=-150 \mathrm{~mA}, \\ \mathrm{I}_{\mathrm{B}}(1)=-13 \mathrm{~mA}, \\ I_{B}(2)=17 \mathrm{~mA}, & \text { See Figure } 2 \end{array}$ | 80 | ns |
| $\mathrm{t}_{\mathrm{f}}$ Fall Time |  | 30 | ns |
| ${ }^{\text {toff }}$ Turn-Off Time |  | 100 | ns |

${ }^{\dagger}$ Voltage and current values shown are nominal; exact values vary slightly with transistor paramaters.


Figure 2

NOTES: A. The input waveforms are supplied by a generator with the following characteristics: $Z_{\text {out }}=50 \Omega, t_{r} \leqslant 2 \mathrm{~ns}, \mathrm{t}_{\mathrm{f}} \leqslant 2 \mathrm{~ns}$, $\mathrm{t}_{\mathrm{w}}=200 \mathrm{~ns}, \mathrm{PAR}=150 \mathrm{~Hz}$.
B. Waveforms are monitored on an oscilloscope with the following characteristics: $\tau_{r} \leqslant 5 \mathrm{~ns}, \mathrm{R}_{\mathrm{in}}=\mathbf{1 0} \mathrm{M} \Omega$.

## TYPE 02T2905 <br> QUAD P-N-P SILICON TRANSISTOR

## DESIGNED FOR MEDIUM-POWER SWITCHING AND GENERAL PURPOSE AMPLIFIER APPLICATIONS

- High Breakdown Voltage Combined with Very Low Saturation Voltage
- hFE . . . Guaranteed from $\mathbf{1 0 0} \mu \mathrm{A}$ to $\mathbf{5 0 0} \mathrm{mA}$
- High fT . . . 200 MHz Min at $\mathbf{2 0}$ V, $\mathbf{2 0} \mathbf{m A}$
mechanical data


NC-No Internal connection

absolute maximum ratings at $25^{\circ} \mathbf{C}$ free-air temperature (unless otherwise noted)


NOTES: 1. This value epplies between 0 and 100 mA collector current when the emitter-base diode is open-circuited.
2. Derate linearly to $150^{\circ} \mathrm{C}$ free-air temperature at the rates of $4 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$ for each triode and $12 \mathrm{~mW} / \mathrm{C}$ for the total device.

[^62]electrical characteristics at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

| PARAMETER | TEST CONDITIONS |  | MIN MAX | UNIT |
| :---: | :---: | :---: | :---: | :---: |
| $V_{\text {(BR) }}$ CBO Collector-Base Breakdown Voltage | $I^{\prime} C=-10 \mu A, \quad I_{E}=0$ |  | -60 | V |
| $V_{\text {(BR) }}$ CEO Collector-Emitter Breakdown Voltage | $\mathrm{I}^{\prime} \mathrm{C}=-10 \mathrm{~mA}, \mathrm{I}_{\mathrm{B}}=0$, | See Note 3 | -40 | V |
| $V_{\text {(BR)EBO }}$ Emitter-Base Breakdown Voltage | $\mathrm{I}_{\mathrm{E}}=-10 \mu \mathrm{~A}, \quad \mathrm{I}^{\prime}=0$ |  | -5 | V |
| Icbo Collector Cutoff Current | $\mathrm{V}_{C B}=-50 \mathrm{~V}, \mathrm{I}_{\mathrm{E}}=0$ |  | -20 | nA |
|  | $V_{C B}=-50 V_{1} I_{E}=0$, | $T_{A}=125^{\circ} \mathrm{C}$ | -10 | $\mu \mathrm{A}$ |
| ICEV Collector Cutoff Current | $\mathrm{V}_{\mathrm{CE}}=-30 \mathrm{~V}, \mathrm{~V}_{\mathrm{BE}}=0.5 \mathrm{~V}$ |  | -50 | nA |
| IBEV Base Cutoff Current | $\mathrm{V}_{\mathrm{CE}}=-30 \mathrm{~V}, \mathrm{~V}_{\mathrm{BE}}=0.5 \mathrm{~V}$ |  | 50 | nA |
| Static Forward Current Transfer Ratio | $\mathrm{V}_{C E}=-10 \mathrm{~V}, \mathrm{I}^{2}=-100 \mu \mathrm{~A}$ |  | 35 |  |
|  | $V_{C E}=-10 \mathrm{~V}, \mathrm{I}_{\mathrm{C}}=-1 \mathrm{~mA}$ |  | 50 |  |
|  | $\mathrm{V}_{\text {CE }}=-10 \mathrm{~V}, \mathrm{I}^{\prime} \mathrm{C}=-10 \mathrm{~mA}$ | See Note 3 | 75 |  |
|  | $\mathrm{V}_{C E}=-10 \mathrm{~V}, \mathrm{I}_{\mathrm{C}}=-150 \mathrm{~mA}$ |  | $100 \quad 300$ |  |
|  | $V_{C E}=-10 \mathrm{~V}, \mathrm{I}^{\prime}=-500 \mathrm{~mA}$ |  | 30 |  |
| Base-Emitter Voltage | $\mathrm{I}_{\mathrm{B}}=-15 \mathrm{~mA}, \mathrm{I}^{\prime} \mathrm{C}=-150 \mathrm{~mA}$ | See Note 3 | -1.3 | V |
|  | $\mathrm{I}_{\mathrm{B}}=-50 \mathrm{~mA}, \mathrm{I}^{\prime} \mathrm{C}=-500 \mathrm{~mA}$ |  | -2.6 |  |
| Collector-Emitter Saturation Voltage | $\mathrm{I}_{\mathrm{B}}=-15 \mathrm{~mA}, \quad \mathrm{I}^{\prime} \mathrm{C}=-150 \mathrm{~mA}$ | See Note 3 | -0.4 | V |
|  | $\mathrm{I}_{\mathrm{B}}=-50 \mathrm{~mA}, \mathrm{I}_{\mathrm{C}}=-500 \mathrm{~mA}$ |  | -1.6 |  |
| Small-Signal Common-Emitter Forward Current Transfer Ratio | $V_{C E}=-10 \mathrm{~V}, 1 \mathrm{C}=-30 \mathrm{~mA}$, | $f=100 \mathrm{MHz}$ | 2 |  |
| Cobo Common-Base Open-Circuit Output Capacitance | $V_{C B}=-10 \mathrm{~V}, \mathrm{I}_{\mathrm{E}}=0$, | $\mathrm{f}=1 \mathrm{MHz}$ | 8 | pF |
| Cibo Common-Base Open-Circuit Input Capacitance | $V_{E B}=-2 \mathrm{~V}, \mathrm{I}^{\prime}=0$, | $f=1 \mathrm{MHz}$ | 30 | pF |

NOTE 3: These parameters must be measured using pulse techniques. $t_{w}=\mathbf{3 0 0} \boldsymbol{\mu s}$, duty cycle $\leqslant 2 \%$.
switching characteristics at $\mathbf{2 5}{ }^{\circ} \mathrm{C}$ free-air temperature

|  | PARAMETER | TEST CONDITIONS ${ }^{\text { }}$ | MAX | UNIT |
| :---: | :---: | :---: | :---: | :---: |
| $t_{\text {d }}$ | Delay Time | $\begin{cases}I_{C}=-150 \mathrm{~mA}, & I_{B(1)}=-15 \mathrm{~mA}, \\ R_{\mathrm{L}}=200 \Omega, & V_{B E}(\text { off })=0, \\ \text { See Figure } 1\end{cases}$ | 10 | ns |
| $\mathrm{t}_{\mathrm{r}}$ | Rise Time |  | 40 | ns |
| $t_{\text {on }}$ | Turn-On Time |  | 45 | ns |
| $\mathrm{t}_{\text {s }}$ | Storage Time | $\begin{array}{ll} I_{C}=-150 \mathrm{~mA}, & I_{\mathrm{B}}(1)=-13 \mathrm{~mA}, \\ I_{\mathrm{B}}(2)=17 \mathrm{~mA}, \\ R_{\mathrm{L}}=37, & \text { See Figure } 2 \end{array}$ | 80 | ns |
| $t_{\text {f }}$ | Fall Time |  | 30 | ns |
| $t_{\text {off }}$ | Turn-Off Time |  | 100 | ns |

tVoltage and current values shown are nominal; exact values vary slightly with transistor parameters.

## PARAMETER MEASUREMENT INFORMATION



FIGURE 1-TURN-ON TIME


(See Notes A and B)
VOLTAGE WAVEFORMS

FIGURE 2-TURN-OFF TIME

NOTES: A. The input waveforms are suppled by genorator with the following characteristics: $Z_{o u t}=50 \Omega, t_{r}<2 \mathrm{~ns}, \mathrm{t}_{\mathrm{f}}<\mathbf{2 n s}$, $t_{w}=\mathbf{2 0 0} \mathrm{ns}, \mathrm{PRR}=\mathbf{1 8 0} \mathrm{pps}$.
B. Weveforms are monitored on an oecilloscope with the following charecteristics: $\mathrm{t}_{\mathrm{r}} \leqslant 5 \mathrm{~ns}, \mathrm{R}_{\mathrm{in}}=\mathrm{M} \Omega, \mathrm{C}_{\mathrm{in}} \leqslant 12 \mathrm{pF}$.

## SILECT ${ }^{\dagger}$ TRANSISTORS: DESIGNED FOR HIGH-SPEED, MEDIUM-POWER SWITCHING AND GENERAL PURPOSE AMPLIFIER APPLICATIONS

- A5T2907, A5T3644, and A5T3645 Electrically Similar to 2N2907, 2N3644, and 2N3645
- TIS112 Processing Includes Operational Aging at $\mathbf{3 0 0} \mathbf{~ m W}$ for $\mathbf{2 4}$ Hours
mechanical data
These transistors are encapsulated in a plastic compound specifically designed for this purpose, using a highly mechanized process developed by Texas Instruments. The case will withstand soldering temperatures without deformation. These devices exhibit stable characteristics under high-humidity conditions and are capable of meeting MIL-STD-202C, Method 106B. The transistors are insensitive to light.

absolute maximum ratings at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

|  | $\begin{gathered} \text { A5T2907 } \\ \text { TIS112 } \end{gathered}$ | A5T3644 | A5T3645 |
| :---: | :---: | :---: | :---: |
| Collector-Base Voltage | -60 V | -45V | $-60 \mathrm{~V}$ |
| Collector-Emitter Voltage (See Note 1) | -40 V | -45V | -60 V |
| Emitter-Base Voltage | -5V | -5V | -5V |
| Continuous Collector Current |  | -600 mA |  |
| Continuous Device Dissipation at (or below) $25^{\circ} \mathrm{C}$ Free-Air Temperature (See Note 2) |  | 625 mW |  |
| Continuous Device Dissipation at (or below) $25^{\circ} \mathrm{C}$ Case and Lead Temperature (See Note 3) |  | 1.6 W |  |
| Storage Temperature Range |  | ${ }^{\circ} \mathrm{C}$ to 1 |  |
| Lead Temperature 1/16 Inch from Case for 10 Seconds | - | $260^{\circ} \mathrm{C}$ | - |

NOTES: 1. This value applites between 0 and 600 mA collector currant when the base-amitter diode in open-circulted.
2. Derate linearly to $150^{\circ} \mathrm{C}$ free-air tempersture at the rate of $\mathrm{EmW} /{ }^{\circ} \mathrm{C}$.
3. This rating appiles with the entire case (including the leads) maintained at $25^{\circ} \mathrm{C}$. Derste linearly to $150^{\circ} \mathrm{C}$ case-and-iesd temperature at the rate of $12.8 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$.
${ }^{\dagger}$ Trademark of Texas Instruments
$\ddagger$ U. 3. Patent No. 3,439,238

## TYPES A5T2807, TIS112 P-N-P SILICON TRANSISTORS

electrical characteristics at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

| PARAMETER |  | TEST CONDITIONS |  |  | $\begin{gathered} \text { ABT2907 } \\ \text { TIS112 } \\ \hline \end{gathered}$ |  | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | MIN | MAX |  |
| $V_{\text {(BR) }}$ CBO | Collector-Base Breakdown Voltage |  |  |  | $1_{C}=-10 \mu A$, | $I_{E}=0$ |  | $-60$ |  | V |
| $V_{\text {(BR) }}$ CEO | Collector-Emitter Breakdown Voltage | ${ }^{1} \mathrm{C}=-10 \mathrm{~mA}$, | $\mathrm{I}_{\mathrm{B}}=0$, | See Note 4 | -40 |  | V |
| $V_{\text {(BR)EBO }}$ | Emitter-Base Breakdown Voltage | ${ }^{\prime} \mathrm{E}=-10 \mu \mathrm{~A}$, | $\mathrm{I}_{\mathrm{C}}=0$ |  | -5 |  | $V$ |
| ${ }^{1} \mathrm{CBO}$ | Collector Cutoff Current | $V_{C B}=-50 \mathrm{~V}$, | $\mathrm{IE}_{\mathrm{E}}=0$ |  |  | -20 | nA |
|  |  | $V_{C B}=-50 \mathrm{~V}$, | $\mathrm{IE}_{\mathrm{E}}=0$, | $T_{A}=125^{\circ} \mathrm{C}$ |  | -10 | $\mu \mathrm{A}$ |
| ICEV | Collector Cutoff Current | VCE ${ }^{\text {m }}-30 \mathrm{~V}$. | $\mathrm{V}_{\mathrm{BE}}=0.6 \mathrm{~V}$ |  |  | -50 | nA |
| IBEV | Base Cutoff Current | $\mathrm{V}_{\text {CE }}=-30 \mathrm{~V}$. | $V_{B E}=0.5 \mathrm{~V}$ |  |  | 50 | nA |
| hfe | Static Forward Current Transfer Ratio | $\mathrm{V}_{\text {CE }}=-10 \mathrm{~V}$, | $\mathrm{IC}^{\prime}=-100 \mu \mathrm{~A}$ |  | 35 |  |  |
|  |  | $V_{\text {CE }}=-10 \mathrm{~V}$, | $1 C=-1 \mathrm{~mA}$ |  | 50 |  |  |
|  |  | $\mathrm{V}_{\text {CE }}=-10 \mathrm{~V}$, | $1 \mathrm{C}=-10 \mathrm{~mA}$ | See Note 4 | 75 |  |  |
|  |  | $V_{C E}=-10 \mathrm{~V}$, | $1 \mathrm{c}=-150 \mathrm{~mA}$ |  | 100 | 300 |  |
|  |  | $V_{C E}=-10 \mathrm{~V}$, | $I_{C}=-500 \mathrm{~mA}$ |  | 30 |  |  |
| VBE | Base-Emitter Voltage | $\mathrm{I}_{B}=-15 \mathrm{~mA}$, | $1 \mathrm{C}=-150 \mathrm{~mA}$ | See Note 4 |  | -1.3 | V |
|  |  | $\mathrm{I}_{B}=-50 \mathrm{~mA}$, | $1 \mathrm{C}=-600 \mathrm{~mA}$ |  |  | -2.6 |  |
| VCE(sat) | Collector-Emitter Saturation Voltage | $\mathrm{I}_{B}=-15 \mathrm{~mA}$, | $I^{\prime} C=-150 \mathrm{~mA}$ | See Note 4 |  | $-0.4$ | V |
|  |  | $A_{B}=-50 \mathrm{~mA}$, | $1 \mathrm{C}=-500 \mathrm{~mA}$ |  |  | -1.6 |  |
| $\left\|h_{f e}\right\|$ | Small-Signal Common-Emitter Forward Current Transfor Ratio | $V_{C E}=-10 \mathrm{~V}$. | $1 C=-30 \mathrm{~mA}$, | $f=100 \mathrm{MHz}$ | 2 |  |  |
| Cobo | Common-Base Open-Circuit Output Capacitance | $V_{C B}=-10 \mathrm{~V}$, | $\mathrm{I} E=0$, | $\mathrm{f}=1 \mathrm{MHz}$ |  | 8 | pF |
| Cibo | Common-Base Open-Circuit Input Capecitance | $V E B=-2 V$, | $1 \mathrm{C}=0$, | $f=1 \mathrm{MHz}$ |  | 30 | pF |

NOTE 4: These parameters must be measured using pulse techniques. $t_{w}=\mathbf{3 0 0} \mu \mathrm{s}$, duty cycle $<\mathbf{2 \%}$.
switching characteristics at $25^{\circ} \mathrm{C}$ free-air temperature

| PARAMETER |  | TEST CONDITIONS ${ }^{\dagger}$ |  | A5T2907 | TIS112 | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | MaX | MAX |  |
| $\mathrm{t}_{\mathrm{d}}$ | Delay Time |  |  | $\begin{aligned} & l_{C}=-150 \mathrm{~mA}, \quad l_{B(1)}=-15 \mathrm{~mA} . \\ & R_{L}=200 \Omega . \end{aligned}$ | $\begin{aligned} & V_{B E \text { (off) }}=0, \\ & \text { See Figure } 1 \end{aligned}$ | 10 | 10 | ns |
| $t_{r}$ | Rise Time | 40 | 40 |  |  | ns |
| $\mathrm{t}_{\text {on }}$ | Turn-On Time | 45 | 45 |  |  | ns |
| $\mathrm{t}_{8}$ | Storage Time | $\left\{\begin{array}{l} I_{C}=-150 \mathrm{~mA}, \\ \mathrm{R}_{\mathrm{L}}=37 \Omega(\mathrm{I}(1)=-13 \mathrm{~mA} . \\ I_{B(2)}=17 \mathrm{~mA}, \\ S_{e e} \mathrm{Figure} 2 \end{array}\right.$ |  | 80 | 80 | ns |
| $t_{4}$ | Fell Time |  |  | 30 | 70 | ns |
| toff | Turn-Off Time |  |  | 100 | 140 | ns |

†Voltage and current values shown are nominal; exact values vary alightly with transistor paramaters.

## TYPES A5T2907, TIS112

P-N-P SILICON TRANSISTORS

 PRR = 150 pps.
B. Wavaforms are monitored on an oscilloscope with the following characteristics: $\mathrm{t}_{\mathrm{r}}<\mathbf{5} \mathrm{ns}, \mathrm{R}_{\mathrm{in}}=10 \mathrm{M} \Omega, \mathrm{C}_{\mathrm{in}}<12 \mathrm{pF}$.

## TIS112 OPERATIONAL AGING

All TIS112 transistors are aged for a minimum of 24 hours in the circuit shown below. Total device dissipation is approximately 300 mW . All static characteristics are tested prior to and after aging. Dynamic characteristics are tested as necessary to guarantee the specified limits after aging.


# TYPES 2N2913 THRU 2N2920, 2N2915A, 2N2918A, 2N2919A, 2N2s20A, 2N2972 THRU 2N2979 DUAL N-P-N SILICON TRANSISTORS <br> BULLETIN NO. DL-S 6911165, MARCH 1969 

## A BROAD FAMILY OF DUAL TRANSISTORS RECOMMENDED FOR

- Differential Amplifiers
- High-Gain, Low-Noise, Audio Amplifiers
- Transducer Signal-Conditioner Amplifiers
- Low-Level Flip-Flops
*mechanical data

quick-selection guide (for details see characteristics on the following pages)

| TYPE |  | MIN V(8R)CEO |  | MIN-MAX $\mathrm{h}_{\mathrm{FE}}$$\left.\mathrm{H}_{\mathrm{C}}=10 \mu \mathrm{~A}\right)$ |  | $\text { MIN } \frac{h_{F E 1}}{h_{F E 2}}$ |  | $\left\|\mathrm{v}_{\mathrm{BE} 1}-\mathrm{v}_{\mathrm{BE} 2}\right\|$$\left.H_{C}=100 \mu \mathrm{~A}\right)$ |  |  | $\begin{gathered} \left\|\Delta V_{B E 1}-V_{B E 2}\right\| \Delta T_{A} \mid \\ \left.T_{A(1)}=25^{\circ} \mathrm{C}, T_{A(2)}=125^{\circ} \mathrm{C}\right) \end{gathered}$ |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| OUTLINE A | OUTLINE ${ }^{\text {a }}$ | 60 V | 45 V | 60-240 | 150-600 | 0.9 | 0.8 | 1.5 mV | 3 mV | 5 mV | 0.5 mV | 1 mv | 2 mV |
| 2N2913 | 2N2972 |  | - | $\bullet$ |  |  |  |  |  |  |  |  |  |
| 2N2914 | 2N2973 |  | - |  | $\bullet$ |  |  |  |  |  |  |  |  |
| 2N2915 | 2N2974 |  | - | - |  | - |  |  | $\bullet$ |  |  | $\bullet$ |  |
| 2N2915A |  |  | - | - |  | - |  | $\bullet$ |  |  | - |  |  |
| 2N2916 | 2N2975 |  | $\bullet$ |  | - | - |  |  | * |  |  | - |  |
| 2N2916A |  |  | - |  | $\bullet$ | $\bullet$ |  | - |  |  | $\bullet$ |  |  |
| 2N2917 | 2N2976 |  | - | - |  |  | - |  |  | $\bullet$ |  |  | $\bullet$ |
| 2N2918 | 2N2977 |  | $\bullet$ |  | $\bullet$ |  | - |  |  | - |  |  | $\bullet$ |
| 2N2919 | 2N2978 | $\bullet$ |  | - |  | $\bullet$ |  |  | $\bullet$ |  |  | - |  |
| 2N2919A |  | - |  | $\bigcirc$ |  | - |  | $\bullet$ |  |  | $\bullet$ |  |  |
| 2N2920 | 2N2979 | - |  |  | $\bullet$ | $\bullet$ |  |  | $\bullet$ |  |  | - |  |
| 2N2920A |  | - |  |  | $\bullet$ | 0 |  | $\bullet$ |  |  | $\bullet$ |  |  |

[^63]
## TYPES 2N2913 THRU 2N2920, 2N2915A, 2N2916A, 2N2919A, 2N2920A, 2N2972 THRU 2 N 2979 <br> DUAL N-P-N SILICON TRANSISTORS

*absolute maximum ratings at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

*electrical characteristics at $\mathbf{2 5}{ }^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

| PARAMETER |  | TEST CONDITIONS | 2N2913 2N2915 2N2915A 2N2917 2N2972 2N2974 2N2976 | 2N2914 <br> 2N2916 <br> 2N2916A <br> 2N2918 <br> 2N2973 <br> 2N2975 <br> 2N2977 | $\begin{aligned} & \text { 2N2919 } \\ & \text { 2N2919A } \\ & \text { 2N2978 } \end{aligned}$ | 2N2920 <br> 2N2920A <br> 2N2979 | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | MIN MAX | MIN MAX | MIN MAX | MIN MAX |  |
| $V_{\text {(batcbo }}$ | Collector-Basp Brakdown Volrepe |  | $I_{C}=10 \mu A, I_{E}=0$ | 45 | 45 | 60 | 60 | v |
| $V_{\text {(br)CEO }}$ | Collector-Emitter Breakdown Voltage | $I_{C}=10 \mathrm{~mA}, \mathrm{I}_{\mathrm{B}}=0, \quad$ Soe Note 5 | 45 | 45 | 60 | 60 | v |
| $V_{\text {(ar) }}$ | Emitter-Base Breakdown Voltage | $\mathrm{I}_{\mathrm{E}}=10 \mu \mathrm{~A}, \mathrm{I}_{\mathrm{C}}=0$ | 6 | 6 | 6 | 6 | V |
| ${ }^{\text {c }}$ ¢ | Colloctor Cutoff Currant | $V_{C B}=45 V_{1} \mathrm{I}^{\prime}=0$ | 10 | 10 | 2 | 2 | nA |
|  |  | $\mathrm{V}_{C B}=45 \mathrm{~V}, \mathrm{t}_{\mathrm{E}}=0, \quad \mathrm{~T}_{A}=150^{\circ} \mathrm{C}$ | 10 | 10 | 10 | 10 | $\mu \mathrm{A}$ |
| $I_{\text {ceo }}$ | Collactor Cutoff Current | $V_{C E}=5 \mathrm{~V}, I_{B}=0$ | 2 | 2 | 2 | 2 | nA |
| IEBO | Emittor Cutoff Current | $V_{E B}=5 \mathrm{~V}, \mathrm{I}^{\prime}=0$ | 2 | 2 | - 2 | 2 | nA |
| $h_{\text {fe }}$ | Stetic Forward Current Transfer Ratio | $\mathrm{V}_{\text {CE }}=5 \mathrm{~V} . \mathrm{I}_{\mathrm{C}}=10 \mu \mathrm{~A}$ | $60 \quad 240$ | 150 600 | $60 \quad 240$ | $150 \quad 600$ |  |
|  |  | $\mathrm{V}_{\text {CE }}=5 \mathrm{~V}$, $\mathrm{IC}^{\prime}=100 \mu \mathrm{~A}$ | 100 | 225 | 100 | 225 |  |
|  |  | $\mathrm{V}_{C E}=5 \mathrm{~V}$. $\mathrm{IC}^{\prime}=1 \mathrm{~mA}$ | 150 | 300 | 150 | 300 |  |
|  |  | $\mathrm{V}_{\text {CE }}=5 \mathrm{~V}, \mathrm{I}_{\mathrm{C}}=10 \mu \mathrm{~A}, \mathrm{~T}_{\mathrm{A}}=-65^{\circ} \mathrm{C}$ | 15 | $\begin{gathered} 30 \\ 1401 \% \end{gathered}$ | 15 | 40 |  |
| $\mathrm{V}_{\text {BE }}$ | Base-Emitter Voltage | $\mathrm{V}_{C E}=5 \mathrm{~V}, 1_{C}=100 \mu \mathrm{~A}$ | 0.7 | 0.7 | 0.7 | 0.7 | $V$ |
| $\mathrm{V}_{\text {CE( } \text { (att) }}$ | Collector-Emitter Seturation Voltege | $\mathrm{I}_{B}=100 \mu \mathrm{~A}, \mathrm{I}_{\mathrm{C}}=1 \mathrm{~mA}$ | 0.35 | 0.35 | 0.35 | 0.35 | $V$ |

NOTES: 1. These values apply when the base-emitter diode is open-circuited.
2. Derate linearly to $200^{\circ} \mathrm{C}$ free-air temperature at the following rates: $1.72 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$ for each triode and $2.86 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$ for total device (2N2913 thru 2N2920, 2N2915A, 2N2916A, 2N2919A, 2N2920A); $1.43 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$ for each triode and $1.72 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$ for total device (2N2972 thru 2N2979).
3. Derate linearly to $200^{\circ} \mathrm{C}$ case temperature at the following rates: $4.3 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$ for ach triode and $8.6 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$ for total device (2N2913 thru 2N2920, 2N2915A, 2N2916A, 2N2919A, 2N2920A); $2.96 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$ for each triode and $4.3 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$ for total device (2N2972 thru 2N2979).
4. The terminals of the triode not under test are open-circuited for the measurement of these characteristics.
5. This parameter must be measured using pulse rechniques. $t_{w}=300 \mu$ s, duty cycle $<\mathbf{1 \%}$.

JEDEC registered data
${ }^{\dagger}$ These values apply to types 2 N2915A, 2 N2916A, 2N2919A, and 2 N2920A only.
$\ddagger$ This value applies to type 2N2916A only.

## TYPES 2N2913 THRU 2N2920, 2N2915A, 2N291BA, 2N2919A, 2N2920A, 2N2972 THRU 2N2979 DUAL N-P-N SILICON TRANSISTORS

"electrical characteristics at $\mathbf{2 5}{ }^{\circ} \mathrm{C}$ free-air temperature (continued)
individual triode characteristics (see note 4)

| PARAMETER |  | TEST CONDITIONS |  | $\begin{aligned} & \text { 2N2913 } \\ & \text { thru } \\ & \text { 2N2920 } \\ & \text { 2N2972 } \\ & \text { thru } \\ & \text { 2N2979 } \end{aligned}$ |  | $\begin{aligned} & \text { 2N2915A } \\ & \text { 2N2916A } \\ & \text { 2N2919A } \\ & \text { 2N2920A } \end{aligned}$ |  | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | MIN | MAX | MIN | MAX |  |
| $\mathrm{h}_{\mathrm{ib}}$ | Smali-Sigual Common-Baoe Input Impedence |  |  | $V_{C B}=5 \mathrm{~V} . \quad \mathrm{I}_{\mathrm{C}}=1$ | $\mathrm{f}=1 \mathrm{kHz}$ |  | 32 | 25 | 32 | $\Omega$ |
| $h_{\text {ob }}$ | Small-Sipnal Common-Bee Output Admittance | $\mathrm{V}_{\mathrm{CB}}=5 \mathrm{~V}, \quad \mathrm{I}_{\mathrm{C}}=1$ | f=1 kHz |  | 1 |  | 1 | umioo |
| \|hial | Smell-Signel Common-Emitter Forward Currem Transfer Rinio | $V_{C E}=5 \mathrm{~V}, \quad \mathrm{I}_{\mathrm{C}}=0$ | f $=20 \mathrm{MHz}$ | 3 |  | 3 | 8 |  |
| $\mathrm{C}_{\text {obo }}$ | Common-Base Open-Circuit Output Cepacitence | $V_{C B}=5 \mathrm{~V} . \quad \mathrm{I}_{\mathrm{E}}=0$, | f=140 $\mathbf{k H z}$ to $1 \mathbf{M H z}$ |  | 6 |  | 6 | pF |
| $\mathrm{C}_{\text {ibo }}$ | Common-8ese Open-Circuit Input Capacizance | $V_{E B}=0.5 \mathrm{~V},{ }^{\prime} \mathrm{C}=0$. | ¢ = 140 kHz to $1 \mathbf{M H z}$ |  |  |  | 10 | pF |


| PARAMETER | TEST CONDITIONS | 2N2915 <br> 2N2916 <br> 2N2919 <br> 2N2920 <br> 2N2974 <br> 2N2975 <br> 2N2978 <br> 2N2979 |  | $\begin{aligned} & \text { 2N2915A } \\ & \text { 2N2916A } \\ & \text { 2N2919A } \\ & \text { 2N2920A } \end{aligned}$ |  | 2N2917 <br> 2N2918 <br> 2N2976 <br> 2N2977 |  | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | MIN | MAX | MiN | MAX | MIN | MAX |  |
|  | $\begin{aligned} & V_{C E}=5 V, \quad I_{C}=100 \mu A, \\ & \text { Sen Note } 6 \end{aligned}$ | 0.9 | 1 | 0.9 | 1 | 0.8 | 1 |  |
|  | $\begin{aligned} & V_{C E}=5 \mathrm{~V}, \quad I_{C}=100 \mu \mathrm{~A} \text { to } 1 \mathrm{~mA}, \\ & T_{A}=-55^{\circ} \mathrm{C} \text { to } 125^{\circ} \mathrm{C} \text {, See Note } 6 \end{aligned}$ |  |  | 0.85 | 1 |  |  |  |
| Base-Emitter-Voltage Differential | $V_{C E}=5 \mathrm{~V}, \quad \mathrm{I}_{\mathrm{C}}=100 \mu \mathrm{~A}$ |  | 3 |  | 1.5 |  | 5 | mV |
|  | $\mathrm{V}_{\text {CE }}=5 \mathrm{~V}$, $\quad \mathrm{I}^{\mathrm{C}}=10 \mu \mathrm{~A} 101 \mathrm{~mA}$ |  | 5 |  | 2 |  | 10 |  |
| Bese-Emitter-Voltago- <br>  <br> With Temperature | $\begin{aligned} & V_{C E}=5 \mathrm{~V}, \quad{ }^{I_{C}=100 \mu \mathrm{~A}}, \\ & V_{A(1)}=25^{\circ} \mathrm{C}, T_{A(2)}=-55^{\circ} \mathrm{C} \end{aligned}$ |  | 0.8 |  | 0.4 |  | 1.6 | mV |
|  | $\begin{aligned} & V_{C E}=5 V, \quad I_{C}=100 \mu A, \\ & T_{A(1)}=25^{\circ} C, \\ & T_{A(2)}=125^{\circ} \mathrm{C} \end{aligned}$ |  | 1 |  | 0.5 |  | 2 |  |

*operating characteristics at $\mathbf{2 5}^{\circ} \mathrm{C}$ free-air temperature
individual triode characteristics (see note 4)

| PARAMETER | TEST CONDITIONS | 2N2913 2N2915 2N2915A 2N2917 2N2919 | $\begin{aligned} & \hline \text { 2N2919A } \\ & \text { 2N2972 } \\ & \text { 2N2974 } \\ & \text { 2N2976 } \\ & \text { 2N2978 } \\ & \hline \end{aligned}$ | 2N2914 2N2916 2N2916A 2N2918 2N2920 | $\begin{aligned} & \hline \text { 2N2920A } \\ & \text { 2N2973 } \\ & \text { 2N2975 } \\ & \text { 2N2977 } \\ & \text { 2N2979 } \\ & \hline \end{aligned}$ | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | MAX |  | MAX |  |  |
| $\overline{\mathrm{F}}$ Avercge Noiso Figure | $\begin{array}{ll} V_{\mathrm{CE}}=5 \mathrm{~V}, & \mathrm{I}_{\mathrm{C}}=10 \mu \mathrm{~A}, \\ \mathrm{f}=1 \mathrm{kHz}, & R_{\mathrm{G}}=10 \mathrm{k} \Omega, \\ \text { Noise bendwidth }=200 \mathrm{~Hz} \end{array}$ |  |  |  |  | dB |
|  | $\begin{aligned} & V_{C E}=5 \mathrm{~V}, \mathrm{I}_{\mathrm{C}}=10 \mu \mathrm{~A}, \quad \mathrm{R}_{\mathrm{G}}=10 \mathrm{k} \Omega, \\ & \text { Noive bendwidth }=15.7 \mathrm{kHz} \text {, See Note } 7 \end{aligned}$ | 4 |  | 3 |  |  |

NOTES: 4. The terminals of the triode not under test are open-circuited for the measurement of these characteristics.
6. The lower of the two hfE readings is taken as $h_{F E 1}$.
7. This parametar is measured in an amplifier with response down 3 dB at 10 Hz and 10 kHz and a high-frequency rolloff of $6 \mathrm{~dB} /$ octave.
-JEDEC registored deta

# TYPES 2N2913 THRU 2N2920, 2N2915A, 2N2916A, 2N2919A, 2N2920A, 2N2972 THRU 2N2979 DUAL N-P-N SILICON TRANSISTORS 

TYPICAL MATCHING CHARACTERISTICS $\dagger$

FOR TYPES 2N2915, 2N2915A, 2N2916, 2N2916A, 2N2919, 2N2919A, 2N2920, 2N2920A, 2N2974, 2N2975, 2N2978, 2N2979


BASE-EMITTER-VOLTAGE DIFFERENTIAL


BASE-EMIITER-VOLTAGE DIFFERENIIAL
vs


NOTE 6: The lower of the two $h_{F E}$ readings is taken as $h_{F E 1}$
tThese curves represent the average behavior of groups of dual transistors. Unlike normal single-triode characteristics, matching characteristics of dual transistors may differ considerably in behavior from the typical. For example, a minority of devices have been observed with smaller $V_{B E}$ mismatch at $150^{\circ} \mathrm{C}$ than at $-65^{\circ} \mathrm{C}$, as opposed to the average behavior as shown in figures 2 and 3 .

## FOR LOW-LEVEL, HIGH-SPEED CHOPPER APPLICATIONS IN INVERTED CONNECTION <br> - Low Guarentieed Offset Voltage <br> - High Emitter-Base Breakdown Voltage <br> - Greatly Improved $h_{\text {fe(inv) }} \ldots 50$ Min of $I_{B}=200 \mu A$ (2N2944A) <br> - Extremely Low racton) ... $4 \Omega$ Max (2N2944A) <br> - Recommended For Complementary Use with 2N2432A

*mechanical deta

$\dagger 71$ guoruntoed minimum. The JEDEC registered minimum loed diemater for the $\mathbf{T 0} 0.46$ is 0.012 .
*absolute maximum rafings of $25^{\circ} \mathrm{C}$ free-air fomperature (unless otherwise noted)


WOTES: 1. This velen epplies when the colloctor-hase diede is open-circuited.
2. Derate linearly to $\mathbf{2 0 0 ^ { \circ }} \mathrm{C}$ frev-air tamparatury of the rate of $\mathbf{2 . 3} \mathrm{m} \mathbf{W} / \mathrm{deg}$.
*Indicatos JEDEC rogistared dota

# TYPES 2N2944, 2N2945, 2N2946, 2N2944A, 2N2945A, 2N2946A P-N-P SILICON TRANSISTORS 

electrical characteristics at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

| PARAMETIER |  | TEST CONDITIONS |  | 2N2944 | 2N294B | 2N2946 | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | MIN MAX | MIN MAX | MIN MAX |  |
| 'coo | Colloctor Cutoff Currme |  |  | $V_{C B}=$ Ratad $V_{C B}$ | It $=0$ | -0.14 | -0.24 | -0.5* | nA |
|  |  | $V_{C B}=$ Ratod $V_{C B}$ | $\mathrm{I}_{1}=0, \quad \mathrm{~T}_{\mathrm{A}}=100^{\circ} \mathrm{C}$ | -10 | -20 | $-25$ | nA |
| 'raso | Emittor Cuteti Currmi | $\gamma_{\text {E }}=$ Rated $V_{\text {E }}$ | $\mathrm{I}_{\mathrm{c}}=0$ | $\rightarrow 0.1{ }^{\circ}$ | $\underline{-0.2}$ | $\rightarrow 0.5^{*}$ | nA |
|  |  | $V_{E I}=$ Rated $\boldsymbol{V}_{\text {E }}$ | $\mathrm{I}_{\mathrm{C}}=0, \quad \mathrm{~T}_{\mathrm{A}}=100^{\circ} \mathrm{C}$ | $-10$ | -13 | -20 | nA |
| $h_{\text {Pe }}$ | Statk Forward Current Trunstor Retlo | $\mathrm{v}_{\text {CE }}=-0.5 \mathrm{~V}_{\text {, }}$ | $\mathrm{I}_{\mathrm{c}}=-1 \mathrm{~mA}$ | 104 | $40^{*}$ | $30^{\circ}$ |  |
| $h_{\text {PEI } \mid \text { Inv }}$ | Statk Forwand Corrmit Transtor hatio (Invertod Conauction) | $\mathrm{V}_{\mathrm{EC}}=-0.5 \mathrm{~V}$, | $1_{1}=-200 \mu \mathrm{~A}$ | 6 | 4 | 3 |  |
| $V_{\text {Eciofs) }}$ | Emilter-Celloctor Offist Veltage | $\mathrm{I}_{1}=-200 \mu_{\text {R }}$, |  | -0.3 | -0.5 | -0.6 | mV |
|  |  | $\mathrm{I}_{1}=-1 \mathrm{~mA}$, |  | $\underline{-0.6}$ | -1* | - | m |
|  |  | $\mathrm{I}_{1}=-2 \mathrm{~mA}$, | $l_{12}=0 \quad 1$ | -1 | -1.6 | -2.5 | mv |
| ${ }^{\text {recoun) }}$ | Smail-Signal Emittor-Colloctor On-State Zesisitance | $I_{1}=-1 \mathrm{~mA}$, | $\begin{array}{ll} I_{z}=0, & I_{6}=100 \mu \lambda_{1} \\ f=1 \mathrm{kHz}, & \text { see Figure } 2 \end{array}$ | $20^{*}$ | $35 *$ | 45* | $\Omega$ |
| $\left\|\mathrm{hf}_{\mathrm{fo}}\right\|$ | Small-Sijnol Conmmen-Emittor Fonward Current Trensier Ratio | $V_{\text {CE }}=-6 V_{\text {, }}$ | $\mathrm{I}_{\mathrm{c}}=-1 \mathrm{md}, 1=1 \mathrm{MHz}$ | 10" | 5 | ${ }^{3}$ |  |
| $C_{\text {abo }}$ | Commen. liase Opan-Girevit Output Capacitenc: | $\mathrm{V}_{\mathrm{CB}}=-6 \mathrm{~V}$, | $\mathrm{I}_{\mathrm{L}}=0, \quad \mathrm{f}=580 \mathrm{kHz}$ | $10^{+}$ | 10* | 10* | PF |
| Cibo | Common-Lase Open-Circuli Input Caperitence | $\mathbf{V}_{\mathbf{E}}=\mathbf{=} \mathbf{y}$, | $\mathrm{I}_{\mathrm{C}}=0, \quad i=500 \mathrm{kHz}$ | 6* | $6{ }^{\circ}$ | 6 | pF |

electrical characteristics at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

| PARAMETER |  | THST CONDITIONS |  | 2N2944A | 2N2945A | 2N2946A | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | MIN MAX | MIN MAX | MIN MAX |  |
| ${ }^{\text {creo }}$ | Coliector Cutoff corront |  |  | $V_{\text {CE }}=$ Rated $V_{\text {ct }}$ | $\mathrm{I}_{1}=0$ | -0.10 | -0.2 | -0.5* | $n \mathrm{~A}$ |
|  |  | $V_{\text {CI }}=$ Rated $V_{\text {Cl }}$ | $\mathrm{IE}_{\mathrm{E}}=0, \quad \mathrm{~T}_{\mathrm{A}}=100^{\circ} \mathrm{C}$ | -104 | $-20^{*}$ | -25* | ${ }^{n}$ in |
| 120 | Emither tutofl Currme | $V_{\text {EIL }}=$ Rotod $V_{\text {EV }}$ | $\mathrm{I}_{\mathrm{c}}=0$ | $\rightarrow 0.1{ }^{\text {- }}$ | -0.2* | -0.5* | nh |
|  |  |  | $l_{C}=0, \quad T_{A}=100^{\circ} \mathrm{C}$ | -10* | -15* | -20\% | ni |
| $h_{\text {Fe }}$ | Static Forward Current Iramior Ratio | $v_{c t}=-0.5 \mathrm{~V}$, | $1_{c}=-1 \mathrm{~mA}$ | $100^{\circ}$ | $70^{*}$ | $50^{4}$ |  |
| $\mathrm{H}_{\text {refinvi }}$ | Static Forware Current Tronsfor Ratlo (Invortod Connection) | $V_{\text {EC }}=-0.5 \mathrm{~V}$, | $\mathrm{I}_{\mathrm{B}}=-200 \mu \mathrm{~A}$ | 50* | 30* | $20^{*}$ |  |
| $V_{\text {ec ( }}^{\text {(fis) }}$ ) | Emifter-Collector Offsal Voltega | $\mathrm{I}_{\mathrm{B}}=-200 \mu \mathrm{~A}$, | $\mathrm{I}_{\mathrm{E}}=0 \quad \mathrm{Sor}$ | -0.3* | -0.5* | $\underline{0.8}$ | mV |
|  |  | $\mathrm{I}_{\mathrm{B}}=-1 \mathrm{ma} \mathrm{A}_{1}$ | $\mathrm{I}_{\mathrm{E}}=0 \quad$ Figuro | -0.6 | -1* | -2* | my |
|  |  | $i_{1}=-2 \mathrm{~m} \mathrm{~A}_{1}$ |  | $-{ }^{-1}$ | -1.6* | -2.5* | mV |
| 'oce(on) | Small-Signal Emittar-Calloctor On-State Rerstianec | $\mathrm{I}_{\mathrm{B}}=-1 \mathrm{~mA}$, | $\begin{array}{ll} I_{E}=0, & I_{\bullet}=100 \mu A_{1} \\ f=1 \mathrm{kHz}, & \text { See } \end{array}$ | 4 | ${ }^{6}$ | $8{ }^{*}$ | $\cap$ |
| $\left\|h_{\text {fo }}\right\|$ | Small-Signel Commen-Emiliter Forward Current Transfor Ratle | $V_{C E}=-6 V_{\text {, }}$ | $\mathrm{I}_{\mathrm{c}}=-1 \mathrm{~mA}, \mathrm{t}=1 \mathrm{mHz}$ | 15* | $10^{*}$ | 5* |  |
| $C_{\text {obe }}$ | Common-loss Open-Clecult Output Copacitance | $V_{C E}=-6 V_{\text {, }}$ | $\begin{aligned} & \mathrm{T}_{\mathrm{E}}=0, \\ & \mathrm{I}=0.1 \mathrm{MHz} \text { to } 1 \mathrm{MHz} \end{aligned}$ | $10^{4}$ | $10^{4}$ | $10^{*}$ | PF |
| Cibe | Cammen-laste Open-Sireuit Input Capectiance | $V_{\text {EI }}=-6 \mathrm{~V}$, | $\begin{aligned} & I_{c}=0, \\ & I^{\prime}=0.1 \mathrm{MHz} \text { to } 1 \mathrm{MHz} \end{aligned}$ | 6 | $6^{*}$ | ${ }^{*}$ | pF |

PARAMETER MEASUREMENT INFORMATION

miasurement circuit for offset voltage


MEASUREMENT CIRCUIT FOR EMITTER-
COLLECTOR ON-STATE RESISTANCE

Note a: The voltemetor must have high enough impodance that halving the value th the voltmets impodanes dow not change the meosured volye.
-Indicates JEDEC raglatiored dala

# TYPES 2N2913 THRU 2N2920, 2N2915A, 2N2916A, 2N2919A, 2N2920A, $2 N 2972$ THRU $2 N 207$ DUAL N-P-N SILICON TRANSISTORS <br> BULLETIN NO. DL-B 6911168, MAMCH 1969 

## A broad family of dual transistors recommended for

- Differential Amplifiers
- High-Gain, Low-Noisa, Audio Amplifiers
- Transducer Signal-Conditioner Amplifiers
- Low-Leval Flip-Flops
*mechanical data

quick-selection guide (for details see characteristics on the following pages)

| TYPE |  | MIN Viemiceso |  | $\operatorname{MiN}-\operatorname{MAXX} h_{F E}$$\mathrm{H}_{\mathrm{C}}=10 \mu \mathrm{Al}$ |  | $\text { MIN } \frac{h_{F} E T}{h_{F} \in z}$ |  | $\begin{aligned} & \left\|V_{B E},-V_{B E 2}\right\| \\ & \left\\|\\|_{C}=100 \mu A \mid\right. \end{aligned}$ |  |  | $\begin{gathered} 1 \Delta V_{E E}-V_{B E 2}\left\|\Delta T_{A}\right\| \\ \left(T_{A(1)}=20^{\circ} C_{,} T_{A(2)}+420^{\circ} \mathrm{Cl}\right. \end{gathered}$ |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| dutilime a | OUTLINTE | Hev | 48V | 20-240 | 180-600 | 0.8 | 0.0 | 1.5 mV | 3 mV | 5 mv | 0.8 mV | 1 mV | 2 mV |
| 2N8013 | 2Nav72 |  | - | - |  |  |  |  |  |  |  |  |  |
| 202314 | 2Nate73 |  | - |  | $\bigcirc$ |  |  |  |  |  |  |  |  |
| 2Nat1 | 2N8974 |  | - | - |  | $\bullet$ |  |  | - |  |  | $\bullet$ |  |
| 2N2015A |  |  | - | - |  | - |  | - |  |  | $\bullet$ |  |  |
| 2Na010 | 2N297 |  | - |  | $\bullet$ | - |  |  | $\bullet$ |  |  | $\bullet$ |  |
| 202nta |  |  | - |  | $\bullet$ | $\bullet$ |  | - |  |  | $\bullet$ |  |  |
| $2 \mathrm{Nz317}$ | $2 \mathrm{Nas74}$ |  | - | - |  |  | - |  |  | - |  |  | - |
| 2N2014 | 2Na971 |  | - |  | - |  | $\bigcirc$ |  |  | - |  |  | $\bullet$ |
| 2N2010 | 2N297 | $\bullet$ |  | - |  | $\bullet$ |  |  | $\bullet$ |  |  | $\bullet$ |  |
| 2N201M |  | $\bullet$ |  | - |  | $\bullet$ |  | $\bullet$ |  |  | $\bullet$ |  |  |
| 2Nata0 | 2N2070 | - |  |  | - | 6 |  |  | $\bullet$ |  |  | $\bullet$ |  |
| ENRE20A |  | 0 |  |  | $\bullet$ | $\bullet$ |  | $\bullet$ |  |  | $\bullet$ |  |  |

[^64]USE8 CHIP N11

## TYPES 2N2913 THRU 2N2920, 2N2915A, 2N2916A, 2N2919A, 2N2920A, 2N2972 THRU 2N2979 DUAL N-P-N SILICON TRANSISTORS

## *absolute maximum ratings at $\mathbf{2 5}{ }^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)


electrical characteristics at $25^{\circ} \mathrm{C}$ free-air temperature (uniess otherwise noted)

- individual triode characteristics (20e note 4)

| PARAMETER | TEST CONDITIONS | 2N2913 2N2915 2N2915A 2N2917 2N2972 2N2974 2N2976 | 2N2914 <br> 2N2916 <br> 2N2916A <br> 2N2918 <br> 2N2973 <br> 2N2975 <br> 2N2977 | $\begin{aligned} & \text { 2N2919 } \\ & \text { 2N2919A } \\ & \text { 2N2978 } \end{aligned}$ |  | $\begin{aligned} & \text { 2N2920 } \\ & \text { 2N2920A } \\ & \text { 2N2979 } \end{aligned}$ | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | MIN MAX | MIN MAX | MIN | MAX | MIN MAX |  |
| $\mathrm{V}_{\text {(BR) }}$ CBO Collector-Bave Bremkdown Valtage | $t_{C}=10 \mu \mathrm{~A}, t_{E}=0$ | 45 | 46 | 60 |  | 60 | $v$ |
| $V_{\text {(BRICEO }}$ O Collector-Emitter Brackdown Voltage | $I_{C}=10 \mathrm{~mA}, \mathrm{I}_{\mathrm{B}}=0, \quad$ Soe Note 5 | 45 | 45 | 60 |  | 60 | V |
| $V_{\text {(BR)EBO }}$ Emittor-Bame Broakdown Voltage | $I_{E}=10 \mu \mathrm{~A}, I_{C}=0$ | 6 | 6 | 6 |  | 6 | V |
| Icbo Collectar Cutoff Current | $\mathrm{V}_{C B}=45 \mathrm{~V}, 1_{\mathrm{E}}=0$ | 10 | 10 |  | 2 | 2 | nA |
|  | $V_{C B}=45 \mathrm{~V}, \mathrm{I}_{E}=0, \quad T_{A}=150^{\circ} \mathrm{C}$ | 10 | 10 |  | 10 | 10 | $\mu \mathrm{A}$ |
| TCEO Collector Cutoff Curront | $\mathrm{V}_{\mathrm{CE}}=5 \mathrm{~V}, 1_{\mathrm{B}}=0$ | 2 | 2 |  | 2 | 2 | nA |
| leBo Emitter Cutofl Current | $\mathrm{V}_{\text {EB }}=5 \mathrm{~V}, \mathrm{I}_{\mathrm{C}}=0$ | 2 | 2 |  | 2 | 2 | nA |
| $\begin{array}{ll} \\ h_{\text {FE }} & \text { Static Forward Current } \\ & \text { Transfor Ratio }\end{array}$ | $\mathrm{V}_{C E}=5 \mathrm{~V}, \mathrm{I}_{\mathrm{C}}=10 \mu \mathrm{~A}$ | $60 \quad 240$ | $150 \quad 600$ | 60 | 240 | 150600 |  |
|  | $\mathrm{V}_{\text {CE }}=5 \mathrm{~V}, \mathrm{I}_{\mathrm{C}}=100 \mu \mathrm{~A}$ | 100 | 225 | 100 |  | 225 |  |
|  | $\mathrm{V}_{C E}=5 \mathrm{~V}, \mathrm{I}_{\mathrm{C}}=1 \mathrm{~mA}$ | 150 | 300 | 150 |  | 300 |  |
|  | $\mathrm{V}_{C E}=5 \mathrm{~V}, \mathrm{I}_{\mathrm{C}}=10 \mu \mathrm{~A}, \mathrm{~T}_{\mathrm{A}}=-55^{\circ} \mathrm{C}$ | 15 | $\begin{gathered} 30 \\ (40) \\ \hline \end{gathered}$ | 15 |  | 40 |  |
| $\mathrm{V}_{\mathrm{BE}} \quad$ Bexe-Emitrer Voltape | $\mathrm{V}_{\mathrm{CE}}=5 \mathrm{~V}, \mathrm{I}_{\mathrm{C}}=100 \mu \mathrm{~A}$ | 0.7 | 0.7 |  | 0.7 | 0.7 | $V$ |
| $\mathrm{V}_{\text {CE(cat) }}$ Collector-Emitter Saturation Voltage | $\mathrm{I}_{\mathrm{B}}=100 \mu \mathrm{~A}, \mathrm{I}_{\mathrm{C}}=1 \mathrm{~mA}$ | 0.35 | 0.35 |  | 0.35 | 0.35 | V |

NOTES: 1. These values apply when the base-emitter dlode is open-circuited.
2. Derate linearly to $200^{\circ} \mathrm{C}$ free-alr temperature at the following retes: $1.72 \mathrm{~mW} / \mathrm{deg}$ for each triode and $\mathbf{2 . 8 6 \mathrm { mW } / \mathrm { deg } \text { for total } \mathrm { f }}$ device (2N2913 thru 2N2920, 2N2915A, 2N2916A, 2N2919A, 2N2920A); $1.43 \mathrm{~mW} /$ deg for asch triode and $1.72 \mathrm{~mW} /$ deg for total device ( 2 N 2972 thru 2 N 2979 ).
3. Derate finearly to $200^{\circ} \mathrm{C}$ case temperature at the following rates: $4.3 \mathrm{~mW} /$ deg for each triode and $8.6 \mathrm{~mW} / \mathrm{deg}$ for total device (2N2913 thru 2N2920, 2N2915A, 2N2916A, 2N2919A, 2N2920A); $2.86 \mathrm{~mW} /$ deg for anch trlode and $4.3 \mathrm{~mW} /$ deg for total dovice (2N2972 thru 2N2979).
4. The terminals of the triode not under test are open-circuited for the measurement of these characteristics.
5. This parameter must be meazured using pulse technlques. $t_{p}=300 \mu \mathrm{~s}$, duty cycle $\leq 1 \%$.

[^65]*electrical characteristics at $25^{\circ} \mathrm{C}$ free-air temperature (continued)
individual triode characteristics (see note 4)

| PARAMETER |  | TEST CONDITIONS |  | $\begin{gathered} \text { 2N2913 } \\ \text { thru } \\ \text { 2N2920 } \\ \text { 2N2972 } \\ \text { thru } \\ \text { 2N2979 } \end{gathered}$ |  | 2N2915A <br> 2N2916A <br> 2N2919A <br> 2N2920A |  | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | MIN | MAX | MilN | MAX |  |
| $\mathrm{h}_{\mathrm{ib}}$ | Small-Signal Common-Base Input Impedance |  |  | $\mathrm{V}_{\mathrm{CB}}=5 \mathrm{~V}, \quad \mathrm{I}_{\mathrm{C}}=1$ | $f=1 \mathrm{kHz}$ | 25 | 32 | 25 | 32 | $\Omega$ |
| $h_{\text {ob }}$ | Small-Signal Common-Base Output Admittance |  | $f=1 \mathrm{kHz}$ |  | 1 |  | 1 | $\mu \mathrm{mho}$ |
| $\left\|h_{\text {fe }}\right\|$ | Small-Signal Common-Emitter Forward Cursent Transfer Ratio | $V_{C E}=5 \mathrm{~V}, \quad I_{C}=0.5$ | $f=20 \mathrm{MHz}$ | 3 |  | 3 | 8 |  |
| Cobo | Common-Base Open-Circuit Output Capacitance | $V_{C B}=5 \mathrm{~V}, \quad \mathrm{I}_{\mathrm{E}}=0$. | $\mathrm{f}=140 \mathrm{kHz}$ to $\mathbf{1} \mathbf{M H z}$ |  | 6 |  | 6 | pF |
| $\mathrm{C}_{\text {ibo }}$ | Common-Base Open-Circuit Input Capacitance | $V_{E B}=0.5 \mathrm{~V}, \mathrm{I}_{\mathrm{C}}=0$. | $t=140 \mathrm{kHz}$ to 1 MHz |  |  |  | 10 | pF |

triode matching characteristics

| PARAMETER | TEST CONDITIONS | 2N2915 <br> 2N2916 <br> 2N2919 <br> 2N2920 <br> 2N2974 <br> 2N2975 <br> 2N2978 <br> 2N2979 |  | $\begin{aligned} & \text { 2N2915A } \\ & \text { 2N2916A } \\ & \text { 2N2919A } \\ & \text { 2N2920A } \end{aligned}$ |  | $\begin{aligned} & \text { 2N2917 } \\ & \text { 2N2918 } \\ & \text { 2N2976 } \\ & \text { 2N2977 } \end{aligned}$ | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | MIN | MAX | MIN | MAX | MIN MAX |  |
| Static Forward-CurrentGain Batance Ratio | $\begin{aligned} & V_{C E}=5 \mathrm{~V}, \quad I_{C}=100 \mu \bar{A}, \\ & \text { See Note } 6 \end{aligned}$ | 0.9 | 1 | 0.9 | 1 | 0.81 |  |
|  | $\begin{aligned} & V_{C E}=5 \mathrm{~V}, \quad \mathrm{I}_{\mathrm{C}}=100 \mu \mathrm{~A} \text { to } 1 \mathrm{~mA}, \\ & T_{A}=-55^{\circ} \mathrm{C} \text { to } 125^{\circ} \mathrm{C} \text {, See Note } 6 \end{aligned}$ |  |  | 0.85 | 1 |  |  |
| $\left\|\mathrm{V}_{\mathrm{BE},}-\mathrm{V}_{\mathrm{BE} 2}\right\|$ | $V_{C E}=5 \mathrm{~V}, \quad I_{C}=100 \mu \mathrm{~A}$ |  | 3 |  | 1.5 | 5 | mV |
|  | $V_{\text {CEE }}=5 \mathrm{~V}, \quad \mathrm{I}_{\mathrm{C}}=10 \mu \mathrm{~A}$ to 1 mA |  | 5 |  | 2 | 10 |  |
| Baso-Emitter-Voltage- <br> $\left.\mid \Delta V_{B E 1}-V_{B E 2}\right)_{\Delta T_{A}} \mid$ Differential Change With Temperature | $\begin{aligned} & V_{C E}=5 \mathrm{~V}, \quad \mathrm{I}_{\mathrm{C}}=100 \mu \mathrm{~A}, \\ & \mathrm{~T}_{\mathrm{A}(1)}=25^{\circ} \mathrm{C}, \mathrm{~T}_{\mathrm{A}(2)}=-65^{\circ} \mathrm{C} \end{aligned}$ |  | 0.8 |  | 0.4 | 1.6 | mV |
|  | $\begin{array}{ll} V_{C E}=5 \mathrm{~V}, & I_{C}=100 \mu \mathrm{~A}, \\ T_{A(1)}=25^{\circ} \mathrm{C}, & T_{A(2)}=125^{\circ} \mathrm{C} \end{array}$ | 1 |  | 0.5 |  | 2 |  |

*operating characteristics at $25^{\circ} \mathrm{C}$ free-air temperature
individual triode characteristics (see note 4)

| PARAMETER | TEST CONDITIONS | $\begin{aligned} & \hline \text { 2N2913 } \\ & \text { 2N2915 } \\ & \text { 2N2915A } \\ & \text { 2N2917 } \\ & \text { 2N2919 } \\ & \hline \end{aligned}$ | 2N2919A <br> 2N2972 <br> 2N2974 <br> 2N2976 <br> 2N2978 | $\begin{aligned} & \text { 2N2914 } \\ & \text { 2N2916 } \\ & \text { 2N2916A } \\ & \text { 2N2918 } \\ & \text { 2N2920 } \\ & \hline \end{aligned}$ | $\begin{aligned} & \text { 2N2920A } \\ & \text { 2N2973 } \\ & \text { 2N2975 } \\ & \text { 2N2977 } \\ & \text { 2N2979 } \\ & \hline \end{aligned}$ | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | MAX |  | MAX |  |  |
| $\bar{F}$ Averege Noise Figure | $\begin{array}{ll} V_{C E}=5 \mathrm{~V}, & I_{C}=10 \mu \mathrm{~A}, \quad R_{\mathrm{G}}=10 \mathrm{k} \Omega, \\ f=1 \mathrm{kHz}, & \text { Noise bandwidth }=200 \mathrm{~Hz} \end{array}$ |  |  |  |  | dB |
|  | $\begin{aligned} & V_{\text {CE }}=5 \mathrm{~V}, \quad \mathrm{I}_{\mathrm{C}}=10 \mu \mathrm{~A}, \quad \mathrm{R}_{\mathrm{G}}=10 \mathrm{k} \Omega, \\ & \text { Noise bandwidth }=15.7 \mathrm{kHz} \text {, See Note } 7 \end{aligned}$ | 4 |  | 3 |  |  |

NOTES: 4. The terminals of the triode not under test are open-circuited for the measurement of these characteristics.
6. The lower of the two hFE readings is taken as hFE1.
7. This parameter is measured in an amplifier with response down 3 dB at $\mathbf{1 0 ~} \mathbf{H z}$ and 10 kHz and a high-frequency rolloff of $6 \mathrm{~dB} / \mathrm{octave}$.

- JEDEC registered data


# TYPES 2N2913 THRU 2N2920, 2N2915A, 2N2916A, 2N2919A, 2N2920A. 2N2972 THRU 2N2979 DUAL N-P-N SILICON TRANSISTORS 

TYPICAL MATCHING CHARACTERISTICS $\dagger$

FOR TYPES 2N2915, 2N2915A, 2N2916, 2N2916A, 2N2919, 2N2919A,
2N2920, 2N2920A, 2N2974, 2N2975, 2N2978, 2N2979


BASE-EMITTER-VOLTAGE DIFFERENTIAL


BASE-EMITTER-VOLTAGE DIFFERENTIAL
vs


NOTE 6: The lower of the two $h_{F E}$ readings is taken as $h_{F E 1}$.
tThese curves represent the average behavior of groups of duai transistors. Unike normal single-triode characteristics, matching characteristics of dual transistors may differ considerably in behavior from the typical. For example, a minority of devices have been observed with smaller $V_{B E}$ mismatch at $150^{\circ} \mathrm{C}$ than at $-65^{\circ} \mathrm{C}$, as opposed to the average behevior as shown in figures 2 and 3.

## DESIGNED FOR HIGH-SPEED SWITCHING APPLICATIONS

- Guaranteed $\mathrm{V}_{\text {(E\{sat) }} \cdots \mathbf{0 . 5} \mathbf{v}$ Max at 100 ma
- High $\mathrm{f}_{\mathrm{t}}$... 400 Mc Min
*mechanical data

*absolute maximum ratings at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

*electrical characteristics at $25^{\circ} \mathrm{C}$ free-air tomperature (unless otherwise noted)

| PARAMETER | TEST CONDITIONS | 2N2894 | 2N3012 | UNIT |
| :---: | :---: | :---: | :---: | :---: |
|  |  | MIN MAX | MIN MAX |  |
| V(wicso Collector-Laso Iroekdown Veltage | $\mathrm{I}_{\mathrm{C}}=-10 \mu \mathrm{a}, \mathrm{I}_{\mathrm{E}}=0$ | - 12 | -12 | $v$ |
| $\mathrm{V}_{\text {(m) Ce }}$ Collector-Emittor Brookdown Voltage | $\mathrm{I}_{\mathrm{C}}=-10 \mathrm{mi}, \mathrm{I}_{\mathrm{B}}=0, \quad$ See Nate 4 | $-12$ | -12 | $v$ |
| V(ER)CEs Collector-Emitter Iromdown Voltage | $\mathrm{I}_{\mathrm{C}}=-10 \mu \mathrm{a}, \quad \mathrm{V}_{\mathrm{BE}}=0$ | -12 | -12 | $v$ |
|  | $\mathrm{I}_{\mathrm{E}}=-100 \mu \mathrm{a}, \quad \mathrm{I}_{\mathrm{C}}=0$ | -4 | -4 | $\checkmark$ |
| $\mathrm{I}_{\text {CBO }}$ Colloctor Cutofi Currmal | $V_{C B}=-6 v_{1} \quad I_{E}=0, \quad T_{A}=125^{\circ} \mathrm{C}$ | -10 |  | $\mu \mathrm{a}$ |
| ${ }^{\text {ches }}$ Celloctor Cutaff Currmi | $\mathrm{V}_{\text {CE }}=-6 \mathrm{y}, \quad \mathrm{V}_{\mathrm{BE}}=0$ | -80 | $-\infty$ | ne |
|  |  |  | -5 | $\mu \mathrm{s}$ |
| $\mathrm{I}_{1} \quad$ Dase Curront | $\mathrm{v}_{\mathrm{CE}}=-6 \mathrm{v}, \quad \mathrm{v}_{\mathrm{BE}}=0$ | 80 | 30 | ne |
| Static Ferward Current Transler Ratio | $\mathbf{v}_{C E}=-0.3 \mathrm{v}, \mathrm{I}_{\mathrm{C}}=-10 \mathrm{ma}, \quad$ See Mere 4 | 30 | 25 |  |
|  |  | $40 \quad 150$ | $30 \quad 120$ |  |
|  | $Y_{C E}=-1 v_{1}, I_{C}=-100 \mathrm{ma}, \quad$ See Mete 4 | 25 | 20 |  |
|  | $\begin{array}{ll} Y_{\mathrm{CE}}=-0.5 \mathrm{~V}, & \mathrm{I}_{\mathrm{C}}=-30 \mathrm{ma}, \\ \mathrm{I}_{\mathrm{A}}=-55^{\circ} \mathrm{C}, & \text { See Mote } 4 \end{array}$ | 17 |  |  |
| Colloctor-Emitior Saturatien Yeltage |  | -0.15 | -0.15 | $V$ |
|  |  | -0.20 | -0.20 | V |
|  | $\mathrm{I}_{B}=-10 \mathrm{~mm}, \quad \mathrm{I}_{C}=-100 \mathrm{ma}$, See Nate 4 | -0.50 | -0.50 | $v$ |
|  | $\begin{array}{ll} T_{B}=-3 \mathrm{mme}, & I_{C}=-30 \mathrm{ma}, \\ T_{A}=15^{\circ} \mathrm{C}, & \text { See Mote } 4 \end{array}$ |  | -0.40 | v |
| Saso-Emitter Voliage | $\mathrm{I}_{\mathrm{B}}=-1 \mathrm{ma}, \quad \mathrm{I}_{\mathrm{C}}=-10 \mathrm{mo}$, Seat Mote 4 | -0.78-0.98 | -0.74 -0.98 | $v$ |
|  | $\mathrm{I}_{\mathrm{B}}=-3 \mathrm{~mm}, \quad \mathrm{I}_{\mathrm{C}}=-30 \mathrm{ma}$, Son Mote 4 | $\begin{array}{ll}-0.85 & -1.2\end{array}$ | -0.85 -1.2 | $v$ |
|  | $\mathrm{I}_{1}=-10 \mathrm{ma}, \mathrm{I}_{\mathrm{C}}=-100 \mathrm{me}$, See Moto 4 | -1.7 | $-1.7$ | $\checkmark$ |

NOTES: 1. This value applies botwaen $10 \mu 0$ and 10 ma cellecter current when the base-emitter diede is epen-circvited.
2. berate lineasly to $200^{\circ} \mathrm{C}$ free-air temperalure of the rale of $2.06 \mathrm{mw} / \mathrm{C}^{\circ}$.
3. Derate linearly to $200^{\circ} \mathrm{C}$ case temperatere af the rate of $6.85 \mathrm{~mm} / \mathrm{C}^{\circ}$.
4. This parameter must be measured using pelse techniques. $\mathrm{PW}=300 \mu \mathrm{sex}, \mathrm{Duly} \mathrm{Cych}=1 \%$.
*Indicetes IEPEC registered dals.
USES CHIP P11

## TYPES 2N2894, 2N3012 <br> P-N-P SILICON TRANSISTORS

*electrical characteristics at $25^{\circ} \mathrm{C}$ free-air temperature

| PARAMETER |  | TEST CONDITIONS | 2N2894 | 2N3012 | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | MIN MAX | MIN MAX |  |
| $\left\|h_{\text {fol }}\right\|$ | Small-Signal Commen-Emittor Forward Current Transfer Rotio |  | $v_{C E}=-10 v_{,} I_{C}=-30 \mathrm{ma}, \quad f=100 \mathrm{Mc}$ | 4 | 4 |  |
| Cobo | Common-Base Open-Circult Output Capacitance | $V_{C B}=-5 \mathrm{v}, \mathrm{l}_{\mathrm{E}}=0, \quad f=140 \mathrm{kc}$ | 6 | 6 | pf |
| $c_{\text {ibo }}$ | Common-Bass Open-Circuit Input Capacitance | $v_{E B}=-0.5 \mathrm{v}, \mathrm{I}_{\mathrm{C}}=0, \quad t=140 \mathrm{kc}$ | 6 | 6 | pt |

*switching characteristics $\mathbf{a} \mathbf{\$} \mathbf{2 5}{ }^{\circ} \mathbf{C}$ free-air temperature

|  | PARAMETER | TEST CONDITIONS ${ }^{\dagger}$ | $\frac{\text { 2N2894 }}{\text { MAX }}$ | $\frac{2 N 3012}{\mathrm{MAX}}$ | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: |
| $\mathrm{t}_{\mathrm{on}}$ | Turn-On Time |  | 60 | 60 | nsec |
| ${ }^{\text {off }}$ | Turn-0ff Time | $\begin{aligned} & I_{\mathrm{C}}=-30 \mathrm{ma}, \mathrm{I}_{\mathrm{BA}(1)}=-1.5 \mathrm{ma}, \mathrm{I}_{\mathrm{B}(2)}=1.5 \mathrm{ma}, \\ & R_{L}=62 \Omega \text {, See figure } 1 \end{aligned}$ | 90 | 75 | nsoc |

## *PARAMETER MEASUREMENT INFORMATION



FIGURE 1 - TURN-ON AND TURN-OFF TIMES

NOTES: a. The input woveforms are supplied by a generator with the fotlowing characteristics: $\boldsymbol{Z}_{\text {out }}=50 \Omega, \mathrm{I}_{\mathrm{r}} \leq 1$ nsec, $\mathrm{PW}>200$ nsec.
b. Waveforms are monitored on an oscilioscope with the following characteristics: $\boldsymbol{i}_{\mathrm{r}} \leq 1 \mathrm{nsec}, \mathrm{a}_{\mathrm{in}} \geq 100 \mathrm{k} \Omega$.
*Indicates JEDEC registered data.

## DESIGNED FOR HIGH-SPEED, HIGH-CURRENT SWITCHING APPLICATIONS

## *mechanical data


*absolute maximum ratings at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise nofed)
Collector-Base Voltage . . . . . . . . . . . . . . . . . . . . . . . . .
Collector-Emitter Voltage (See Note 1). ..... 30 r
Emitter-Base Voltage ..... 5 r
Total Device Dissipation at (or below) $\mathbf{2 5}{ }^{\circ} \mathrm{C}$ Free-Air Temperature (See Note 2) ..... 0.8 w
Total Device Dissipation af (or below) $25^{\circ} \mathrm{C}$ Case Temperature (See Note 3) ..... 3.0 w
Oparating Collector Junction Temperature ..... $200^{\circ} \mathrm{C}$
Storage Temperature Range ..... $-65^{\circ} \mathrm{C}$ to $+200^{\circ} \mathrm{C}$

*electrical characteristies of $\mathbf{2 5}{ }^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)


2. Barate lineorly te $200^{\circ} \mathrm{C}$ free-ali fomperatere at the rete of $4.6 \mathrm{~mm} / \mathrm{C}^{\circ}$.


*indicates JEDEC registered Inta

## TYPE 2N3015

## N-P-N SILICON TRANSISTOR

*gwitching characteristics at $\mathbf{2 5}{ }^{\circ} \mathrm{C}$ free-air femperafure

tVoltape end curroal valum chewn ere neminal; exect values vary silghily with mansister parmantors.
*PARAMETER MEASUREMENT INFORMATION

| Nominal $\mathrm{I}_{\mathrm{c}}$ | $\mathrm{R}_{\mathrm{L}}$ | $\mathrm{V}_{\mathrm{in}}$ |
| :---: | :---: | :---: |
| 300 ma | $80 \Omega$ | +7 v |
| 500 ma | $48 \Omega$ | +11 v |

CIRCUIT CONDITIONS
test CIRCUIT


VOLTAGE WAVEFORMS


TEST CIRCUIT


CIRCUIT CONDITIONS


VOLTAGE WAVEFORMS

FIGURE 2 - TURN-OFF TIMES



## FOR GENERAL PURPOSE, MEDIUM-POWER AMPLIFIER AND SWITCHING APPLICATIONS

- High Power Dissipation Capability: 10 w at $\mathrm{TC}=\mathbf{2 5}{ }^{\circ} \mathrm{C}$
- High Breakdown Voltage Combined with Very Low Saturation Voltage
- DC Beta Guaranteed From $100 \mu \mathrm{a}$ to 1 amp
mechanical detes
THE COLLECTOR IS IN ELECTRICAL CONTACT WITH THE CASE
absolute maximum ratings at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

*electrical characteristics at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

| PARAMETĖR | TEST CONDITIONS | MIN MAX | UNIT |
| :---: | :---: | :---: | :---: |
| $V_{(m \times\})}$ cio Collector-Base Breakdown Voltage | $\mathrm{I}_{\mathrm{c}}=100 \mu \mathrm{a}, \mathrm{I}_{\mathrm{E}}=0$ | 120 | $v$ |
| $V_{\text {(ox)ceo }}$ Collector-Emitter Breakdown Voltage | $\mathrm{I}_{\mathrm{C}}=30 \mathrm{ma}, \quad \mathrm{I}_{\mathrm{I}}=0, \quad$ (Seer Note 4) | 80 | $v$ |
| $V_{\text {(0a)ELO }}$ Emitter-Base Breakdown Voltage | $\mathrm{I}_{\mathrm{E}}=100 \mu \mathrm{a}, \mathrm{I}_{\mathrm{c}}=0$ | 7 | $v$ |
| Collector Cutoff Current | $V_{\text {Cit }}=60 \mathrm{v}_{1} \quad \mathrm{I}_{\mathrm{E}}=0$ | 10 | no |
|  | $V_{C I}=60 \mathrm{v}_{1} \quad \mathrm{I}_{\mathrm{E}}=0, \quad \mathrm{~T}_{\mathrm{A}}=150^{\circ} \mathrm{C}$ | 10 | $\mu \mathrm{a}$ |
| IEOO Emittor Cutoff Current | $v_{\text {Et }}=5 v_{\text {d }}, \quad \mathrm{l}_{\mathrm{c}}=0$ | 10 | na |
| Static Forward Current Transfor Ratio | $V_{C E}=10 v_{1} \quad l_{C}=100 \mu \mathrm{a}$ | 20 |  |
|  | $V_{C E}=10 \mathrm{v}, \quad I_{C}=10 \mathrm{ma}$ | 40 |  |
|  | $V_{C E}=10 v_{1} \quad I_{C}=150 \mathrm{ma},($ See Note 4) | $50 \quad 150$ |  |
|  | $V_{C E}=10 \mathrm{v}, \quad l_{C}=500 \mathrm{mc}$, (Soe Note 4) | 25 |  |
|  | $V_{C E}=10 v_{1}, l_{c}=1 \mathrm{a}, \quad$ (See Nolo 4) | 15 |  |
|  | $V_{C E}=1 v_{1}, \quad l_{c}=150 \mathrm{ma}$, (See Note 4) | 30 |  |
| Base-Emitter Voltage | $\mathrm{I}_{\mathrm{B}}=15 \mathrm{mo}, \quad \mathrm{I}_{\mathrm{C}}=150 \mathrm{ma}$, (Sos Note 4) | $0.75 \quad 1.1$ | $v$ |
|  | $\mathrm{I}_{\mathrm{B}}=50 \mathrm{ma}, \quad \mathrm{I}_{\mathrm{c}}=500 \mathrm{ma}$, (S00 Nota 4) | 1.5 | $v$ |
| Collector-Emitter Saluration Voltage | $\mathrm{l}_{\mathrm{g}}=15 \mathrm{ma}, \quad \mathrm{l}_{\mathrm{c}}=150 \mathrm{ma}$, (So0 Nota 4) | 0.25 | $v$ |
|  | $\mathrm{I}_{\mathrm{t}}=50 \mathrm{ma}, \mathrm{Ic}_{\mathrm{c}}=500 \mathrm{mo}$, (See Note 4) | 1.0 | $v$ |

NOTES: 1. This value applies when the bese-emitter diode is open-circuited.
2. Derate linaurly to $200^{\circ} \mathrm{C}$ free-air tamparature at the rate of $4 . \overline{\mathrm{E}} \mathrm{mw} /{ }^{\circ} \mathrm{C}$.
3. Derate the 10 -watt rating linaarly to $200^{\circ} \mathrm{C}$ case temperature at the rate of $57.1 \mathrm{mw} /{ }^{\circ} \mathrm{C}$.

Derate the 5 -watt (JEDEC reglatered) rating linearly to $200^{\circ} \mathrm{C}$ case temperature at the rate of $28.6 \mathrm{mw} /{ }^{\circ} \mathrm{C}$.
4. Thase parameters must be masared using pulse techniques, $\mathrm{PW}=\mathbf{3 0 0} \mu \mathrm{s}$, Duty Cyele $<\mathbf{2 \%}$.
*The JEDEC registered outilne for these devices is TO-6. TO-39 falls within TO-5 with the exception of lead length.

- JEDEC raglatered data. This data sheet contalne all applicable registered dete in affect at the time of publication.

TThis value is gueranteed by Texas Instrumente in addition to tha JEDEC registared vaiue which is also shown. -
*electrical characteristics at $25^{\circ} \mathrm{C}$ free-air temperature

| PARAMETER |  | TEST CONDITIONS |  |  | MIN | MAX | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| $\mathrm{h}_{\text {i }}$ | Small-Signal Common-Emilter Input Impodance | $V_{C E}=10$ | $\mathrm{Ic}_{\mathrm{c}}=10 \mathrm{ma}$, | $f=1 \mathrm{kc}$ | 120 | 900 | ohm |
| $h_{\text {fo }}$ | Smail-Signal Common-Emitter Forward Current Ironsfer Ratio | $v_{\text {ce }}=10$ | $l_{c}=10 \mathrm{ma}$, | $f=1 \mathrm{kc}$ | 40 | 180 |  |
| $\mathrm{h}_{\boldsymbol{6}}$ | Small-Signal Common-Emitter Output Admittanco | $V_{C E}=10$ | $\mathrm{Ic}_{\mathrm{c}}=10 \mathrm{ma}$ | $f=1 \mathrm{kc}$ |  | 120 | $\mu \mathrm{mho}$ |
| \|heol | Small-Signal Common-Emitter Forward Current Transtor Ratio | $V_{\text {CE }}=10$ | $l_{c}=10 \mathrm{ma}$, | $\mathrm{f}=20 \mathrm{mc}$ | 2.5 |  |  |
| $C_{\text {ab }}$ | Common-Base Open-Circuit Output Capacitance | $V_{\text {cı }}=10$ | $I_{E}=0$, | $\mathrm{f}=1 \mathrm{mc}$ |  | 15 | pf |
| $\mathrm{C}_{\mathrm{ib}}$ | Common-Base Open-Circuit Input Capadtance | $V_{\text {Et }}=0.5$ | $\mathrm{l}_{\mathrm{c}}=0$, | $\mathrm{f}=1 \mathrm{mc}$ |  | 85 | pf |

*switching characteristics ef $25^{\circ} \mathrm{C}$ free-air temperature

| PARAMETER | TEST CONDITIONS $\dagger$ | MIN MAX | UNIT |
| :---: | :---: | :---: | :---: |
| $t_{\text {d }}$ Delay Time | $\begin{aligned} & I_{c}=150 \mathrm{ma}, \quad I_{\mathrm{M} 11}=15 \mathrm{ma}, \\ & I_{\mathrm{m}(1)}=-15 \mathrm{ma}, \\ & V_{\mathrm{BEl} \text { leff }}=-2.75 \mathrm{v}, \quad R_{L}=40 \Omega, \\ & \text { (See Figure 1) } \end{aligned}$ | 30 | nsoc |
| $t_{t} \quad$ Rise lime |  | 150 | nsor |
| $t_{3} \quad$ Storage Time |  | 1 | $\mu \mathrm{soc}$ |
| $t_{f} \quad$ Foll Time |  | 200 | nsoc |

$\dagger$ Valiage and current values shown are nominal; exact values vary silghtly with transister parametors.
*PARAMETER MEASUREMENT INFORMATION



*Iadicates JEDEC ragisterad dato

## FOR GENERAL PURPOSE AMPLIFIER AND SWITCHING APPLICATIONS

- High Breakdown Voltage Combined With Very Low Saturation Voltage
- DC Beta - Guaranteed From $100 \mu$ a to $\mathbf{5 0 0}$ ma
- Electrically Similar to 2N2243
- Recommended for Complementary Use With 2N3039 and 2N3040
*mechanical dafa

*absolute maximum ratings af $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

*electrical characteristics af $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

| PARAMETER | TEST CONDITIONS | 2N3037 |  | 2N3038 |  | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | MIN | MAX | MIN | MAX |  |
|  | $\mathrm{I}_{\mathrm{c}}=100 \mu \mathrm{a}, \mathrm{I}_{\mathrm{E}}=0$ | 120 |  | 100 |  | $V$ |
| $V_{\text {(BR)CEO }}$ Collector-Emitter Breakdown Voltage | $I_{C}=30 \mathrm{ma}_{2} I_{s}=0, \quad$ (See Mote 4) | 70 |  | 60 |  | $V$ |
| $V_{(B R) E 80}$ Emitfer-Bose Breakdown Voltage | $I_{E}=100 \mu n, l_{C}=0$ | 7 |  | 7 |  | $v$ |
| Collector Cutoff Current | $V_{C B}=60 \mathrm{v}, \quad \mathrm{I}_{\mathrm{E}}=0$ |  | 10 |  | 10 | no |
|  | $V_{C B}=60 y_{1}, \quad I_{E}=0, \quad T_{A}=150^{\circ} \mathrm{C}$ |  | 10 |  | 10 | $\mu \mathrm{a}$ |
| $\mathrm{I}_{\text {EMO }}$ Emitter Cutoff Current | $v_{E B}=5 \mathrm{v}, \quad \mathrm{l}_{\mathrm{c}}=0$ |  | 10 |  | 10 | na |
| Static Forward Current Transfer Ratio | $V_{C E}=10 \mathrm{v}, \quad \mathrm{I}_{\mathrm{C}}=100 \mu \mathrm{O}$ | 15 |  | 30 |  |  |
|  | $V_{C E}=10 \mathrm{v}, \mathrm{I}_{C}=10 \mathrm{ma}$, (See Note 4) | 30 |  | 60 |  |  |
|  | $V_{C E}=10 \mathrm{v}, \mathrm{l}_{\mathrm{c}}=150 \mathrm{~ms}$, (See Note 4) | 40 | 120 | 80 | 240 |  |
|  | $V_{C E}=10 \mathrm{v}, \mathrm{I}_{\mathrm{c}}=500 \mathrm{mc}$, (See Note 4) | 20 |  | 40 |  |  |
|  | $V_{C E}=1 \mathrm{v}, \mathrm{l}_{\mathrm{C}}=150 \mathrm{ma},($ See Note 4) | 25 |  | 50 |  |  |
| Base-Emitter Yoltage | $l_{1}=1 \mathrm{ma}, \quad l_{c}=10 \mathrm{mo}$ | 0.6 | 0.8 | 0.6 | 0.8 | V |
|  | $\mathrm{I}_{\mathrm{s}}=15 \mathrm{ma}, \mathrm{I}_{\mathrm{c}}=150 \mathrm{ma}$, (See Note 4) | 0.75 | 1.1 | 0.75 | 1.1 | V |
| $\mathbf{V}_{\text {cEinit }}$ Collector-Emitter Saturation Voltoge | $\mathrm{I}_{\mathrm{B}}=1 \mathrm{ma}, \quad \mathrm{I}_{\mathrm{c}}=10 \mathrm{ma}$ |  | 0.2 |  | 0.2 | V |
|  | $I_{1}=15 \mathrm{ma}, I_{c}=150 \mathrm{ma}$, (See Note 4) |  | 0.35 |  | 0.35 | V |

NOTES: 1. This value applies whem the base-emitter diede is epen-circulted.
2. Derale lineariy to $185^{\circ} \mathrm{C}$ froe-air temperature at the rate of $2.4 \mathrm{~mm} / 6^{\circ}$.
3. Darate linearly to $175^{\circ} \mathrm{C}$ case temperature at the rete of $6.67 \mathrm{mw} / \mathrm{C}^{\circ}$.
4. These paramaters must be measured using pulse techniques. $\mathbf{F W}=300 \mu \mathrm{soc}$, Duty Cycle $\leq \mathbf{~} \%$.
*Indicates JEDEC registared date

## TYPES 2N3037, 2N3038

N-P-N SILICON TRANSISTORS
*electrical characteristics at $\mathbf{2 5}{ }^{\circ} \mathrm{C}$ free-air temperature

| PARAMETER |  | TEST CONDITIONS |  | 2N3037 |  | 2N3038 |  | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | MIN | max | MIN | MaX |  |
| $\mathrm{hio}^{\text {i }}$ | Small-Signal Common-Emitter Input Impedance |  |  | $V_{\text {CE }}=10 \mathrm{y}, \mathrm{l}_{\mathrm{c}}=1$ | $\mathrm{f}=1 \mathrm{kc}$ | 90 | 700 | 180 | 1500 | ohm |
| $\mathrm{hfo}_{6}$ | Small-Signal Commen-Emitter Forward Current Transfer Ratio | $\mathbf{v}_{\mathbf{c E}}=10 \mathrm{v}_{\mathbf{c}} \mathrm{l}_{\mathbf{c}}=$ | $\mathrm{f}=1 \mathrm{kc}$ | 30 | 140 | 60 | 300 |  |
| $\mathrm{h}_{0}$ | Small-Signal Common-Emittor Output Admittance | $\mathbf{V}_{\mathbf{C E}}=10 \mathrm{v}, \mathrm{I}_{\mathbf{C}}=$ | = 1 kc |  | 100 |  | 200 | $\mu \mathrm{mho}$ |
| $\left\|h_{\text {fer }}\right\|$ | Small-Signal Common-Emitter Forword Current Transfer Ratio | $v_{\text {ce }}=10 \mathrm{v}, \mathrm{l}_{\mathrm{c}}=$ | $=20 \mathrm{mc}$ | 2.5 |  | 2.5 |  |  |
| $C_{0}$ | Common-Base Open-Circuit Output Caporitance | $\mathbf{v}_{\mathrm{ct}}=10 \mathrm{v}, \mathrm{l}_{\mathrm{E}}=0$, | $\mathrm{f}=1 \mathrm{mc}$ |  | 15 |  | 15 | pf |
| $\mathrm{C}_{\mathrm{ib}}$ | Common-Base Open-Circuit Input Capacitance |  | $\mathbf{f}=1 \mathrm{mc}$ |  | 85 |  | 85 | pf |

*switching characteristics at $25^{\circ} \mathrm{C}$ free-air temperature

| PARAMETER |  | TEST CONDITIONS $\dagger$ | 2N3037 | 2N3038 | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | MIN MAX | MIN MaX |  |
| $t_{\text {d }}$ | Delay Time |  | $\begin{aligned} & I_{c}=150 \mathrm{ma}, I_{(I)}=15 \mathrm{mo} \\ & I_{\mathbb{L 2 ]}}=-15 \mathrm{ma} \\ & V_{\mathbb{I E \| O f f}}=-2.75 \mathrm{v}, \mathrm{R}_{\mathrm{L}}=40 \Omega \\ & \text { (See Figure } 1 \text { ) } \end{aligned}$ | 30 | 30 | nsot |
| $t_{r}$ | Rise Time | 150 |  | 150 | nser |
| $t_{5}$ | Storoge Time | 1 |  | 1 | $\mu \mathrm{sec}$ |
| ${ }_{\text {f }}$ | Fall Time | 200 |  | 200 | nsoc |

$\dagger$ Veltage and curroat velues shown are nominal; exact velves vary slightly with transistor parcometers.
*PARAMETER MEASUREMENT INFORMATION


## FIGURE I - SWITCMINE TIMES



*Indicates JEDEC ragistored dets

## TYPES 2N3039, 2N3040 P-N-P SILICON TRANSISTORS

## FOR GENERAL PURPOSE AMPLIFIER AND SWITCHING APPLICATIONS

- High Breakdown Voltaga Combined With Very Low Saturation Voltage
- DC Beta - Guaranteed From $100 \mu a$ to $\mathbf{5 0 0}$ ma
- Recommended for Complementary Use With 2N3037 and 2N3038


## *mechanical data


*absolute maximum ratings at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)
2Ns009 2N3040

*electrical characteristics at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

| PARAMETER | TEST CONDITIONS | 2N3039 | 2N3040 | UNIT |
| :---: | :---: | :---: | :---: | :---: |
|  |  | MIN MAX | MIN MAX |  |
| V(as)cso Collextor-hase Ireakdown Voltaye | $\mathrm{I}_{\mathrm{c}}=-100 \mu \mathrm{a}, \mathrm{l}_{E}=0$ | -50 | $-40$ | $V$ |
| $V_{\text {(a) }}$ ceo Collector-Emitter Breakdown Yoltage | $\mathrm{I}_{\mathrm{C}}=-30 \mathrm{ma}, \mathrm{I}_{\mathrm{B}}=0, \quad$ (See Nole 4) | -35 | $-30$ | $v$ |
| V(te)Eso Emitter-Lase Breakdown Yoltoge | $\mathrm{l}_{\mathrm{E}}=-100 \mu \mathrm{c}, \mathrm{l}_{\mathrm{c}}=0$ | -5 | -5 | $\checkmark$ |
| Collector Cutoff Current | $V_{C E}=-30 \mathrm{v}, \quad \mathrm{l}_{\mathrm{E}}=0$ | -25 | -25 | no |
|  | $V_{C B}=-30 \mathrm{~V}, \mathrm{I}_{\mathrm{E}}=0, \quad \mathrm{~T}_{\mathrm{A}}=150^{\circ} \mathrm{C}$ | -25 | -25 | $\mu \mathrm{L}$ |
| IEso Emitter Cutoff Current | $V_{E E}=-3 v_{i} \quad I_{C}=0$ | -10 | -10 | na |
| Static Forword Current Trenster Ratio | $V_{C E}=-10 v_{\text {g }} \quad I_{C}=-100 \mu 0$ | 15 | 30 |  |
|  | $V_{C E}=-10 v_{,} I_{c}=-10 \mathrm{~ms}$, (See Nofe 4) | 20 | 40 |  |
|  | $V_{C E}=-10 v_{0} I_{C}=-150 \mathrm{ma}$, (See Note 4) | $20-80$ | $40 \quad 160$ |  |
|  | $V_{C E}=-10 v_{\text {g }} \quad I_{C}=-500 \mathrm{~mm}$, (Soe Note 4) | 15 | 25 |  |
|  | $V_{C E}=-1 \mathrm{v}, \quad \mathrm{I}_{\mathrm{C}}=-150 \mathrm{ma}$, (Sae Nate 4) | 15 | 20 |  |
| Baso-Emitter Vottoge | $\mathrm{l}_{\mathrm{B}}=-1 \mathrm{ma}, \quad \mathrm{l}_{\mathrm{c}}=-10 \mathrm{mo}$ | -0.6-1.0 | -0.6-1.0 | $v$ |
|  | $\mathrm{Im}_{4}=-15 \mathrm{ma}, \mathrm{I}_{\mathrm{c}}=-150 \mathrm{mo}$, (See Note 4) | -0.8-1.3 | -0.8 -1.3 | $V$ |
| $V_{\text {cefsan }}$ Collecter-Emitter Saturotion Voltage | $\mathrm{l}_{\mathrm{L}}=-1 \mathrm{ma}, \quad \mathrm{lc}_{\mathrm{c}}=-10 \mathrm{me}$ | $-0.2$ | -0.2 | $v$ |
|  | $\mathrm{I}_{\mathrm{S}}=-15 \mathrm{mo}, \mathrm{Ic}=-150 \mathrm{ma}$, (See Mote 4) | -0.5 | -0.5 | $v$ |

WOTES: 1. This value applies when the baso-amither dibide is apen-ciresited.
2. Derole linerily to $175^{\circ} \mathrm{C}$ frow-air temperature of the rele of $2.4 \mathrm{~mm} / \mathrm{C}^{\circ}$.
3. Dorate limearly to $175^{\circ} \mathrm{C}$ esse thapprative at the ruse of $6.67 \mathrm{~mm} / \mathrm{C}^{\circ}$.

*indicatas seake moghtorad dato
*electrical characteristics af $25^{\circ} \mathrm{C}$ free-air temperature

| PARAMETER |  | TEST CONDITIONS |  | 2N3039 |  | 2N3040 |  | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | MIN | MAX | MIN | MAX |  |
| $\mathrm{h}_{\text {i* }}$ | Small-Signal Common-Emitter Input Impedance |  |  | $V_{C E}=-10 \mathrm{v}, \mathrm{l}_{\mathrm{c}}=-10 \mathrm{ma}, \mathrm{f}=1 \mathrm{kc}$ |  | 60 | 600 | 120 | 1200 | ohm |
| $\mathrm{hfo}_{\text {for }}$ | Small-Signal Common-Emititer Forward Current Transfer Ratio | $V_{C E}=-10 \mathrm{v}, \mathrm{I}_{\mathrm{C}}=-10 \mathrm{ma}, \mathrm{f}=1 \mathrm{kc}$ |  | 20 | 120 | 40 | 240 |  |
| $h_{\text {o }}$ | Small-Signal Common-Emitter Output Admiltonce | $V_{C E}=-10 v_{,} l_{c}=-10 \mathrm{ma}, \mathrm{f}=1 \mathrm{kc}$ |  |  | 250 |  | 500 | $\mu \mathrm{mmo}$ |
| $\left\|h_{\text {fol }}\right\|$ | Small-Signal Commen-Emitter Forword Current Transfer Ratio | $V_{C E}=-10 \mathrm{v}, I_{C}=-10 \mathrm{ma}, f=20 \mathrm{mc}$ |  | 2.5 |  | 2.5 |  |  |
| Cob | Common-Base Open-Circuit Output Capacitance | $v_{C B}=-10 \mathrm{v}, \mathrm{t}_{\mathrm{E}}=0$, | $\mathrm{f}=1 \mathrm{mc}$ |  | 40 |  | 40 | pf |
| $\mathrm{c}_{\mathrm{ib}}$ | Common-Base Open-Crevit Input Capaditance | $V_{E a}=-0.5 \mathrm{v}, \mathrm{l}_{\mathrm{C}}=0$, | $\mathrm{f}=1 \mathrm{mc}$ |  | 80 |  | 80 | pf |

*switching characteristics at $25^{\circ} \mathrm{C}$ free-air temperature

| PARAMETER |  | TEST CONDITIONS $\dagger$ | 2N3039 | 2N3040 | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | MIN MAX | MIN MAX |  |
| $t_{d}$ | Delay Time |  | $\begin{aligned} & I_{C}=-150 \mathrm{ma}, I_{(1)}=-15 \mathrm{ma}, \\ & I_{\mathbb{Q}(2)}=15 \mathrm{ma}, \\ & V_{\text {BEOf }}=+2.75 \mathrm{v}, \mathrm{R}_{\mathrm{L}}=40 \Omega \\ & \text { (See Figure I) } \end{aligned}$ | 50 | 50 | nser |
| $\mathrm{t}_{\mathrm{r}}$ | Rise Time | 100 |  | 100 | nsec |
| $\mathrm{t}_{5}$ | Storage Time | 500 |  | 500 | nsec |
| $\mathrm{t}_{\mathrm{f}}$ | Fall Time | 150 |  | 150 | nsec |

†Voltoge and corrant values shown are mominal; exact volees vary slighty with transister parametors.
*PARAMETER MEASUREMENT INFORMATION

figure i-switchine times

NOTES: . The input waveform has tha following cheracteristics: $t_{r} \leq 1$ nsac, $t_{i} \leq 1$ nsec, $\mathbf{P W} \geq 500$ nsec, Dusy Cycte $\leq 2 \%$.

*Inditates JEDEC ragistered data

## TYPES 2N3043 THRU 2N3048 DUAL N-P-N SILICON TRANSISTORS

## dESIGNED FOR DIFFERENTIAL AMPLIFIERS AND HIGH-GAIN LOW-NOISE AUDIO AMPLIFIERS

- Eloctrically Similar to 2N2639-2N2644 Series
- Individual Triodes are Electrically Similar to 2N929, 2N930
- Popular T0-89 Flatpack Facilitates High-Density Packaging
- Welded Metal Construction
mechanical defta

*absolute maximum ratings at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)


MOTES: 1. This value applies when the beso-mititer diede is apen-circtitod.


*Imdicates JEDEC migitorad deta

## TYPES 2N3043 THRU 2N3048 DUAL N-P-N SILICON TRANSISTORS

## -lectrical characterlstics at $\mathbf{2 5}{ }^{\circ} \mathrm{C}$ free-air tomperature (unless athorwise noted)

| PARAMETER |  | TIST CONDITIONS | $\begin{aligned} & \text { 2N3O43 } \\ & 2 N 204 \\ & 2 N 3045 \end{aligned}$ |  | $\begin{aligned} & \text { 2N3046 } \\ & \text { 2N3047 } \\ & 2 N T 048 \\ & \hline \end{aligned}$ |  | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | MIN | MAX | MIN | MAX |  |
| $V_{\text {(ma)cso }}$ | Colloctor-Emithtr Zrsakdown Voltage |  | $\mathrm{l}_{\mathrm{c}}=10 \mathrm{ma}, \mathrm{l}_{\mathrm{s}}=0, \quad$ Sese Mote 5 | 45 |  | 45 |  | V |
| $V_{\text {(0a) }}^{100}$ | Emiftor-Besa Braakdown Voltage. | $h_{4}=10 \mu \mathrm{a}, l_{c}=0$ | 5 |  | 5 |  | $v$ |
| lemo | Collectior Cutoff Curront | $V_{C E}=4.5 v_{1} h_{1}=0$ |  | 10 |  | 10 | ma |
|  |  | $V_{C I}=45 v_{1} I_{B}=0, \quad T_{A}=150^{\circ} \mathrm{C}$ |  | 10 |  | 10 | $\mu \mathrm{O}$ |
| 180 | Emithor Cutoff Current | $v_{10}=4 v_{1} \quad l_{c}=0$ |  | 10 |  | 10 | no |
| hre | Stotic Forward Currenf Transfor Ratio | $V_{C E}=5 v_{1}, I_{c}=10 \mu \mathrm{c}$ | 100 | 300 | 50 | 200 |  |
|  |  | $V_{\text {CE }}=5 v_{\text {, }}, l_{C}=1 \mathrm{ma}$ | 130 |  | 65 |  |  |
| $V_{\text {E }}$ | Boso-Emittar Voltage | $\mathrm{V}_{\mathrm{CE}}=5 \mathrm{v}, \mathrm{I}_{\mathrm{c}}=10 \mathrm{ma}$ | 0.6 | 0.8 | 0.6 | 0.8 | $v$ |
| $V_{\text {ctinat }}$ | Colloctor-Emitter Saturation Voltroge | $\mathrm{I}_{\mathrm{s}}=0.5 \mathrm{ma}, \mathrm{I}_{\mathrm{c}}=10 \mathrm{mc}$ |  | 1 |  | 1 | $v$ |
| $h_{\text {i }}$ | Small-Signal Common-Emifter Input Impedance | $\mathbf{V}_{\text {CE }}=5 \mathrm{v}, \quad \mathrm{l}_{\mathrm{C}}=1 \mathrm{ma}, \quad f=1 \mathrm{kc}$ | 3.2 | 19 | 1.6 | 13 | $\mathrm{k} \Omega$ |
| $h_{6}$ | Small-Signal Common-Emitter Forword Current Transter Ratio | $V_{C E}=5 \mathrm{v}, \mathrm{l}_{\mathrm{c}}=1 \mathrm{ma}, \mathrm{f}=1 \mathrm{kc}$ | 130 | 600 | 65 | 400 |  |
| $h_{06}$ | Small-Signal Common-Emifter Output Admittance | $\mathbf{V}_{\mathbf{C E}}=5 \mathrm{v}, \quad \mathbf{l}_{\mathbf{C}}=1 \mathrm{mag}, \quad 1=1 \mathrm{kc}$ |  | 100 |  | 70 | $\mu \mathrm{mho}$ |
| $\left\|h_{60}\right\|$ | Smail-Signal Common-Emitter Forword Current Transfer Ratio | $V_{\text {ce }}=5 \mathrm{v}, \quad \mathrm{l}_{\mathrm{c}}=1 \mathrm{ma}, \quad 1=20 \mathrm{Mc}$ | 1.5 |  | 1.5 |  |  |
| $\mathrm{C}_{\text {obo }}$ | Common-Base Open-Circuit Output Capocitance | $V_{C I}=5 \mathrm{v}, \quad \mathrm{l}_{\mathrm{E}}=0, \quad \mathrm{i}=1 \mathrm{Mc}$ |  | 8 |  | 8 | pf |

*triode matching characteristics

| PARAMETER |  | TEST CONDITIONS | $\begin{aligned} & \text { 2N3043 } \\ & 2 \mathrm{~N} 3046 \\ & \hline \end{aligned}$ |  | $\begin{aligned} & \text { 2N3O44 } \\ & 2 \mathrm{~N} 3047 \\ & \hline \end{aligned}$ |  | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | MIN | max | MIN | MAX |  |
| $\frac{h_{\text {FE1 }}}{h_{\text {fe2 }}}$ | Static Forward-Curront- <br> Gain Bolance Ratio |  | $V_{\mathrm{CE}}=5 \mathrm{v}, \quad \mathrm{I}_{\mathrm{C}}=10 \mu \mathrm{a},$ <br> See Note 6 | 0.9 | 1 | 0.8 | 1 |  |
|  | Baso-Emifter-VoltagoDifferential | $V_{\text {CE }}=5 \mathrm{v}, \quad \mathrm{I}_{\mathrm{C}}=10 \mu \mathrm{a}$ |  | 5 |  | 10 | mv |
|  | Base-Emitter-VoltagoDifferential Change Whth Temperature | $\begin{array}{ll} \hline V_{C E}=5 \mathrm{v}, & I_{\mathrm{C}}=10 \mu \mathrm{a}_{\prime}{ }^{\circ} \mathrm{C} \\ T_{A(1)}=25^{\circ} \mathrm{C}, & \mathrm{~T}_{A(2)}=-55^{\circ} \end{array}$ |  | 0.8 |  | 1.6 | mv |
|  |  | $\begin{aligned} & V_{\mathrm{CE}}=5 \mathrm{~V}, \quad \mathrm{I}_{\mathrm{C}}=10 \mu \mathrm{a}_{\mathrm{o}} \\ & \mathrm{I}_{\mathrm{A}(1)}=25^{\circ} \mathrm{C}, \mathrm{~T}_{A(2]}=125^{\circ} \mathrm{C} \end{aligned}$ |  | 1 |  | 2 | mv |

operating characteristics at $\mathbf{2 5}{ }^{\circ} \mathbf{C}$ free-air temperature
*individual triode characteristics (see note 4)

| PARAMETER | TEST CONDITIONS | ALL TYPES | UNIT |
| :---: | :---: | :---: | :---: |
|  |  | MIN MAX |  |
| $\overline{\text { NF }} \quad$ Average Noise Figure | $\begin{aligned} & V_{\mathrm{CE}}=5 \mathrm{v}, \mathrm{I}_{\mathrm{c}}=10 \mu \mathrm{a}, \mathrm{R}_{\mathrm{E}}=10 \mathrm{k} \Omega, \\ & \text { Hoise Bondwidth }=15.7 \mathrm{kc} \text {, See Note } 7 \end{aligned}$ | 5 | dh |

NOTES: 4. The torminals of the triode not under test are open-circultod fer the messurament of theso cherecteristics.
5. This parameter must be mossurod esing pulse techniques. PW $=\mathbf{3 0 0}{ }^{\circ} \mu \mathrm{soc}$, Duty Cycis $\leq \mathbf{2 \%}$.
6. The lower of the two $h_{\text {FE }}$ roodings is taken as $\mathrm{h}_{\mathrm{FE}}$.
7. Avorage Noisa Figure is mossurod in en emplifior with tow-froquency-roppense down 3 de at 10 cps.
*Imdicatos JEDEC registerad data

## TYPES 2N3049, 2N3050, 2N3051 DUAL P-N-P SILICON TRANSISTORS

dESIGNED FOR DIFFERENTIAL AMPLIFIERS, LOW-NOIS: AMPLIFIERS, AND LOW.LEVEL SWITCHING

- Each Triodo Eloctrically Similar to 2 N 2411 and 2 N 2412 Transistors

Popular T0-89 Flatpack Facilitates HIgh-Donsity Packaging

- Welded Motal Construction
mochanical deta

*absolute maximum ratings at $25^{\circ} \mathrm{C}$ free-air temperature (uniess otherwise noted)

Collector-Emitter Voltage (See Note 1) . . . . . . . . . . . . . . . $\mathbf{- 2 0 \mathrm { V }}$
Emitter-Base Voltage . . . . . . . . . . . . . . . . . . . . . -5 r

Continuous Collector Current . . . . . . . . . . . . . . . . . . - 100 ma
Continuous Dissipation at (or below) $25^{\circ} \mathrm{C}$ Free-Air Temperature (See Note 2) . . . 250 mw 350 mw
Continuous Dissipation at (or below) $25^{\circ} \mathrm{C}$ Case Temperature (See Note 3) . . . . 0.7 w 1.4 w
Storage Temperature Range . . . . . . . . . . . . . . . . . . . $-65^{\circ} \mathrm{C}$ to $+200^{\circ} \mathrm{C}$
Lead Temperature $1 / 1$ Inch from Case for 10 Seconds.
$230^{\circ} \mathrm{C}$
electrical characteristics at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)
*individual triode characteristics (see note 4)

| PARAMETER |  | TEST CONDITIONS | MIN | MAX | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: |
| $V_{\text {(ta) }}$ CEO | Collector-Emitter Iraakdown Yoltage | $I_{c}=-10 \mathrm{ma}, \mathrm{I}_{\mathbf{0}}=0, \quad$ Seo Mote 5 | -20 |  | $v$ |
| Icro | Coliector Cufoff Current | $V_{C I}=-25 v_{1} \mathrm{I}_{\mathrm{E}}=0$ |  | -10 | no |
|  |  | $V_{C E}=-25 y_{1} \mathrm{I}_{\mathrm{E}}=0, \quad \mathrm{~V}_{\mathrm{A}}=150^{\circ} \mathrm{C}$ |  | -10 | $\mu 0$ |
| $\mathrm{I}_{\text {ELO }}$ | Emittar Cutoff Curreal | $v_{\text {Ef }}=-5 v_{\text {d }}, \quad I_{c}=0$ |  | -10 | na |
| hre | Static Forward Curreat Transter Ratio | $V_{C E}=-5 v_{1} \quad l_{c}=-10 \mu 0$ | 20 | 120 |  |
|  |  | $v_{\text {cE }}=-5 v, \quad l_{c}=-100 \mu \mathrm{a}$ | 30 | 120 |  |
|  |  | $V_{c k}=-5 v_{\text {c }}, l_{c}=-1 \mathrm{ma}$ | 30 | 120 |  |
|  |  | $V_{C E}=-5 v_{0} \quad \mathrm{l}_{\mathrm{c}}=-10 \mathrm{ma}$, See Note 5 | 30 | 120 |  |
|  |  | $V_{\mathrm{ce}}=-1 \mathrm{v}, \quad \mathrm{l}_{\mathrm{c}}=-10 \mathrm{mo}$ | 20 |  |  |
| $V_{\text {ge }}$ | Base-Emifter Voltage | $\mathrm{l}_{1}=-1 \mathrm{mo}, \mathrm{l}_{C}=-10 \mathrm{~ms}$ | -0.7 | -0.9 | $v$ |
| $V_{\text {CEfati) }}$ | Collector-Emitter Soturation Voltoge | $\mathrm{l}_{\mathrm{s}}=-1 \mathrm{ma}, \mathrm{l}_{\mathrm{c}}=-10 \mathrm{mo}$ |  | -0.2 | $v$ |
| $h_{\text {ie }}$ | Small-Signal Common-Emitter Input Impedonce | $V_{\mathrm{ct}}=-5 \mathrm{v}, \quad \mathrm{lc}_{\mathrm{c}}=-1 \mathrm{mo}, \quad f=1 \mathrm{kc}$ | 0.75 | 4.5 | $k \Omega$ |
| $h_{\text {\% }}$ | Small-Signal Common-Emiltor Forword Current Pransfer latio | $\mathbf{V}_{\mathbf{C E}}=-5 \mathrm{v}, \quad \mathrm{l}_{\mathrm{c}}=-1 \mathrm{ma}, \quad i=1 \mathrm{kc}$ | 30 | 130 |  |
| $h_{\text {o6 }}$ | Small-Signal Comwnon-Emitter Output Admittence | $V_{\text {ce }}=-5 \mathrm{v}, \quad \mathrm{l}_{\mathrm{c}}=-1 \mathrm{ma}, \quad f=1 \mathrm{kc}$ |  | 50 | $\mu \mathrm{mho}$ |
| \|hel | Small-Signal Common-Emitter Forward Currunt Ironster Ratio | $\mathrm{V}_{\text {cE }}=-5 \mathrm{v}, \quad \mathrm{l}_{\mathrm{c}}=-1 \mathrm{mo}, \quad t=20 \mathrm{Mc}$ | 3 |  |  |
| Cobo | Common-Bose Opan-Circuit Output Copocilance | $V_{\text {ct }}=-5 v, \quad l_{E}=0, \quad f=1 \mathrm{Mc}$ |  | 8 | pf |

NOTES: 1 . This value applies when the bese-smitter diede is apen-circuited.
2. Derate linearly te $175^{\circ} \mathrm{C}$ fros-air temperature at the rate of $1.67 \mathrm{mw} / \mathrm{C}^{\circ}$ for each triode and $2.33 \mathrm{~mm} / \mathrm{C}^{\circ}$ for totat device.
3. Derate limarly to $175^{\circ} \mathrm{C}$ case tumperature at the rate of $4.67 \mathrm{mw} / \mathrm{c}^{\circ}$ for sach triode and $9.33 \mathrm{~mm} / \mathrm{c}^{\circ}$ for total device.
4. The terminals of the triede not under test are open-circuited for tho meosurement of those cheractaristics.
5. Thase paremoters must be measured using pulse tochniques. $\mathrm{PW}=300 \mu$ sec, Duty Cycle $\leq 2 \%$.
*Indicates JEDEC registored dale

## DUAL P-N-P SILICON TRANSISTORS

electrical characteristics af $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)
*triode matching characteristics

| PARAMETER |  | TEST CONDITIONS | 2N3049 | 2N3050 | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | MIN MAX | MIN MAX |  |
| $\frac{h_{f \in 1}}{h_{F E 2}}$ | Static-Forward-CurrentGain Balance Ratio |  | $\begin{aligned} & V_{C E}=-5 v, I_{C}=-100 \mu \mathrm{a}, \text {. } \\ & \text { Seo Note } 6 \end{aligned}$ | 0.91 | 0.81 |  |
| \| $\mathbf{V}_{\text {de1 }}-V_{\text {dez }} \mid$ | Base-Emitter-Voltage Differential | $V_{C E}=-5 \mathrm{v}, \mathrm{I}_{\mathrm{c}}=-100 \mu \mathrm{a}$ | 5 | 10 | mv |
| $\left\|\Delta\left(V_{\text {ve }}-V_{\text {bez }}\right)_{\Delta T_{A}}\right\|$ | \|Base-Emitter-Voltage Differential Change With Temperature | $\begin{aligned} & V_{\mathrm{CE}}=-5 \mathrm{v}_{,}, I_{\mathrm{C}}=-100 \mu \mathrm{a} \\ & \mathrm{I}_{\mathrm{A}(1)}=25^{\circ} \mathrm{C}, \mathrm{~T}_{A(2)}=-55^{\circ} \mathrm{C} \end{aligned}$ | 0.8 | 1.6 | mv |
|  |  | $\begin{aligned} & V_{\mathrm{CE}}=-5 v_{,} I_{\mathrm{c}}=-100 \mu \mathrm{a}, \\ & \mathrm{I}_{\mathrm{A}(1)}=25^{\circ} \mathrm{C}, \mathrm{I}_{\mathrm{A}(2)}=125^{\circ} \mathrm{C} \end{aligned}$ | 1 | 2 | mv |

NOTE 6: The lower of the two $\mathrm{h}_{\mathrm{FE}}$ madings is taken as $\mathrm{h}_{\text {fet }}$.
operating characteristics af $25^{\circ} \mathrm{C}$ free-air temperature
*individual triode characteristics (see note 4)

| PARAMETER |  | TEST CONDITIONS | ALL TYPES |  | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | MiN | MAX |  |
| $\overline{\text { MF }}$ | Average Noise Figure |  | $\begin{aligned} & V_{\mathrm{CE}}=-5 \mathrm{v}, \mathrm{I}_{\mathrm{C}}=-100 \mu \mathrm{a}, \mathrm{R}_{\mathrm{G}}=1 \mathrm{k} \Omega \text {, } \\ & \text { Nolse Bandwidth }=15.7 \mathrm{kc} \text {, Soe Nole } 7 \end{aligned}$ |  | 6 | db |

MOTE 7: Avoroge Moise Figure is measured in an amplifiar with low-froquency-response down 3 db at 10 cps.
switching characteristics at $25^{\circ} \mathbf{C}$ free-air temperature
*individual triode characteristics (see note 4)

| PARAMETER | TEST CONDITIONSt | 2N3051 | UNIT |
| :---: | :---: | :---: | :---: |
|  |  | MIN MAX |  |
| $t_{d} \quad$ Delay Time | $\begin{aligned} & I_{C}=-10 \mathrm{ma}, I_{B(1)}=-2.5 \mathrm{mo}, I_{\{(2]}=2 \mathrm{mo}, \\ & V_{B \in[\text { oft }}=+1.2 \mathrm{v}, R_{\mathrm{L}}=300 \Omega . \end{aligned}$ <br> See Figure 1 | 15 | nsec |
| $\mathrm{f}_{\mathbf{r}} \quad$ Rise Time |  | 20 | Asec |
| $t_{s} \quad$ Storage Time |  | 120 | nsec |
| $\mathrm{t}_{\mathbf{f}} \quad$ Fall Time |  | 30 | nsac |

†Valtage and current valuess shown are nominal; exact values vary silightly with transister paramaters.
"PARAMETER MEASUREMENT INFORMATION


TEST CIRCUIT


VOLTAGE WAVEFORMS

FIGURE 1 - SWITCHING TIMES




[^66]
# DESIGNED FOR MINIATURIZED APPLICATIONS REQUIRING DEVICES SIMILAR TO 2N706, 2N708, 2N744, 2N753, 2N834, 2N914, ETC. 

- Popular T0-89 Flatpack Facilitates High-Density Packaging
- Welded Metal Construction
mechanical data

*absolute maximum ratings af $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)


[^67]electrical characteristics at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)
*individual triode characteristics (see note 4)

| PARAMETER | TEST CONDITIONS | MIN MAX | UNIT |
| :---: | :---: | :---: | :---: |
| $V_{\text {(ax) cto }}$ Collector-Buse Breakdown Voltage | $\mathrm{I}_{C}=10 \mu \mathrm{a}, \mathrm{I}_{\mathrm{E}}=0$ | 35 | v |
| $V_{\text {(ma)ceo }}$ Collector-Emitter Breakdown Voltage | $\mathrm{I}_{\mathrm{C}}=10 \mathrm{ma}, \mathrm{I}_{\mathrm{B}}=0, \quad$ See Note 5 | 15 | $v$ |
| V(0x)Eso Emitter-Base Breakdown Voltage | $\mathrm{I}_{\mathrm{E}}=10 \mu \mathrm{a}, \mathrm{I}_{\mathrm{c}}=0$ | 5 | $v$ |
| Collector Cutoff Current | $\mathrm{V}_{\mathrm{CB}}=20 \mathrm{v}, \mathrm{I}_{\mathrm{E}}=0$ | 25 | na |
|  | $V_{C B}=20 \mathrm{v}, \mathrm{I}_{\mathrm{E}}=0, \quad \mathrm{~T}_{\mathrm{A}}=150^{\circ} \mathrm{C}$ | 25 | $\mu$ |
| Ices Collector Cutoff Current | $V_{C E}=20 \mathrm{v}, V_{\text {bE }}=0$ | 25 | na |
| It Base Current | $\mathrm{V}_{\text {CE }}=20 \mathrm{~V}, \mathrm{~V}_{\text {BE }}=0$ | -25 | na |
| $\mathrm{I}_{\text {EsO }}$ Emitter Cutoff Current | $\mathrm{V}_{E E}=4 \mathrm{v}_{1} \quad \mathrm{I}_{\mathrm{c}}=0$ | 100 | na |
| Slatik Forward Current Transler Ratio | $V_{C E}=1 v_{1} \quad I_{C}=10 \mathrm{ma}$ | $25 \quad 130$ |  |
|  | $V_{C E}=1 v_{1}, I_{C}=100 \mathrm{ma}$, See Note 5 | 20 |  |
| Base -Emilter Voltoge | $\mathrm{I}_{\mathrm{B}}=1 \mathrm{ma}, \quad \mathrm{I}_{\mathrm{c}}=10 \mathrm{ma}$ | $0.65 \quad 0.8$ | $v$ |
|  | $\mathrm{I}_{\mathrm{B}}=10 \mathrm{ma}, \mathrm{I}_{\mathrm{C}}=100 \mathrm{ma}$, See Note 5 | 0.81 .2 | $v$ |
| Collector-Emitter Saturation Voltage | $\mathrm{I}_{\mathrm{B}}=1 \mathrm{ma}, \quad \mathrm{I}_{\mathrm{c}}=10 \mathrm{ma}$ | 0.25 | $v$ |
|  | $\mathrm{I}_{\mathrm{B}}=10 \mathrm{ma}, \mathrm{I}_{\mathrm{C}}=100 \mathrm{ma}$, See Note 5 | 0.6 | $v$ |
| $\left\|h_{\text {fo }}\right\| \quad \begin{aligned} & \text { Smell-Signal Common-Emitter } \\ & \text { Forword Current Iranster Ratio }\end{aligned}$ | $V_{\text {CE }}=5 \mathrm{v}, \quad \mathrm{l}_{\mathrm{c}}=10 \mathrm{ma}, \quad 1=100 \mathrm{Mc}$ | 2 |  |
| Cobo $\begin{aligned} & \text { Common-Base Open-Ciravit } \\ & \text { Dutput Capatitance }\end{aligned}$ | $V_{\text {Ca }}=5 \mathrm{v}, \quad \mathrm{I}_{\mathbf{E}}=0, \quad \mathrm{f}=1 \mathrm{Mc}$ | 8 | pf |
| $C_{\text {ibo }} \begin{aligned} & \text { Common-Base Open-Ciruif } \\ & \text { Imput Capacitance }\end{aligned}$ | $v_{E B}=0.5 \mathrm{v}, \mathrm{l}_{\mathrm{C}}=0, \quad \mathrm{l}=1 \mathrm{Mc}$ | 12 | pf |

switching characteristics af $25^{\circ} \mathrm{C}$ free-air temperature
*individual triode characteristics (see note 4)

|  | PARAMETER | TEST CONDITIONS $\dagger$ | MIN MAX | UNIT |
| :---: | :---: | :---: | :---: | :---: |
| $\mathrm{t}_{\text {d }}$ | Delay Time |  | 12 | nsec |
| $\mathrm{t}_{\mathrm{r}}$ | Rise Time |  | 50 | nsec |
| $t_{s}$ | Storage Time |  | 35 | nsec |
| ${ }_{1}$ | Fall Time |  | 20 | nsec |

†Voltage and current vatues shown ore nominal; axect values very slightly with transisfor parameiers.
*PARAMETER MEASUREMENT INFORMATION


## FIGURE 1 - SWITCHING TIMES

MOTES: a. The input waveform has the following charcctoristics: $t_{r} \leq 1$ nsec, $t_{f} \leq 1$ nsec, $P W \geq 300$ nsec, Duty cycle $\leq 2 \%$.
b. Wevelorms are monitored on an oscilloscope with tha following characteristics: $\mathbf{t}_{\mathrm{r}} \leq 1$ nsec, $\mathrm{k}_{\mathrm{in}} \geq 100 \mathrm{k} \Omega, \mathrm{c}_{\mathrm{in}} \leq 5 \mathrm{pf}$.
*Indicatas JEDEC ragistrored data

FOR HIGH-CURRENT, HIGH-DISSIPATION, GENERAL PURPOSE APPLICATIONS

- High Current Capability ... $\mathbf{7 0 0} \mathrm{mA}$
- High Dissipation Capability . . . 10 W
- fT . . . $\mathbf{1 0 0} \mathbf{~ M H z}$ Min
mechanical data

absolute maximum ratings at $25^{\circ} \mathrm{C}$ case temperature (unless otherwise noted)



## *electrical characteristics at $25^{\circ} \mathrm{C}$ free-air temperature

| PARAMETER | TEST CONDITIONS |  | MIN MAX | UNHT |
| :---: | :---: | :---: | :---: | :---: |
| $\mathrm{V}_{\text {(BR) }}$ CBO Collector-Base Breakdown Voltage | $I_{C}=100 \mu A, I_{E}=0$ |  | 60 | $V$ |
| $\mathrm{V}_{\text {(BR) }}$ CEO Collector-Emitter Breakdown Voltage | $I_{C}=100 \mu A, I_{B}=0$ |  | 40 | V |
| $V_{\text {(BR) }}$ CER Collector-Emitter Breakdown Voltage | $I_{C}=100 \mathrm{~mA}, \mathrm{R}_{\mathrm{BE}}=10 \Omega$, See Note 5 |  | 50 | V |
| V(BR)EBO Emitter-Base Breakdown Voltage | $\mathrm{I}_{\mathrm{E}}=100 \mu \mathrm{~A}, \mathrm{I}^{\prime} \mathrm{C}=0$ |  | 5 | V |
| ICEV Collector Cutoff Current | $\mathrm{V}_{\mathrm{CE}}=30 \mathrm{~V}, \mathrm{~V}_{\text {BE }}=-1.5 \mathrm{~V}$ |  | 250 | nA |
| IEBO Emirter Cutoff Current | $\mathrm{V}_{E B}=4 \mathrm{~V}, \quad \mathrm{I}_{\mathrm{C}}=0$ |  | 250 | nA |
| Static Forward Current Transfer Ratio | $V_{C E}=2.5 \mathrm{~V}, \mathrm{I}_{\mathrm{C}}=150 \mathrm{~mA}$ | See Note 5 | 25 |  |
|  | $V_{C E}=10 \mathrm{~V}, \mathrm{I}^{\prime} \mathrm{C}=160 \mathrm{~mA}$ |  | $50 \quad 250$ |  |
| Base-Emitter Voltage | $V_{C E}=2.5 \mathrm{~V}, \mathrm{I}_{\mathrm{C}}=150 \mathrm{~mA}$ | See Note 5 | 1.7 | V |
|  | $\mathrm{I}_{\mathrm{B}}=15 \mathrm{~mA}, \quad \mathrm{I}_{\mathrm{C}}=150 \mathrm{~mA}$ |  | 1.7 |  |
| $V_{\text {CE }}$ (sat) Collector-Emitter Saturation Voltege | $\mathrm{I}_{\mathrm{B}}=15 \mathrm{~mA}, \mathrm{I}_{C}=150 \mathrm{~mA}$, | See Note 5 | 1.4 | V |
| \|hfe| Small-Signal Common-Emitter | $V_{C E}=10 \mathrm{~V}, \mathrm{IC}=50 \mathrm{~mA}$, | $\mathrm{f}=\mathbf{2 0} \mathbf{M H z}$ | 5 |  |
| Cobo Common-Base Open-Circuit Output Capacitance | $V_{C B}=10 \mathrm{~V}, \mathrm{I}_{\mathrm{E}}=0$, | $\mathrm{f}=140 \mathrm{kHz}$ | 15 | pF |
| Cibo Common-Base Open-Circuit Input Capacitance | $\mathrm{V}_{\mathrm{EB}}=0.5 \mathrm{~V}, \mathrm{I}^{\prime}=0$, | $\mathrm{f}=140 \mathrm{kHz}$ | 80 | pF |

NOTES: 1. This value applies batween 0 and 700 mA collector current when the base-emitter diode is open-clrcuited. The instantaneous product of collector-emitter voltage and collector curr ant must not exceed $\mathbf{6} \mathbf{W}$ for longer than $300 \mu s$ at a $2 \%$ duty cyele.
2. This value applies when the base-emitter resistance $\mathrm{R}_{\mathrm{BE}}<10 \Omega$.
3. Derate linearly to $200^{\circ} \mathrm{C}$ free-air temperature at the rate of $5.71 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$.
4. Derate the 10 -watt rating linearly to $200^{\circ} \mathrm{C}$ case temperature at the rate of $57.1 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$. Derate the 5 -watt (JEDEC registered) rating linearly to $200^{\circ} \mathrm{C}$ cese temperature at the rate of $28.6 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$.
5. These parameters must be measured using pulse techniques. $t_{w}=\mathbf{3 0 0} \mu \mathrm{s}$, duty cycle $<\mathbf{2 \%}$.
*The JEDEC registered outline for this devics is TO-5. TO-39 falls within TO-5 with the exception of lead tength.
*JEDEC registered data. This data sheat contains all applicable registered data in effect at the time of publication.
$\dagger$ These values are guaranteed by Texas instruments in addition to the JEDEC registered values which are also shown.
USES CHIP N13

# TYPE 2N3114 <br> N-P-N SILICON TRANSISTOR 

BULLETIN NO. DL-S 737397, MARCH 1965-REVISED MARCH 1973

## DESIGNED FOR USE AS HIGH VOLTAGE VHF AMPLIFIER <br> - Featuring 150-Volt $\mathbf{V}_{\text {(axereo }}$

mechanical data
THE COLLECTOR IS IN ELECTRICAL CONTACT WITH THE CASE
absolute maximum ratings at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)
Collector-Base Voltage . . . . . . . . . . . . . . . . . . . . . . . . . $150 \mathrm{v}^{*}$
Collector-Emitter Voltage (See Note 1) . . . . . . . . . . . . . . . . . . . 150 v *
Emitter-Base Voltage . . . . . . . . . . . . . . . . . . . . . . . . . . 5 v .
Collector Current . . . . . . . . . . . . . . . . . . . . . . . . . . $200 \mathrm{ma}{ }^{*}$
Continuous Device Dissipation at (or below) $25^{\circ} \mathrm{C}$ Free-Air Temperature (See Note 2) . . . . $0.8 \mathrm{w}^{\text {* }}$
Continuous Device Dissipation at (or below) $25^{\circ} \mathrm{C}$ Case Temperature (See Note 3) . . . . . $\left\{\begin{array}{l}10 w^{\dagger} \\ 5 w^{\dagger}\end{array}\right.$
Storage Temperature Range . . . . . . . . . . . . . . . . . . . $-65^{\circ} \mathrm{C}$ to $+200^{\circ} \mathrm{C}$
Lead Temperature $\%_{6}$ Inch from Case for 10 Seconds . . . . . . . . . . . . . . . $300^{\circ} \mathrm{C}$
*electrical characteristics at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

| PARAMETER |  | TEST CONDITIONS |  |  | MIN | max | $\frac{\text { UNIT }}{v}$ |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| $V_{\text {(0x) }}$ Cro | Collector-Bose Breakdown Voltage | $\mathrm{I}_{\mathrm{c}}=100 \mu \mathrm{a}$, | $\mathrm{I}_{\mathrm{E}}=0$ |  | 150 |  |  |
|  | Collector-Emitter Breokdown Voltage | $\mathrm{Ic}_{\mathrm{c}}=30 \mathrm{mo}$, | $\mathrm{I}_{2}=0$, | See Note 4 | 150 |  | $v$ |
| $V_{\text {(m) }} \times \pm 0$ | Emitter-Base Breakdown Voltage | $\mathrm{I}_{\mathrm{E}}=100 \mu \mathrm{~m}$, | $\mathrm{Ic}_{\mathrm{c}}=0$ |  | 5 |  | V |
| Icto | Collector Cutoff Current | $v_{C E}=100 \mathrm{v}$, | $\mathrm{I}_{\mathrm{E}}=0$ |  |  | 10 | no |
|  |  | $\mathrm{V}_{\mathbf{c a}}=100 \mathrm{v}$, | $\mathrm{I}_{\mathrm{E}}=0$, | $\mathrm{T}_{\mathrm{A}}=150^{\circ} \mathrm{C}$ |  | 10 | $\mu \mathrm{O}$ |
| IE00 | Emitter Cutoff Current | $v_{E E}=4 \mathrm{v}$, | $\mathrm{l}_{\mathrm{c}}=0$ |  |  | 100 | na |
| $\mathrm{hfe}^{\text {fer }}$ | Static Forward Current Transfer Ratio | $\mathrm{V}_{\text {CE }}=10 \mathrm{v}$, | $\mathrm{I}_{C}=100 \mu \mathrm{O}$, | See Note 4 | 15 |  |  |
|  |  | $V_{C E}=10 \mathrm{r}$, | $\mathrm{I}_{\mathrm{c}}=30 \mathrm{mo}$, | See Mote 4 |  | 120 |  |
|  |  | $\mathrm{V}_{\text {CE }}=10 \mathrm{r}$, | $I_{c}=30 \mathrm{mo},$ | $T_{A}=-55^{\circ} \mathrm{C}$ <br> See Note 4 | 12 |  |  |
| $V_{\text {re }}$ | Base-Emitter Voltage | $\mathrm{I}_{\mathrm{s}}=5 \mathrm{ma}$, | $\mathrm{I}_{\mathrm{C}}=50 \mathrm{ma}$ |  |  | 0.9 | $v$ |
| $V_{\text {cEfat }}$ | Collector-Emitter Saturation Voltage | $\mathrm{I}_{\mathrm{s}}=5 \mathrm{ma}$ | $\mathrm{I}_{\mathrm{C}}=50 \mathrm{mo}$ |  |  | 1 | $v$ |

NOTES: 1. This value applies between 1 ma and 30 ma collector current when the base-emitter diode is open-circulted.
2. Derate linearly to $200^{\circ} \mathrm{C}$ free-air temperature at the rate of $4.57 \mathrm{mw} f^{\circ} \mathrm{C}$.
3. Derate the 10 -watt rating linearly to $200^{\circ} \mathrm{C}$ case tamperature at the rate of $57.1 \mathrm{mw} /{ }^{\circ} \mathrm{C}$. Derate the 5 -watt (JEDEC registered) rating linearly to $200^{\circ} \mathrm{C}$ case temperature at the rate of $28.6 \mathrm{mw} /{ }^{\circ} \mathrm{C}$.
4. These parameters must be measured using pulse techniques. $\mathrm{PW}=300 \mu \mathrm{sec}$, Duty Cycle $\leqslant 1 \%$.
*The JEDEC registered outline for these devices is TO-5. TO-39 falls within TO-5 with the exception of lead length
-JEDEC registered data. This data sheet contains all applicable registered data in effect at the time of publication.
this value is guaranteed by Texas Instruments in addition to the JEDEC registered value which is also shown.
USES CHIP N15

## *electrical characteristics at $25^{\circ} \mathrm{C}$ free-air temperature

|  | PARAMIER | TEST CONDITIONS |  |  | MIN | MaX | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| $h_{6}$ | Small-Sigual Commen-Emither Forward Cormat Truastar Ratio | $\mathbf{V}_{\text {CE }}=5 \mathrm{r}$, | $l_{c}=1 \mathrm{ma}$, | $\mathrm{f}=1 \mathrm{kc}$ | 25 |  |  |
| $\left\|m_{n}\right\|$ | Smell-Sipall Commen-Emitter Fowwerd Currout Ireasior Retio | $V_{C E}=10 \mathrm{v}$, | $\mathrm{Ic}_{\mathrm{c}}=\mathbf{3 0} \mathrm{ma}$, | $\mathrm{f}=20 \mathrm{Mc}$ | 2 |  |  |
| $C_{0}$ | Comman-lase Opem-Cirait Ovtpot Copadinace | $\mathrm{V}_{\mathrm{cs}}=20 \mathrm{v}$, | $\mathrm{I}_{\mathrm{E}}=0$, | $f=140 \mathrm{kc}$ |  | 9 | pf |
| 40 | Commm-lasa Opm-Crowit Input Cepactrace | $V_{\text {Ei }}=0.5 \mathrm{y}$ | $l_{c}=0$, | $\mathrm{f}=140 \mathrm{kc}$ |  | 80 | pf |
|  | Reol Port of Smell-Sipual Common-Emititor lupet Impedance | $\mathbf{V}_{\mathbf{C E}}=10 \mathrm{v}$ | $\mathbf{l c}_{\mathbf{c}}=\mathbf{1 0} \mathrm{ma}$, | $f=100 \mathrm{mc}$ |  | 30 | $\Omega$ |

## THERMAL INFORMATION




## 

## DESIGNED FOR USE <br> IN LOW-LEVEL, LOW-NOISE AMPLIFIERS

- Guaranteed Low-Noise Characteristics at $10 \mathrm{~Hz}, 100 \mathrm{~Hz}, 1 \mathrm{kHz}$ and 10 kHz
- High Guaranteed $h_{\text {fe }}$ at
$I_{c}=10 \mu \mathrm{~A} \ldots 250$ Minimum


## *mechaniceal data


*absolute maximum ratings at $\mathbf{2 3 ^ { \circ }} \mathbf{}$ C free-air temperature (unless otherwise noted)


MOTES: 1 . This value applies when the bose-wnition dilide is open-sirculted.
2. Derate limeariy to $200^{\circ} \mathrm{C}$ trea-air temperature at the rate of $\mathbf{2 . 0 6} \mathrm{mW} / \mathrm{deg}$.
3. Derate linserily to $200^{\circ} \mathrm{C}$ cesa temperature at the rate of $6.05 \mathrm{~mW} / \mathrm{dag}$.
*Indicetss JEDEC magistered dato
*electrical charecteristics af $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

*operafing characteristics af $25^{\circ} \mathrm{C}$ free-air temperature

|  | PARAMITER | TEST CONDITIONS |  | MIN MAX | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: |
| $\bar{W}$ | Avercage Motse Figurs | $\begin{aligned} & V_{c:}=5 \mathrm{~V}, \\ & f=10 \mathrm{~Hz}, \end{aligned}$ | $\begin{aligned} & \mathrm{I}_{c}=30 \mu \mathrm{~h}, R_{\epsilon}=10 \mathrm{k} \Omega, \\ & \text { Mokse Bandwidth }=2 \mathrm{~Hz} \end{aligned}$ | 15 | ${ }^{\text {d }}$ |
|  |  | $\begin{aligned} & V_{c:}=5 V_{1} \\ & i=100 \mathrm{~Hz}, \end{aligned}$ | $\begin{aligned} & T_{c}=30 \mu h_{1} \mathrm{R}_{6}=10 \mathrm{k} \Omega, \\ & \text { Molst Bondwidh }=20 \mathrm{~Hz} \end{aligned}$ | 4 | d |
|  |  | $\begin{aligned} & V_{\mathrm{ct}}=5 \mathrm{~V}, \\ & 1=1 \mathrm{kHz}, \end{aligned}$ | $\begin{aligned} & T_{c}=5 \mu \lambda_{1} \Omega_{e}=50 \mathrm{k} \Omega_{1} \\ & \text { Moss gandwidth }=200 \mathrm{~Hz} \end{aligned}$ | 1 | dB |
| MF | Spot Molsa Fipurs | $\begin{aligned} & V_{\mathrm{ct}}=5 V_{1} \\ & 1=10 \mathrm{kHz} \end{aligned}$ | $I_{c}=5 \mu h_{1} \quad R_{8}=50 \mathrm{k} \Omega_{1}$ | 1 | d |




TYPES 2N3244, 2N3245, 2N3467. 2N3468 P-N-P SILICON TRANSISTORS

## DESIGNED FOR HIGH-SPEED CORE-DRIVER APPLICATIONS

- High Dissipation Capability ... 10 Watts at $25^{\circ} \mathrm{C}$ Case Temperature
- High V(BR)ceo ... 50 V Min (2N3245, 2N3468)
- High Speed... 60 ns Max is at $500 \mathrm{~mA}(2 N 3467,2 N 3468)$
- High Collector Current Rating... 1 A
mechanical derta

absolute maximum ratings af $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

|  | 2N3244 | 2N3245 | 2N3467 | 2N3468 | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: |
| Collector-Base Voltage | $-40^{*}$ | $-50^{*}$ | $-40^{*}$ | -50* | $V$ |
| Collector-Emitter Voltage (See Note 1) | $-40^{*}$ | -50* | $-40^{*}$ | -50* | $V$ |
| Emitter-Base Voltage | -5* | -5* | -5* | -5* | V |
| Continuous Collector Current | -1* | -1* | - ${ }^{*}$ | $-{ }^{*}$ | 1 |
| Continuous Device Dissipation af (or below) $25^{\circ} \mathrm{C}$ Free-Air Tomperature (See Note 2) | 1* | 1* | 1* | $1 *$ | W |
| Continuous Device Dissipation af (or below) $25^{\circ} \mathrm{C}$ Case Temperature (See Note 3) | $\begin{gathered} 10^{\dagger} \\ 5^{*} \\ \hline \end{gathered}$ | $\begin{gathered} 10^{\dagger} \\ 5^{\circ} \\ \hline \end{gathered}$ | 10 | 10 | W |
| Storage Temperature Range | -65 to 200* |  |  |  | ${ }^{\circ} \mathrm{C}$ |
| Lead Temperature $\mathrm{K}_{6}$ Inch from Case for 10 Seconds |  |  |  |  | ${ }^{\circ} \mathrm{C}$ |
| Lead Temperoture $K_{6}$ Inch from Case for 60 Seconds | $300^{*}$ |  | $300^{\dagger}$ |  | ${ }^{\circ} \mathrm{C}$ |

NOTES: 1. These values apply between 0 and 1 A collector current when the base-emitter diode is open-circulted.
2. Derate linearly to $200^{\circ} \mathrm{C}$ free-air temperature the rate of $5.71 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$.
3. Derate the 10 -watt Ti value linearly to $200^{\circ} \mathrm{C}$ case temperature at the rate of $57.1 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$. Derate the 5 -watt JEDEC velue linearly to $200^{\circ} \mathrm{C}$ case temperature at the rate $0128.6 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$.

The JEDEC reglstered outline for these devlces is TO-5. TO-39 falls within TO-5 with the exception of lead length.
*JEDEC ragistered data. This data shaet contains all applicable data in effact at the time of publication.
t These values are guaranteed by Texas instruments in addition to the JEDEC regigtered values which are also shown.

## TYPES 2N3244, 2N3245, 2N3467, 2N3468 P-N-P SILICON TRANSISTORS

## *electrical characteristics at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

|  | PARAMETER | TEST CONDITIONS |  | 2N3244 | 2N3245 | 2N3467 | 2N3468 | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  | MIN MAX | MJN MAX | MNN MAX | MIN MAX |  |
| $V_{\text {(1ajcso }}$ | Collactor-Base Breakdown Volfaga | $l_{C}=-10 \mu \mathrm{~A}, \mathrm{I}_{\mathrm{E}}=0$ |  | -40 | -50 | -40 | -50 | V |
| $\mathrm{V}_{\text {(m) } \mathrm{C}=0}$ | Collector-Emitter Breakdown Voltage | $I_{c}=-10 \mathrm{~mA}, I_{z}=0$, | See Note 4 | -40 | -50 | -40 | -50 | $V$ |
| $\mathrm{V}_{\text {(10) }}$ | Emitter-Bose Breakdown Valtage | $\mathrm{I}_{\mathrm{E}}=-10 \mu \mathrm{~h}, \mathrm{l}_{\mathrm{c}}=0$ |  | -5 | -5 | -5 | -5 | $V$ |
| ${ }_{\text {cho }}$ | Collector Cutoff Current | $V_{C t}=-30 \mathrm{~V}, \mathrm{I}_{\mathrm{E}}=0$ |  | -50 |  | -100 | -100 | nA |
|  |  | $V_{C I}=-30 \mathrm{~V}, \mathrm{~L}_{\mathrm{E}}=0, \quad \mathrm{~T}_{\mathrm{A}}=100^{\circ} \mathrm{C}$ |  |  |  | -15 | -15 | $\mu \mathrm{A}$ |
|  |  | $V_{C B}=-50 \mathrm{~V}, \mathrm{I}_{\mathrm{E}}=0$ |  |  | -50 |  |  | nA |
| $L_{\text {cev }}$ | Collector Cutoff Current | $V_{C E}=-30 \mathrm{~V}, \mathrm{Y}_{\text {EE }}=3 \mathbf{V}$ |  | -50 | -50 | -100 | -100 | nA |
| Imev | Base Cutoff Current | $V_{\text {CE }}=-30 \mathrm{~V}, \mathrm{~V}_{\text {EE }}=3 \mathbf{V}$ |  | 80 | 80 | 120 | 120 | nA |
| E*o | Emitter Cutoff Current | $V_{E I}=-4 V_{\text {, }} \quad I_{C}=0$ |  | -30 | -30 |  |  | nA |
| $\mathrm{href}^{\text {f }}$ | Static forword Current Transier Ratio | $V_{\text {ce }}=-1 \mathrm{~V}, \quad \mathrm{Ic}_{\mathrm{c}}=-150 \mathrm{~mA}$ | $\begin{gathered} \text { See } \\ \text { Note } \\ 4 \end{gathered}$ | 60 | 35 | 40 | 25 |  |
|  |  | $V_{C E}=-1 \mathrm{~V}, \quad \mathrm{I}_{\mathbf{C}}=-500 \mathrm{~mA}$ |  | $50 \quad 150$ | $30 \quad 90$ | $40 \quad 120$ | $25 \quad 75$ |  |
|  |  | $\mathrm{V}_{\text {cE }}=-5 \mathrm{~V}, \quad \mathrm{l}_{\mathrm{C}}=-750 \mathrm{~mA}$ |  | 25 |  |  |  |  |
|  |  | $\mathrm{V}_{\mathrm{CE}}=-5 \mathrm{~V}, \quad \mathrm{I}_{\mathrm{C}}=-1 \mathrm{~A}$ |  |  | 20 | 40 | 20 |  |
| $\mathrm{v}_{\text {EE }}$ | Base-Emittar Vohage | $\mathrm{I}_{\mathrm{B}}=-15 \mathrm{~mA}, \quad \mathrm{Ic}_{C}=-150 \mathrm{~mA}$ | $\begin{gathered} \text { See } \\ \text { Note } \\ 4 \end{gathered}$ | -1.1 | -1.1 | -1 | -1 | $V$ |
|  |  | $\mathrm{I}_{\mathrm{B}}=-50 \mathrm{~mA}, \quad \mathrm{I}_{\mathrm{C}}=-500 \mathrm{~mA}$ |  | -0.75-1.5 | -0.75-1.5 | $-0.8-1.2$ | -0.8-1.2 | $V$ |
|  |  | $\mathrm{I}_{\mathrm{g}}=-75 \mathrm{~mA}, \mathrm{t}_{\mathrm{c}}=-750 \mathrm{~mA}$ |  | -2 |  |  |  | V |
|  |  | $\mathrm{I}_{\mathrm{B}}=-100 \mathrm{~mA}, \mathrm{l}_{\mathrm{c}}=-1 \mathrm{~A}$ |  |  | -2 | -1.6 | -1.6 | V $V$ |
| $V_{\text {CE[ }(\text { at })}$ | Collector-Emitter Saturation Voltage | $\mathrm{l}_{1}=-15 \mathrm{~mA}, \mathrm{l}_{\mathrm{c}}=-150 \mathrm{~mA}$ | $\begin{gathered} \text { See } \\ \text { Mote } \\ 4 \end{gathered}$ | -0.3 | -0.35 | -0.3 | -0.35 | $V$ |
|  |  | $\mathrm{I}_{\mathrm{B}}=-50 \mathrm{~mA}, \quad \mathrm{lc}_{\mathrm{c}}=-500 \mathrm{~mA}$ |  | -0.5 | -0.6 | -0.5 | -0.6 | V |
|  |  | $\mathrm{I}_{\mathrm{g}}=-100 \mathrm{~mA}, \mathrm{I}_{\mathrm{c}}=-1 \mathrm{~A}$ |  | -1 | -1.2 | -1 | -1.2 | 2 |
| $\mathrm{f}_{T}$ | Transition Frequency | $V_{C E}=-10 \mathrm{~V}, \mathrm{l}_{\mathbf{c}}=-50 \mathrm{~mA}$, Soe Note 5 |  | 175 | 150 | 175 | 150 | M ${ }^{\text {M }}$ |
| $C_{\text {obo }}$ | Common-Base Open-Gircuit Output Capacitance | $V_{C i}=-10 \mathrm{~V}, \quad \mathrm{I}_{\mathrm{E}}=0$, | $f=100 \mathrm{kHz}$ | 25 | 25 | 25 | 25 | pF |
| $C_{\text {ibo }}$ | Common-Base Open-Circuit Input Capacitance | $\mathrm{V}_{\mathrm{Et}}=-0.5 \mathrm{~V}, \mathrm{~L}_{\mathrm{c}}=0$, | $f=100 \mathrm{kHz}$ | 100 | 100 | 100 | 100 | 0 pF |

HOTES: 4. These parameters must be mossured using pulse techniques. $\mathrm{t}_{\mathrm{p}}=\mathbf{3 0 0} \mu \mathrm{s}$, dury cycle $\leq \mathbf{2 \%}$.
5. To obtain $f_{T}$, the $\left|h_{\text {fol }}\right|$ respense with froquency is extrapotatad at the rate of -6 d per ecteve from $f=100$ mHz to the froquency al which $\left|h_{f_{0}}\right|=1$.
*Indicates JEDEC registered data

## TYPES 2N3244, 2N3245, 2N3467, 2N3468 P-N-P SILICON TRANSISTORS

*swifching characteristics at $25^{\circ} \mathrm{C}$ free-air temperafure

| Parameter | TEST CONDITIONS $\dagger$ | 2N3244 | $\begin{array}{\|c\|} \hline \text { 2N3245 } \\ \hline \text { MAX } \\ \hline \end{array}$ | 2N3467 | $\frac{2 \text { N3468 }}{\text { MAX }}$ | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| $\mathrm{t}_{\mathrm{d}} \quad$ Delay Time | $\begin{aligned} & I_{C}=-500 \mathrm{~mA}, \quad I_{\text {R(1) }}=-50 \mathrm{~mA}, \quad V_{B E(\mathrm{of\mid} \mid}=2 \mathrm{~V}, \\ & R_{L}=59 \Omega, \quad \text { See Figure } 1 \end{aligned}$ | 15 | 15 | 10 | 10 | ns |
| $\mathrm{tr}_{\mathbf{r}} \quad$ Rise Time |  | 35 | 40 | 30 | 30 | ns |
| $t_{5} \quad$ Storage Time | $\begin{aligned} & I_{\mathrm{C}}=-500 \mathrm{~mA}, I_{\&(1)}=-50 \mathrm{~mA}, I_{(\|2\|}=50 \mathrm{~mA}, \\ & R_{L}=59 \Omega, \quad \text { See Figure } 2 \end{aligned}$ | 140 | 120 | 60 | 60 | us |
| $i_{f}$ foll Time |  | 45 | 45 | 30 | 30 | ns |
| Q ${ }_{\text {T }}$ Total Control Charge | $\boldsymbol{v}_{\boldsymbol{c}}=-500 \mathrm{~mA}, \mathrm{I}_{\boldsymbol{s}}=-50 \mathrm{~mA}, \quad$ See Figure 3 | 14 | 12 | 6 | 6 | $n$ |

†Valtages and current volues shown are nominal, exact volues vary slightly wilh transistor patameters. Mominal bose current for delay and rise times is calculated using the minimum values of $\boldsymbol{V}_{\text {BE }}$. Meminal base curronts tor storage and fall times are catculated esing the maximum value of $\boldsymbol{V}_{\mathbf{E E}}$

## *PARAMETER MEASUREMENT INFORMATION



TEST CIRCUIT

figure I - delay and rise times


FIGURE 2-STORAGE AND FALL TIMES
C = 1400 pf for 243244
$c=1200$ of for $2 \mathrm{Na245}$



FIGURE 3 - TOTAL CONTROL ChARGE


OUTPUT
NOTE: $Q_{T}$ is less than the specified
maximum value when the transistor
turns off monotonically as shown
by the solid line.
VOLTAGE WAVEFORMS

MOTES: ©. The input waveforms heve the following cherecteristics:
Fer maosuring delay and rise timas: $\mathrm{t}_{\mathrm{r}} \leq \mathbf{2 n s}, \mathrm{t}_{\mathrm{p}}=\mathbf{2 0 0} \mathrm{ns}$, duly cycle $=\mathbf{2 \%}$.
For measuring slorage and fall timess $t_{f} \leq 5 \mathrm{~ns}$, $\mathrm{t}_{\mathrm{p}}=2$ to $500 \mu \mathrm{~s}$, duty cycle $=\mathbf{2 \%}$.
For messuring $Q_{T}: t_{f} \leq 10 \mathrm{~ns}, \mathrm{t}_{\mathrm{p}}=10 \mu \mathrm{~s}$, duty cycle $=\mathbf{2} \%$
b. Waveforms are meniterad on on oselloscope with the follewing choracteristics: $\mathrm{t}_{\mathrm{r}} \leq \mathbf{1 m s}, \mathbb{R}_{\text {in }} \geq 100 \mathrm{kN}, \mathrm{c}_{\mathrm{in}} \leq \mathbf{7 p F}$.
*Indicates JEDEC registered deta

## FAST, HIGH-CURRENT CORE DRIVER

- hFE . . . Guaranteed from 150 mA to 1 A
- V(BR)CEO ... 40 V
- VBE and VCE(sat) . . . Guaranteed from 150 mA to 1 A
- Guaranteed Switching Time at $\mathbf{5 0 0} \mathbf{~ m A}$
mechanical data


NC-No internal connection

absolute maximum ratings at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)


NOTES: 1. This value applies between 0 and 1 A colibetor current when the emitter-base diode is open-circulted.
2. Derate linearly to $150^{\circ} \mathrm{C}$ froe-air temperature at the rates of $4 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$ for each triode and $\mathbf{1 2} \mathrm{mW} / \mathrm{C}$ for the total device.

[^68]
## TYPE Q2T3244 <br> QUAD P-N-P EPITAXIAL PLANAR SILICON TRANSISTOR

electrical characteristics at $\mathbf{2 5} \mathbf{}{ }^{\circ} \mathrm{C}$ free-air temperature

| PARAMETER | TEST CONDITIONS |  | MIN . MAX | $\begin{array}{\|c\|} \hline \text { UNITT } \\ \hline V \\ \hline \end{array}$ |
| :---: | :---: | :---: | :---: | :---: |
| $V_{\text {(BRI) }}$ CBO Collector-Base Breakdown Voltage | $I^{\prime} C=-10 \mu A, \quad I^{\prime}=0$ |  | -40 |  |
| $V_{\text {(BR)CEO }}$ Collector-Emitter Breakdown Voltage | $\mathrm{I}^{\prime}=-10 \mathrm{~mA}, \quad \mathrm{I}_{\mathrm{B}}=0$, | See Note 3 | -40 | V |
| $V_{\text {(BR)EBO }}$ Emitter-Base Breakdown Voltage | $\mathrm{I}_{\mathrm{E}}=-10 \mu \mathrm{~A}, \quad \mathrm{I}_{\mathrm{C}}=0$ |  | -5 | V |
| ${ }^{\text {I CBO }}$ Collector Cutoff Current | $V_{C B}=-30 \mathrm{~V}, \mathrm{I}_{\mathrm{E}}=0$ |  | -50 | nA |
| TCEV Collector Cutoff Current | $\mathrm{V}_{C E}=-30 \mathrm{~V}, \mathrm{~V}_{\mathrm{BE}}=3 \mathrm{~V}$ |  | -50 | nA |
| IBEV Base Cutoff Current | $V_{C E}=-30 \mathrm{~V}, V_{B E}=3 \mathrm{~V}$ |  | 80 | nA |
| ${ }^{\text {IEBO }}$ Emitter Cutoff Current | $\mathrm{V}_{\mathrm{EB}}=-4 \mathrm{~V}, \quad \mathrm{I}_{\mathrm{C}}=0$ |  | -30 | $n A$ |
| Static Forward Current Transfer Ratio | $V_{C E}=-1 \mathrm{~V}, \quad \mathrm{I}_{\mathrm{C}}=-150 \mathrm{~mA}$ | See Note 3 | 60 |  |
|  | $V_{C E}=-1 \mathrm{~V}, \quad I_{C}=-500 \mathrm{~mA}$ |  | $50 \quad 150$ |  |
|  | $V_{C E}=-5 \mathrm{~V}, \quad \mathrm{I}_{\mathrm{C}}=-750 \mathrm{~mA}$ |  | 25 |  |
| Base-Emitter Voltage | $\mathrm{I}_{B}=-15 \mathrm{~mA}, \quad \mathrm{I}_{C}=-150 \mathrm{~mA}$ | See Note 3 | -1.1 | $V$ |
|  | $\mathrm{I}_{\mathrm{B}}=-50 \mathrm{~mA}, \quad \mathrm{I}_{\mathrm{C}}=-500 \mathrm{~mA}$ |  | -0.75-1.5 |  |
|  | $\mathrm{I}_{\mathrm{B}}=-75 \mathrm{~mA}, \quad \mathrm{I}_{\mathrm{C}}=-750 \mathrm{~mA}$ |  | -2 |  |
| Collector-Emitter Saturation Voltage | $\mathrm{I}_{\mathrm{B}}=-15 \mathrm{~mA}, \quad \mathrm{I}_{\mathrm{C}}=-150 \mathrm{~mA}$ | See Note 3 | -0.3 | V |
|  | $\mathrm{I}_{B}=-50 \mathrm{~mA}, \quad \mathrm{I}_{C}=-500 \mathrm{~mA}$ |  | -0.5 |  |
|  | $\mathrm{I}_{B}=-100 \mathrm{~mA}, \mathrm{I}_{C}=-1 \mathrm{~A}$ |  | -1 |  |
| Hfe\|Small-Signal Common-Emitter <br> Forward Current Transfer Ratio | $V_{C E}=-10 \mathrm{~V}, \mathrm{I}^{\prime}=-50 \mathrm{~mA}$, | $f=100 \mathrm{MHz}$ | 1.75 |  |
| Cobo Common-Base Open-Circuit Output Capacitance | $\mathrm{V}_{C B}=-10 \mathrm{~V}, \mathrm{I}_{\mathrm{E}}=0$, | $\mathrm{f}=1 \mathrm{MHz}$ | 25 | pF |
| Cibo Common-Base Open-Circuit Input Capacitance | $\mathrm{V}_{\mathrm{EB}}=-0.5 \mathrm{~V}, \mathrm{I}^{\prime} \mathrm{C}=0$. | $f=1 \mathrm{MHz}$ | 100 | pF |

NOTE 3: These parameters must be measured using puise techniques. $t_{w}=300 \mu \mathrm{~s}$, duty cycle $\leqslant 2 \%$.

## switching characteristics at $25^{\circ} \mathrm{C}$ free-air temperature

| PARAMETER |  | TEST CONDITIONS ${ }^{\dagger}$ |  | MAX | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: |
| td | Delay Time | $\mathrm{I}_{\mathrm{C}}=-500 \mathrm{~mA}, \mathrm{I}$ | $\mathrm{I}_{\mathrm{B}(1)}=-50 \mathrm{~mA}, \mathrm{~V}_{\mathrm{BE}}(\mathrm{off})=2 \mathrm{~V}$. | 15 | ns |
| $t_{r}$ | Rise Time | $\mathrm{R}_{\mathrm{L}}=59 \mathrm{\Omega}$, $\quad$ S | See Figure 1 | 35 | ns |
| $\mathrm{t}_{5}$ | Storage Time | ${ }^{\prime} \mathrm{C}=-500 \mathrm{~mA}$, 1 | $I_{B(1)}=-50 \mathrm{~mA}, \mathrm{I}_{\mathrm{B}(2)}=50 \mathrm{~mA}$, | 140 | ns |
| $\mathrm{tif}_{\text {f }}$ | Fall Time | $R_{L}=59 \Omega, \quad S$ | See Figure 2 | 45 | ns |

tVoltages and current values shown are nominal; exact values vary slightly with transistor parameters. Nominal base current for delay and rise time is calculated using the minimum values of $V_{B E}$. Nominal base currents for storage and fall times are calculated using the maximum value of $V_{\mathrm{BE}}$.


NOTES: a. The input waveforms have the following characteristics:
For measuring delay and rise times: $\mathrm{t}_{\mathbf{r}} \leqslant 2 \mathrm{~ns}, \mathrm{t}_{\mathbf{w}}=200 \mathrm{~ns}$, duty cycle $=\mathbf{2 \%}$.
For measuring storage and fall times: $\mathrm{t}_{\mathrm{f}} \leqslant 5 \mathrm{~ns}, \mathrm{t}_{\mathrm{w}}=\mathbf{1 0}$ to $\mathbf{5 0 0} \mu \mathrm{s}$, duty cycle $=\mathbf{2 \%}$.
b. Waveforms are monitored on an oscilloscope with the following characteristics: $t_{r} \leqslant 1 \mathrm{~ns}, \mathrm{R}_{\mathrm{in}} \geqslant 100 \mathrm{k} \Omega, \mathrm{C}_{\mathrm{in}} \leqslant 7 \mathrm{pF}$.

## DESIGNED FOR LOW-POWER SATURATED-SWITCHING AND AMPLIFIER APPLICATIONS - Low-Level $h_{\text {FE }}$ : $\mathbf{8 0}$ Min of $100 \mu A$ (2N3251 and 2N3251A)

*mechanical dafa

*absolute maximum ratings of $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

*electrical characteristics at $25^{\circ} \mathrm{C}$ free-air temperature

\begin{tabular}{|c|c|c|c|c|c|c|}
\hline PARAMETER \& TEST CONDITIONS \&  \& \[
\begin{aligned}
\& 2 \mathrm{~N} 3250 \mathrm{~A} \\
\& \mathrm{MINMAX}
\end{aligned}
\] \& \[
\begin{aligned}
\& 2 \mathrm{~N} 325! \\
\& \hline \mathrm{MIN} M A X \\
\& \hline
\end{aligned}
\] \& \[
\begin{aligned}
\& \text { 2N3251A } \\
\& \hline \text { MIN MAX } \\
\& \hline
\end{aligned}
\] \& UNIT \\
\hline \(V_{\text {Iax) }}\) cso Collector-Base Breakdown Voltage \& \(\mathrm{I}_{\mathrm{c}}=-10 \mu \Lambda, I_{E}=0\) \& -50 \& -60 \& -50 \& \(-60\) \& \(V\) \\
\hline \(V_{\text {(Ra|CEO }}\) Collector-Emittar Breokdown Voltage \& \(\mathrm{I}_{\mathrm{C}}=-10 \mathrm{~mA}, \mathrm{I}_{\mathrm{g}}=0, \quad\) See Mote 4 \& \(-40\) \& -60 \& -40 \& -60 \& \(V\) \\
\hline \(V_{\text {(m) }}\) EEO Emitter-Base Broakdown Voltage \& \(\mathrm{I}_{\mathrm{E}}=-10 \mu \mathrm{~A}, \mathrm{I}_{C}=0\) \& -5 \& -5 \& -5 \& -5 \& \(V\) \\
\hline ICev Collector Cutoff Current \& \(V_{C E}=-40 \mathrm{~V}, V_{\text {IE }}=3 \mathrm{~V}\) \& -20 \& -20 \& -20 \& -20 \& nA \\
\hline Inev Base Cutoff Current \& \(\mathrm{V}_{\text {CE }}=-40 \mathrm{~V}, \mathrm{~V}_{\text {KE }}=3 \mathrm{~V}\) \& 50 \& 50 \& 50 \& 50 \& nA \\
\hline \multirow{4}{*}{\(h_{\text {fe }} \quad\) Static For} \& \(V_{\text {CE }}=-1 \mathrm{~V}_{1} \quad \mathrm{I}_{\mathrm{C}}=-0.1 \mathrm{~mA}\) \& 40 \& 40 \& 80 \& 80 \& \\
\hline \& \(V_{C E}=-1 \mathrm{~V}, \mathrm{I}_{\mathrm{C}}=-1 \mathrm{~mA}\) Soe \& 45 \& 43 \& 90 \& 90 \& \\
\hline \& \(V_{C E}=-1 \mathrm{~V}, \mathrm{I}_{\mathrm{C}}=-10 \mathrm{~mA}\) \& \(50 \quad 150\) \& \(50 \quad 150\) \& 100300 \& \(100 \quad 300\) \& \\
\hline \& \(\mathrm{V}_{\text {CE }}=-1 \mathrm{~V}, \quad \mathrm{I}_{\mathrm{C}}=-50 \mathrm{~mA}\) \& 15 \& 15 \& 30 \& 30 \& \\
\hline \multirow[t]{2}{*}{Base-Emitter Voltage} \& \(\mathrm{I}_{\mathrm{B}}=-1 \mathrm{~mA}, \quad \mathrm{I}_{C}=-10 \mathrm{~mA}\) See \& -0.6-0.9 \& -0.6-0.9 \& \(-0.6-0.9\) \& -0.6-0.9 \& \(V\) \\
\hline \& \(\mathrm{I}_{1}=-5 \mathrm{~mA}, \mathrm{I}_{c}=-50 \mathrm{~mA}\) See \& -1.2 \& -1.2 \& -1.2 \& -1.2 \& \(V\) \\
\hline \multirow[t]{2}{*}{Collector-Emiltar Saturation Voltage} \& \(\mathrm{I}_{\mathrm{E}}=-1 \mathrm{~mA}, \mathrm{I}_{C}=-10 \mathrm{~mA}\), \& -0.25 \& -0.25 \& -0.25 \& -0.25 \& \(V\) \\
\hline \& \(\mathrm{I}_{\mathrm{B}}=-5 \mathrm{~mA}, \quad \mathrm{I}_{\mathrm{C}}=-50 \mathrm{~mA}\) \& -0.5 \& -0.5 \& -0.5 \& -0.5 \& \(V\) \\
\hline \begin{tabular}{ll}
\hline hie \(\quad\)\begin{tabular}{l} 
Small-Signal Common-Emittor \\
Input Impedance
\end{tabular} \\
\hline her
\end{tabular} \& \multirow[t]{4}{*}{\(V_{\text {CE }}=-10 \mathrm{~V}\),
\(\mathrm{I}_{\mathrm{C}}=-1 \mathrm{~mA}\),

$f=1 \mathrm{kHz}$} \& 16 \& 16 \& 212 \& 212 \& $\mathrm{k} \Omega$ <br>

\hline | $h_{\text {to }}$ | Small-Signal Common-Emitter <br> Forward Current Tronsfor Ratio |
| :--- | :--- | \& \& $50 \quad 200$ \& $50 \quad 200$ \& 100400 \& 100400 \& <br>


\hline | $h_{r s}$ | $\left.\begin{array}{l}\text { Small-Signal Common-Emitter } \\ \text { Roverse Voltage Transfor Ratio }\end{array}\right]$ |
| :--- | :--- | \& \& \[

$$
\begin{gathered}
10 x \\
10^{-1} \\
\hline
\end{gathered}
$$

\] \& \[

$$
\begin{aligned}
& 10 x \\
& 10^{-4} \\
& \hline
\end{aligned}
$$

\] \& \[

$$
\begin{gathered}
20 x \\
10^{-4} \\
\hline
\end{gathered}
$$

\] \& \[

$$
\begin{aligned}
& 20 \mathrm{x} \\
& 10^{-4} \\
& \hline
\end{aligned}
$$
\] \& <br>

\hline $h_{\infty} \quad$ Small-signal Common-Emittor \& \& \& 440 \& $10 \quad 60$ \& $10 \quad 60$ \& $\mu \mathrm{mho}$ <br>
\hline
\end{tabular}

NOTES: 1. These veiues apply botween 0 and 200 mA celiector current when the bese-amilter diede is open-lircultod.
2. Derate linearly to $200^{\circ} \mathrm{C}$ frev-air temperalure at the rete of $2.06 \mathrm{mw} / \mathrm{deg}$.
3. Derate lineerly to $200^{\circ} \mathrm{C}$ case temperature at the rate of $6.9 \mathrm{~mW} / \mathrm{deg}$.
4. These parameters must be measured wing pulse techniqus. $\mathrm{I}_{\mathrm{p}}=\mathbf{3 0 0} \mu$ s, duty cycle $\leq \mathbf{2 \%}$.

## TYPES 2N3250, 2N3250A, 2N3251, 2N3251A P-N-P SILICON TRANSISTORS

*electrical characteristics at $25^{\circ} \mathrm{C}$ free-air temperafure (continued)

| PARAMETER |  | TEST CONDITIONS | $\begin{array}{r} 2 N 3250 \\ 2 \mathrm{~N} 3250 \mathrm{~A} \\ \hline \end{array}$ | $\begin{array}{r} 2 N 3251 \\ \text { 2N3251A } \\ \hline \end{array}$ | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | MIN MAX | MIN MAX |  |
| \|htol | Small-Signal Common-Emitter Forward Current Transfer Rafio |  | $V_{c E}=-20 \mathrm{~V}, \mathrm{I}_{\mathbf{c}}=-10 \mathrm{~mA}, \mathrm{I}=100 \mathrm{MHz}$ | 2.5 | 3 |  |
| $\mathrm{fr}_{1}$ | Transition Frequency | $\mathrm{V}_{C E}=-20 \mathrm{~V}, \mathrm{I}_{\mathrm{C}}=-10 \mathrm{~mA}$, See Hote 5 | 250 | 300 | MHz |
| $C_{\text {obo }}$ | Common-Base Opan-Circuit Output Capacitance | $V_{C B}=-10 \mathrm{~V}, \mathrm{I}_{\mathrm{E}}=0, \quad 1=100 \mathrm{kHz}$ | 6 | 6 | pf |
| $C_{i b o}$ | Common-Base Open-Circuit Input Capacitance | $V_{E t}=-\mathrm{IV}, \quad \mathrm{I}_{\mathbf{c}}=0, \quad \mathrm{f}=100 \mathrm{kHz}$ | 8 | 8 | pf |
| $\mathrm{r}_{\mathrm{b}} \mathrm{C}_{\mathrm{c}}$ | Collector-Base Time Constant | $V_{C E}=-20 \mathrm{~V}, \mathrm{I}_{\mathrm{C}}=-10 \mathrm{~mA}, f=31.8 \mathrm{mHz}$ | 250 | 250 | ps |

NOTE 5: To obtain $f_{T}$, the $\left|h_{\text {fel }}\right|$ respanse with frequency is extrapolated at the rate of -6 die per octave from $f=100 \mathrm{MHz}_{2}$ to the frequancy at which $\left|\boldsymbol{h}_{\mathrm{fo}}\right|=\mathbf{1}$.
*operafing characteristics at $25^{\circ} \mathrm{C}$ free-air temperature

| PARAMETER | TEST CONDITIONS | $\begin{array}{r} 2 \mathrm{~N} 3250 \\ 2 \mathrm{~N} 3250 \mathrm{~A} \\ \hline \end{array}$ | $\begin{array}{r} 2 \mathrm{~N} 3251 \\ 2 \mathrm{~N} 3251 \mathrm{~A} \\ \hline \end{array}$ | UNiT |
| :---: | :---: | :---: | :---: | :---: |
|  |  | MAX | MAX |  |
| NF Spot Noise Figure | $V_{C E}=-5 \mathrm{~V}, \mathrm{I}_{C}=-100 \mu \mathrm{~A}, \mathrm{R}_{G}=1 \mathrm{k} \Omega, f=100 \mathrm{~Hz}$ | 6 | 6 | dB |

*switching characteristics at $25^{\circ} \mathrm{C}$ free-air temperature

| PARAMETER |  | TEST CONDITIONS $\dagger$ | $\begin{gathered} 2 \mathrm{~N} 3250 \\ 2 \mathrm{~N} 3250 \mathrm{~A} \\ \hline \end{gathered}$ | $\begin{aligned} & 2 N 3251 \\ & 2 N 3251 \mathrm{~A} \\ & \hline \end{aligned}$ | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | MAX | MAX |  |
| $t_{d}$ | Delay Time |  | $I_{C}=-10 \mathrm{~mA}, I_{B(1]}=-1 \mathrm{~mA}, V_{\text {EE (ff }}=0.5 \mathrm{~V},$$R_{L}=275 \Omega, \text { See figure } 1$ | 35 | 35 | ns |
| $t_{r}$ | Rise Time | 35 |  | 35 | ns |
| $\mathrm{t}_{5}$ | Storage Time | $\begin{aligned} & I_{C}=-10 \mathrm{~mA}, I_{8(1)}=-1 \mathrm{~mA}, I_{[(2)}=1 \mathrm{~mA}, \\ & R_{L}=275 \Omega, \text { See figure } 2 \end{aligned}$ | 175 | 200 | ns |
| $t_{f}$ | Foll Time |  | 50 | 50 | ns |

tYoltage and current valuas shown are naminal; exact values very slightly with transistor parameters. Nominal base surrent for delay and rise fimes is calculated using the minimum value of $\mathbf{V}_{\mathrm{gE}}$. Nominal base currents for storage ond foll times are calculated using the maximum value of $\mathrm{V}_{\mathrm{BE}}$.
*PARAMETER MEASUREMENT INFORMATION

test cincuit


VOLTAGE WAVEFORMS


VOLIAGE WAVEFORMS
FIOURE 2-\$TORAGE AND FALL TIMES

MOTES; a. The input waveforms are supplied by a gonorator with the following charactatstics: $z_{\text {out }}=50 \Omega$, duty cycle $=\mathbf{2 \%}$.
b. Waviforms are monitorat on on oscillostope with the following characteristics: $\mathbf{t}_{\mathrm{r}} \leq 1 \mathrm{~ns}, \mathbf{R}_{\text {in }} \geq 100 \mathrm{kR}$.
*Indicalos JEDEC registorod defe

## TYPES 2N3252, 2N3253 N-P-N SILICON TRANSISTORS

DESIGNED FOR HIGH-SPEED, HIGH-CURRENT SWITCHING APPLICATIONS

## mechanical data

|  |  | $\sqrt{q \rightarrow p}$ |
| :---: | :---: | :---: |

absolute maximum ratings at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)


## *electrical charactoristics at $\mathbf{2 5}{ }^{\circ} \mathrm{C}$ free-air temperature (unless otherwiso noted)

| Paramitir | TEST CONDITIONS | 2N3] 5 | 2N3239 | UNIT |
| :---: | :---: | :---: | :---: | :---: |
|  |  | MIN MAX | MIN MaX |  |
|  | $I_{c}=10 \mu \mathrm{a}, h_{1}=0$ | 60 | 75 | $v$ |
| $V_{\text {Imicto }}$ Collocior-Emittor Irueksown Vohape | $\mathrm{l}_{\mathrm{c}}=10 \mathrm{mo}, \mathrm{l}_{\mathrm{B}}=0, \quad$ S00 Note 4 | 30 | 40 | $\checkmark$ |
| Vimysio Emitter-bose Erackiown Yelioue | $l_{1}=10 \mu \mathrm{a}, l_{C}=0$ | 5 | 5 | $v$ |
| Coilector Culoff Current | $V_{C I}=40 y_{0} I_{1}=0$ | 0.5 |  | $\mu$ |
|  | $V_{\text {c! }}=60 \mathrm{v}, \mathrm{l}_{1}=0$ |  | 0.5 | $\mu \mathrm{A}$ |
|  | $V_{C!}=40 v_{1} I_{E}=0, \quad T_{A}=+100^{\circ} \mathrm{C}$ | 75 |  | 只 |
|  | $V_{C!}=60 v_{1} l_{E}=0, \quad t_{A}=+100^{\prime} \mathrm{C}$ |  | 75 | $\mu$ |
| Colicter Cuthef Currant | $V_{\text {Ci }}=40 v_{1} V_{v_{2}}=-4 v$ | 0.5 |  | $\mu$ |
|  |  |  | 0.5 | $\mu 0$ |
| Hase Curoff Curnem | $V_{e l}=40 v_{1} V_{m}=-4 v$ | -0.5 |  | $\mu{ }^{\prime \prime}$ |
|  | $V_{C E}=60 v_{1}, V_{w}=-4 v$ |  | -0.5 | $\mu$ |
| IERO Emither Cutoff Curront | $V_{\text {EI }}=4 v_{0} \quad l_{c}=0$ | 50 | 50 | n |
| Statit Ferward Curreal Trumster latio | $Y_{\text {ce }}=1 v_{1}, l_{c}=150 \mathrm{mg}$ Sem | 30 | 25 |  |
|  | $V_{c_{B}}=1 v_{1} \quad I_{c}=500 \mathrm{mad}$ Noth | 30 | $25 \quad 75$ |  |
|  | $\begin{array}{ll}V_{\text {ce }}=5 v_{1} & l_{c}=10\end{array}$ | 25 | 20 |  |
| Tass-Emittor Yollope |  | 1 | 1 | $V$ |
|  | $\mathrm{I}_{\mathrm{E}}=50 \mathrm{mo}, \mathrm{I}_{\mathrm{c}}=500 \mathrm{man}$ ( mot | $0.7-1.3$ | $0.7-1.3$ | $\checkmark$ |
|  | $l_{1}=100 \mathrm{ma}, l_{c}=10 \quad 4$ | 1.8 | 1.8 | $v$ |
| Collector-Enifiter Sonurrotion Voltage |  | 0.3 | 0.35 | $v$ |
|  | $I_{1}=50 \mathrm{ma}, I_{c}=500 \mathrm{ma}$ ( Wote | 0.5 | 0.6 | $v$ |
|  | $\mathrm{I}_{\mathrm{s}}=100 \mathrm{mo}, l_{c}=1 \mathrm{a}$, 4 | 1 | 1.2 | $V$ |
| If Transition Pruquacy | $V_{c s}=10 r, l_{c}=50 \mathrm{me}$, sen Mofte 5 | 200 | 175 | $\underline{\square}$ |
| Commen-Eate Opan-Grait <br> Outpul Copactionse | $Y_{C B}=10 y_{i} l_{1}=0, \quad i=100 \mathrm{ks}$ | 12 |  | 南 |
|  | $V_{C i}=20 \mathrm{v}, \mathrm{l}_{1}=0, \quad i=100 \mathrm{kt}$ |  | 12 | 1 |
| $\text { Ciso } \begin{aligned} & \text { Commen-Daw Open-Oitrail } \\ & \text { Inpet Copactionce } \end{aligned}$ | $v_{1 t}=0.5 \mathrm{v}, \mathrm{l}_{\mathrm{c}}=0, \quad f=100 \mathrm{ht}$ | 60 | 0 | A |

NOTES: 1. This value appliee between 0 and 1 a collector euprent when the bese-emitter diode is open-cirouited.
2. Derate IInearly to $200^{\circ} \mathrm{C}$ free-sir temperature at the rate of $\mathrm{B} .71 \mathrm{mw} /{ }^{\circ} \mathrm{C}$.
3. Derate the 10 -watt rating linearly to $200^{\circ} \mathrm{C}$ case temparature at the rate of $57.1 \mathrm{mw} /{ }^{\circ} \mathrm{C}$. Derate the B -watt (JEDEC regirtared) rating linearly to $200^{\circ} \mathrm{C}$ case temperature at the rate of $28.6 \mathrm{mw} /{ }^{\circ} \mathrm{C}$.
4. These parameters must be masured using pulse techniquen, PW $=\mathbf{3 0 0} \mu$ sec, Duty Cycle $<\mathbf{2 \%}$
6. To obtain ${ }^{\dagger}$ T, the $\mathrm{M}_{\mathrm{f}}$ | reeponse with frequency t extrapolated at the rate of -6 db per octeve from $\mathrm{f}=100 \mathrm{Mc}$ to the frequency at which $\left.\right|_{\text {fal }} \mid=1$.
*The JEDEC registered outline for these devices ls TO-5. TO-39 falls within TO-5 with the exception of lead length.
-JEDEC registered data. This data sheet containe all applicable registered data in effect at the time of publication.
TThis velue is guaranteed by Texas instruments in addition to the JEDEC registered value which is also shown.

## N-P-N SILICON TRANSISTORS

*switching characteristics $\mathbf{a t} 25^{\circ} \mathrm{C}$ free-air temperature

| PARAMETER | TEST CONDITIONS $\dagger$ | 2N3232 | 2N3253 | UNIT |
| :---: | :---: | :---: | :---: | :---: |
|  |  | MAX | MAX |  |
| $\mathrm{t}_{\text {d }}$ Delay Time |  | 15 | 15 | nsee |
| $t_{r} \quad$ Rise Time |  | 30 | 35 | nser |
| $t_{3} \quad$ Storuge Time | $\begin{aligned} & I_{c}=500 \mathrm{ma}, \quad l_{\text {ma1 }}=--_{x_{(2)}}=50 \mathrm{ma}, \\ & R_{L}=59 \Omega, \quad \text { Soe Figure } 2 \end{aligned}$ | 40 | 40 | nsoc |
| $\mathrm{t}_{1} \quad$ Fall Time |  | 30 | 30 | nser |
| Of $^{\text {T }}$ Total Control Charge | $\mathrm{I}_{\mathrm{c}}=500 \mathrm{ma}, \mathrm{I}_{\mathrm{s}}=50 \mathrm{ma}$, Soe Figure 3 | 5 | 5 | ncb |



## *PARAMETER MEASUREMENT INFORMATION



TEST CIRCUIT
figure 1 - delay and rise times


TEST CIRCUIT
NOTE: $Q_{T}<5$ neb whan the transistor turns off monotonically as shown by the solid line.
FIGURE 3 - TOTAL CONTROL CHARGE
WOTES: a. The iaput wevoforms hews the fillowing chercateristics
For meosuring dolay ond rise times; $\mathrm{I} \leq \mathbf{2}$ noce, PW $\geq \mathbf{2 0 0}$ nucc, Duty cyclo $\leq \mathbf{2 \%}$.


 *Indicates JEDEC sagistored data

# TYPES 2N3329 THRU 2N3332 P-CHANNEL SILICON JUNCTION FIELD-EFFECT TRANSISTORS 

## FOR SMALL-SIGNAL, LOW-NOISE APPLICATIONS

## - Active Elements Insulated from Case

- High Input Impedance ( $>5$ megohms af 1 kc )


## *mochenical data


*absolute maximum rarings $\mathbf{a t} \mathbf{2 5}{ }^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

*electrical characteristics at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

| PARAMETER |  | TEST CONDITIONS $\dagger$ |  | 2N3329 |  | 2N3330 |  | 2N3331 |  | 2N3332 |  | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | MIN | MAX | MIN | MAX | MIN | MAX | MIN | MaX |  |
| $V_{\text {(ER) }}$ gss | Gato-Source Breakdown Voltage |  |  | $\mathrm{I}_{6}=10 \mu 0^{\prime}$ | $V_{\text {DS }}=0$ | 20 |  | 20 |  | 20 |  | 20 |  | $V$ |
| Igss | Gate Cutoff Current | $\mathbf{v}_{6 S}=10 \mathrm{v}_{\text {g }}$ | $v_{D S}=0$ |  | 0.01 |  | 0.01 |  | 0.01 |  | 0.01 | $\mu$ |
| 'gess | Gate Cutoff Curient | $\mathbf{V}_{\text {GS }}=10 \mathrm{v}$, | $\begin{aligned} & V_{D S}=0, \\ & T_{A}=150^{\circ} \mathrm{C} \end{aligned}$ |  | 10 |  | 10 |  | 10 |  | 10 | $\mu$ |
| ${ }^{\text {D Dionl }}$ | Lero-Gate-Voltage Drain Current | $\mathrm{V}_{\mathrm{DS}}=-10 \mathrm{v}^{\text {, }}$ | $\mathrm{v}_{6 S}=0$ | -1 | $\rightarrow$ | -2 | -6 | -5 | -15 | -1 | -6 | me |
| $V_{6 S}$ | Goto-Source Cwiff Yoltoge | $y_{\text {DS }}=-15 y_{0}$ | $\mathrm{i}_{\mathrm{D}}=-10 \mu \mathrm{a}$ |  | 5 |  | 6 |  | 8 |  | 6 | $V$ |
| ${ }^{\text {r }}$ S | Static Drain-Source Resistonce | $\mathrm{l}_{\mathrm{D}}=-100 \mu \mathrm{a}$, | $\mathrm{V}_{\mathrm{GS}}=0$ |  | 1000 |  | 300 |  | 600 |  |  | dhm |
| $\left\|y_{\text {is }}\right\|$ | Small-Signal Common-Source Input Admittance | $\begin{aligned} & V_{D S}=-10 \mathrm{v}, \quad I_{D}-S_{\text {See Mote 2 }} \\ & f=1 \mathrm{kc} \end{aligned}$ |  |  | 0.2 |  | 0.2 |  | 0.2 |  | 0.2 | $\mu \mathrm{m} k$ ¢ |
| $\left\|y_{t s}\right\|$ | Small-Signal Common-Source Forward Transfer Admittanca |  |  | 1000 | 2000 | 1500 | 3000 | 2000 | 4000 | 1000 | 2200 | $\mu \mathrm{mme}$ |
| $\left\|y_{r s}\right\|$ | Small-Signal Common-Source Reverse Ironsfor Admiltance |  |  |  | 0.1 |  | 0.1 |  | 0.1 |  | 0.1 | $\mu \mathrm{nmbo}$ |
| \|ros ${ }_{\text {os }}$ \| | Small-Signal Commen-Source Output Admittance |  |  |  | 20 |  | 40 |  | 100 |  | 20 | $\mu \mathrm{mmb}$ |
| $\left\|y_{\text {fs }}\right\|$ | Small-Signal Common-Source Forward Iransfer Admithanca | $\begin{aligned} & V_{D S}=-10 \mathrm{r} \\ & \mathrm{f}=10 \mathrm{mc} \end{aligned}$ | $I_{D}-S_{000} \text { Mose } 2_{0}$ | 900 |  | 1350 |  | 1800 |  | 900 |  | $\mu \mathrm{mmb}$ |
| $\mathrm{c}_{\text {is }}$ | Common-Source Short-Circuif Input Capacifance | $\begin{aligned} & v_{D S}=-10 v_{1} \\ & f=1 M c \end{aligned}$ | $\mathbf{v}_{\mathbf{G S}}=\mathrm{I} \mathbf{v}$ |  | 20 |  | 20 |  | 20 |  | 20 | - ${ }^{\text {d }}$ |

*operating characteristics at $25^{\circ} \mathrm{C}$ free-air temperature

| Spot Moise Figure | $\begin{aligned} & \begin{array}{l} \mathrm{vSS}_{\mathrm{DS}}=-5 \mathrm{v}, \\ \mathrm{i}=1 \mathrm{kc}, \end{array} \end{aligned}$ | $\begin{aligned} & 1_{p}=-1 \mathrm{mo} \\ & \mathrm{~s}_{6}=1 \mathrm{~m} \mathrm{\Omega} \\ & \hline \end{aligned}$ | 3 | 3 | 4 | 1 | ¢ |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | $\begin{aligned} & y_{\mathrm{os}}=-5 \mathrm{v}, \\ & =10 \mathrm{cps}, \end{aligned}$ | $\begin{aligned} & T_{0}=-1 \mathrm{ma} \\ & \mathrm{R}_{6}=10 \mathrm{mn} \end{aligned}$ |  |  |  | 5 | db |

NOTE 1: Derate linearly to $175^{\circ} \mathrm{C}$ frea-air temperature at the rate of $2 \mathrm{mw} / \mathrm{C}^{\circ}$.

|  | $2 \times 3329$ | $2 N 3330$ | $2 N 3331$ | $2 N 3332$ |
| :---: | :---: | :---: | :---: | :---: |
| NOTE 2: $\mathrm{I}_{\mathrm{D}}=$ | -1 ma | -2 ma | -5 mu | -1 ma |

$\dagger$ The fourth lead (case) is connected to the source for all meosurements.
*indicates JEDEC registered data.

## TYPES 2N3347 THRU $2 N 3352$ DUAL P-N-P SILICON TRANSISTORS

## TWO P-N-P TRANSISTORS IN ONE PACKAGE

- Each Triode Electrically Similar to 2N2604 and 2N2605 Transistors
- Recommended for Low-Noise, High-Gain Differential Amplifiers
- Designed for Complementary Use with 2N2639 through 2N2644 Dual N.P-N Transistors

*absolute maximum ratings at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)
EACH
TOTAL

NOTES: 1. This value applies when the base-emitter ciode is open-circuited.
2. Derate linearly to $175^{\circ} \mathrm{C}$ free-air temperature at the rates of $2 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$ for each triode and $4 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$ for total device.
3. Derate linearly to $175^{\circ} \mathrm{C}$ case temperature at the rates of $4 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$ for each triode and $8 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$ for total device.

JEDEC repistered data. This dste sheat contains all applicable registered data in affect at the time of publication.

## TYPES 2N3347 THRU 2N3352 DUAL P-N-P SILICON TRANSISTORS

## *electrical characteristics at $\mathbf{2 5 ^ { \circ }} \mathbf{C}$ free-air temperature (unless otherwise noted)

individual triode charactoristics (see note 4)

| PARAMETER |  | TEST CONDITIONS | $\begin{aligned} & \text { 2N3347 } \\ & \text { 2N3348 } \\ & \text { 2N3349 } \end{aligned}$ |  | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | MIN MAX | MIN MAX |  |
| $V_{\text {(BR) }}$ CBO | Collector-Base Breakdown Voltage |  | $I^{\prime}=-10 \mu A, \quad I_{E}=0$ | -60 | -60 | $V$ |
| $V_{\text {(BR)CEO }}$ | Collector-Emitter Breakdown Voltage | $I_{C}=-10 \mathrm{~mA}, \mathrm{I}_{\mathrm{B}}=0, \quad$ See Note 5 | -45 | -45 | $V$ |
| $V_{\text {(BR)EBO }}$ | Emitter-Base Breakdown Voltage | $\mathrm{I}_{\mathrm{E}}=-10 \mu \mathrm{~A}, \mathrm{I}^{\prime}=0$ | -6 | -6 | $V$ |
| IC8O | Collector Cutoff Current | $\mathrm{V}_{C B}=-45 \mathrm{~V}, \mathrm{I}_{\mathrm{E}}=0$ | -10 | -10 | nA |
|  |  | $V_{C B}=-45 \mathrm{~V}, \mathrm{IE}=0, \quad \mathrm{~T}_{\mathrm{A}}=150^{\circ} \mathrm{C}$ | -10 | -10 | $\mu \mathrm{A}$ |
| IEBO | Emitter Cutoff Current | $V_{E B}=-6 V_{\text {, }} \mathrm{I}_{\text {c }}=0$ | -2 | -2 | nA |
| hFE | Static Forward Current Transfer Ratio | $V_{C E}=-5 V, I_{C}=-10 \mu \mathrm{~A}$ | $40 \quad 300$ | $100 \quad 300$ |  |
|  |  | $V_{C E}=-5 \mathrm{~V}, \quad \mathrm{IC}^{\prime}=-1 \mathrm{~mA}$ | 60 | 150 |  |
| $V_{B E}$ | Base-Emitter Voltage | $V_{C E}=-5 V, I_{C}=-10 \mathrm{~mA}$ | -0.9 | -0.9 | $V$ |
| $\mathrm{V}_{\text {CE }}$ (sat) | Collector-Emitter Saturation Voltage | $\mathrm{I}_{\mathrm{B}}=-0.5 \mathrm{~mA}, \mathrm{I}^{\prime}=-10 \mathrm{~mA}$ | -0.5 | -0.5 | V |
| $h_{\text {ie }}$ | Small-Signal Common-Emitter Input Impedance | $V_{C E}=-5 V, \quad I^{\prime}=-1 \mathrm{~mA}, f=1 \mathrm{kHz}$ | $1.5 \quad 20$ | $3.7 \quad 20$ | $k \Omega$ |
| $h_{\text {fe }}$ | Small-Signal Common-Emitter Forward Current Transfer Ratio |  | 60600 | 150600 |  |
| $h_{\text {oe }}$ | Small-Signal Common-Emitter Output Admittance |  | 100 | 100 | Mrmo |
| $h^{\text {fel }}$ | Small-Signal Common-Emitter Forward Current Transfer Ratio | $V_{C E}=-5 \mathrm{~V}, \quad 1 \mathrm{C}=-1 \mathrm{~mA}, \quad \mathrm{f}=30 \mathrm{MHz}$ | 28 | 28 |  |
| Cobo | Common-Base Open-Circuit Output Capacitance | $V_{C B}=-5 \mathrm{~V}, \quad \mathrm{I}_{\mathrm{E}}=0, \quad f=1 \mathrm{MHz}$ | 6 | 6 | pF |
| $\mathrm{C}_{\text {ibo }}$ | Common-Base Open-Circuit Input Capacitance | $V_{E B}=-0.5 \mathrm{~V}, \mathrm{I}^{\prime}=0 . \quad f=1 \mathrm{MHz}$ | 8 | 8 | pF |

triode matching chavacteristics

| PARAMETER | TEST CONDITIONS | $\begin{array}{\|l\|} \hline \text { 2N3347 } \\ \text { 2N3360 } \\ \hline \end{array}$ | $\begin{aligned} & \text { 2N3348 } \\ & \text { 2N3351 } \\ & \hline \end{aligned}$ | $\begin{aligned} & \text { 2N3349 } \\ & \text { 2N33.62 } \\ & \hline \end{aligned}$ | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | MIN MAX | MIN MAX | MIN MAX |  |
| hFE1 Static Forward-Current- <br> hFE2 Gain Balance Ratio | $V_{C E}=-5 V, I_{C}=-10 \mu \mathrm{~A},$ <br> See Note 6 | 0.91 | 0.81 | 0.61 |  |
| $\left\|\mathrm{V}_{\text {BE1 }}-\mathrm{V}_{\text {BE } 21}\right\|$ Base-Emitter-Voltage Differential | $\mathrm{V}_{\text {CE }}=-5 \mathrm{~V}, \mathrm{I}_{\mathrm{C}}=-10 \mu \mathrm{~A}$ | 5 | 10 | 20 | $m \mathrm{~V}$ |
| $\left\|\triangle\left(V_{\mathrm{BE1}}-\mathrm{V}_{\mathrm{BE} 2}\right)^{\prime} T_{\mathrm{A}}\right\| \begin{aligned} & \text { Base-Emitter-Volta } \\ & \text { Differential Chang } \\ & \text { with Temperature }\end{aligned}$ | $\begin{array}{ll} V_{C E}=-5 V, & T_{C}=-10 \mu \mathrm{~A}, \\ T_{A(1)}=25^{\circ} \mathrm{C}, & T_{A(2)}=-55^{\circ} \mathrm{C} \\ \hline \end{array}$ | 0.8 | 1.6 | 3.2 | mV |
|  | $\begin{array}{ll} V_{C E}=-5 V, & I_{C}=-10 \mu A \\ T_{A(1)}=25^{\circ} \mathrm{C}, & T_{A(2)}=125^{\circ} \mathrm{C} \end{array}$ | 1 | 2 | 4 |  |

## *operating characteristics at $\mathbf{2 5}{ }^{\circ} \mathrm{C}$ free-air temperature

individual triode characteristics (see note 4)

| PARAMETER |  | TEST CONDITIONS | $\begin{aligned} & \text { ALL } \\ & \text { TYPES } \end{aligned}$ | UNIT |
| :---: | :---: | :---: | :---: | :---: |
|  |  | MAX |  |
| $\overline{\mathbf{F}}$ | Average Noise Figure |  | $V_{C E}=-5 V, \quad I_{C}=-10 \mu A, R_{G}=10 k \Omega,$ <br> Noise Bandwidth $=15.7 \mathbf{k H z}$, See Note 7 | 4 | dB |

NOTES: 4. The terminals of the triode not under test are open-circuited for the measurement of these characteristics.
5. This parameter must be measurad using putse techniques. $\mathrm{t}_{\mathrm{w}}=\mathbf{3 0 0} \mu \mathrm{s}$, duty cycle $\leqslant \mathbf{2 \%}$.
6. The lower of the two hFE resdings is taken hFEY.
7. Averege Noise Figure is measured in an amplifier with response down 3 dB at 10 Hz and 10 kHz and a high-frequency rolloff of 6 dB /octave.
*JEDEC registered data

## SILECT ${ }^{\dagger}$ TRANSISTORS $\ddagger$

- For Small-Signal Amplifier Applications
- Rugged One-Piece Construction with In-Line Leads or Standard TO-18 100-mil Pin-Circle Configuration
- A7T3391, A7T3391A, and A7T3392 are Plug-In Replacements for 2N3391, 2N3391A, 2N3392 (TO-98 Package)


## mechanical data

These transistors are encapsulated in a plastic compound specifically designed for this purpose, using a highly mechanized process developed by Texas Instruments. The case will withstand soldering temperatures without deformation. These devices exhibit stable characteristics under high-humidity conditions and are capable of meeting MIL-STD-202C, Method 106B. The transistors are insensitive to light.

electrical characteristics at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

| PARAMETER | TEST CONDITIONS |  | A5T3381 <br> A7T3391 <br> A8T3391 <br> A5T3391A <br> A7T3381A <br> A8T3391A |  | A5T3392 <br> A7T3392 <br> A8T3392 |  | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  | MiN | MAX | MIN | Max |  |
| $\mathbf{V}_{\text {(BR) }}$ CEO Collector-Emitter Breakdown Voltage | $\mathrm{I}^{\prime} \mathrm{C}=1 \mathrm{~mA}, \quad \mathrm{I}_{\mathrm{B}}=0$ | See Note 3 |  |  | 25 |  | V |
|  | $I_{C}=10 \mathrm{~mA}, \quad I_{B}=0$ |  | 25 |  |  |  |  |
| Collector Cutoff Current | $V_{C B}=25 \mathrm{~V}, \quad I_{B}=0$ |  |  | 100 |  | 100 | nA |
|  | $V_{C B}=25 \mathrm{~V}, \mathrm{I}_{\mathrm{B}}=0$, | $T_{A}=100^{\circ} \mathrm{C}$ |  | 10 |  | 10 | $\mu \mathrm{A}$ |
| IEBO Emitter Cutoff Current | $V_{E B}=5 \mathrm{~V}, \quad \mathrm{I}^{\prime}=0$ |  |  | 100 |  | 100 | nA |
| hFE Static Forward Current Transfer Ratio | $\mathrm{V}_{\text {CE }}=4.5 \mathrm{~V}, \mathrm{IC}=2 \mathrm{~mA}$ |  | 250 | 500 | 150 | 300 |  |
| $\mathrm{h}_{\mathrm{fe}}$ Small-Signal Common-Emitter <br> Forward Current Trensfer Ratio | $V_{C E}=4.5 \mathrm{~V}, \quad 1 \mathrm{C}=2 \mathrm{~mA}$, | $\mathrm{f}=1 \mathrm{kHz}$ | 250 | 800 | 150 | 500 |  |
| Cobo Common-Base Open-Circuit <br> Output Capacitanca | $V_{C B}=10 \mathrm{~V}, \quad \mathrm{I}_{\mathrm{E}}=0$. | $\mathrm{f}=1 \mathrm{MHz}$ | 2 | 10 | 2 | 10 | pF |

NOTE 3: This parameter must be mebeured using pulse techniques. $t_{w}=300 \mu s$, duty cycle $\leqslant 2 \%$.
operating characteristics at $\mathbf{2 5} \mathbf{}{ }^{\circ} \mathbf{C}$ free-air temperature


NOTE 4: Average Noise Figure is measured in an amplifier with response down 3 dB at 10 Hz and 10 kHz and a high-frequancy rollotf of $6 \mathrm{~dB} / \mathrm{octav}^{2}$.

THERMAL INFORMATION
DISSIPATION DERATING CURVE


## TYPE 2N3444 <br> N-P-N SILICON TRANSISTOR

## DESIONED FOR HIGH-SPEED, HICH-CURRENT SWITCHING APPLICATIONS

mechanical data

| THE COLLECTOR IS IN ELECTRICAL CONTACT WITH THE CABE |  |  | $\sqrt{T 7}$ |
| :---: | :---: | :---: | :---: |
|  |  |  |  |
|  |  |  |  |
|  |  |  |  |

absolute maximum ratings at $23^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

*electrical charactoristics at $25^{\circ} \mathrm{C}$ free-air tomperature (unloss otherwise noted)

| PARAMITER |  | TEST CONDITIONS |  | MIN MAX | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: |
| $V_{\text {(m) }}$ Cuo | Coliector-8ase Breakdown Voliage | $\mathrm{l}_{\mathrm{c}}=10 \mu 0_{,} \mathrm{I}_{\mathrm{E}}=0$ |  | 80 |  |
| $V_{\text {(ta) }}$ CEO | Collector-Emitter Breakdown Voltage | $\mathrm{l}_{\mathrm{c}}=10 \mathrm{ma} \mathrm{l}_{1}=0$, | See Note 4 | 50 | $v$ |
| $V_{\text {(ex) }}$ | Emitter-Base Breakdown Voltage | $\mathrm{I}_{\mathrm{E}}=10 \mu \mathrm{a}, \mathrm{I}_{\mathrm{C}}=0$ |  |  | $v$ |
| Icuo | Collector Cutoff Current | $\mathrm{V}_{\mathrm{CB}}=60 \mathrm{v}, \mathrm{I}_{\mathrm{E}}=0$ |  | 0.5 | $\mu \mathrm{O}$ |
|  |  | $V_{C B}=60 \mathrm{~V}, \mathrm{I}_{\mathrm{E}}=0, \quad \mathrm{~T}_{\mathrm{A}}=100^{\circ} \mathrm{C}$ |  | 75 | $\mu \mathrm{a}$ |
| TCEv | Collector Cutoff Current |  |  | 0.5 | $\mu \mathrm{a}$ |
| Ingv | Base Culoff Current | $V_{C E}=60 \mathrm{v}, \mathrm{V}_{\text {ME }}=-4 \mathrm{v}$ |  | -0.5 | $\mu \mathrm{O}$ |
| IELO | Emitter Cutoff Current | $V_{E B}=4 \mathrm{v}, \quad \mathrm{l}_{C}=0$ |  | 50 | no |
| $h_{\text {fe }}$ | Static Forward Current Transfer Ratio | $V_{C E}=1 v_{1} \quad I_{C}=150 \mathrm{ma}$ | $\begin{gathered} \hline \text { Sou } \\ \text { Note } \\ 4 \end{gathered}$ | 20 |  |
|  |  | $\begin{array}{ll} V_{C E}=1 \mathrm{v}, & \mathrm{I}_{\mathrm{C}}=500 \mathrm{ma} \\ \hline \mathrm{~V}_{\mathrm{CE}}=5 \mathrm{v}, & \mathrm{I}_{\mathrm{C}}=1 \mathrm{a} \\ \hline \end{array}$ |  | $20 \quad 60$ |  |
|  |  |  |  | 15 |  |
| $V_{\text {be }}$ | Base-Emitter Voltage | $I_{B}=15 \mathrm{ma}_{,} I_{C}=150 \mathrm{ma}$ | $\underset{\text { Note }}{\substack{\text { Sen }}}$ | 1 | $v$ |
|  |  | $\begin{aligned} & I_{\mathrm{B}}=50 \mathrm{ma}, I_{\mathrm{c}}=500 \mathrm{ma} \\ & \mathrm{I}_{\mathrm{A}}=100 \mathrm{ma}, \mathrm{I}_{\mathrm{c}}=1 \mathrm{a} \end{aligned}$ |  | 0.7 1.3 | $V$ |
|  |  |  |  | 1.8 | $V$ |
| $V_{\text {CE\{ } 2+1\}}$ | Collector-Emitter Saturation Voltage | $I_{B}=15 \mathrm{ma}, I_{c}=150 \mathrm{mo}$ | $\begin{gathered} \text { Soe } \\ \text { Note } \\ 4 \end{gathered}$ | 0.35 | $V$ |
|  |  | $\begin{aligned} & i_{B}=50 \mathrm{ma}, i_{C}=500 \mathrm{ma} \\ & \mathrm{I}_{\mathrm{B}}=100 \mathrm{ma}, \mathrm{I}_{\mathrm{c}}=1 \mathrm{a} \end{aligned}$ |  | 0.6 | V |
|  |  |  |  | 1.2 |  |
| $F_{\text {F }}$ | Transition Frequency | $V_{C E}=10 \mathrm{v}, \mathrm{I}_{\mathrm{C}}=50 \mathrm{ma}$, See Hote 5 |  | 150 | Mc |
| $C_{\text {abo }}$ | Common-Base Open-Crailt Output Capacilonce | $v_{C t}=10 \mathrm{v}, \mathrm{l}_{\mathrm{E}}=0, \quad 1=100 \mathrm{kc}$ |  | 12 | pf |
| $C_{i b o}$ | Common-Base Open-Circuit Input Copacitance | $V_{E L}=0.5 \mathrm{v}, \mathrm{I}_{\mathrm{C}}=0$, | $\mathrm{f}=100 \mathrm{kc}$ | 80 | pf |

NOTES: 1. This value applies between 0 and 1 collector current when the base-emitter diode is open-circuited.
2. Derate linearly to $200^{\circ} \mathrm{C}$ free-air temperature at the rate of $5.71 \mathrm{mw} /{ }^{\circ} \mathrm{C}$.
3. Derate the 10 -watt rating inearly to $200^{\circ} \mathrm{C}$ case temperature at the rate of $57.1 \mathrm{mw} /{ }^{\circ} \mathrm{C}$. Derate the 5 -watt (JEDEC registered) rating linearly to $200^{\circ} \mathrm{C}$ case temperature at the rate of $28.6 \mathrm{mw} /^{\circ} \mathrm{C}$.
4. These parameters must be measured using pulse tech niques. $\mathrm{PW}=300 \mu \mathrm{~s}$, Duty Cycle $\leqslant 2 \%$.
5. To obtain $f_{T}$, the $\boldsymbol{H}_{\text {fel }}$ response with frequency is extrapolated at the rate of -6 db per octave from $f=100$ Mc to the frequency at which $\left|h_{f e}\right|=1$.
The JEDEC registered outline for these devices is TO-5. TO-39 falls within TO-5 with the exception of teed length.

- JEDEC registered data. This data sheet contains all applicable registered data in effect at the time of publication.
t These values are guaranteed by Texas Instruments in addition to the JEDEC registered values which are also shown.


## TYPE 2N3444 <br> N-P-N SILICON TRANSISTOR

## *swifehing characterlstics at $25^{\circ} \mathrm{C}$ free-air temperature

| PARAMITIR | TIST CONDITIONS | MaX | UNIT |
| :---: | :---: | :---: | :---: |
| td Defloy Time | $\mathrm{l}_{\mathrm{c}}=500 \mathrm{ma}, \mathrm{l}_{\text {m11 }}=50 \mathrm{ma}, \mathrm{V}_{\text {wiot }}=-2 \mathrm{v}$, | 15 | nese |
| $t_{\text {tr }}$ R Rise Time | $\mathrm{h}_{\mathbf{L}}=59 \Omega$, See Figura 1 | 35 | nsot |
| $t_{1}$ Storage time | $\begin{aligned} & I_{c}=500 \mathrm{mo}, I_{m(1)}=-I_{(a)}=50 \mathrm{ma}, \\ & h_{2}=59 \Omega, \quad \text { Sen Figure } 2 \end{aligned}$ | 40 | nsec |
| $t_{1}$ Fall Time |  | 30 | nsor |
| OT Fotal Control Charge | $I_{C}=500 \mathrm{ma}, I_{1}=50 \mathrm{ma}$, Seo Fligure 3 | 5 | ncb |

†Voltege and current values thown are nominal; exact valuer very slightiy wifh Itemsister parameters.

## *PARAMETER MEASUREMENT INFORMATION



test cincult


VOLTAGE WAVEFORMS

NOTE: $Q_{\uparrow}<5$ neb when the transistor turns off monotonically ex shown by the solid line.

FIGURE 3-TOTAL CONTROL CHARGE

HOTES: $\quad$. The input wavefonms heva the following charecteristics:
For measuring delay ond rise times; $\mathrm{I}_{\mathrm{r}} \leq \mathbf{2} \mathbf{m a c}, \mathrm{PW} \geq \mathbf{2 0 0}$ nsoc, Duty Cycle $\leq \mathbf{2 \%}$.
For measuring slorage and fall times; $\mathrm{t}_{\mathrm{f}} \leq \mathbf{5} \mathrm{nsoc}, \mathrm{PW}=10$ to $200 \mu \mathrm{sec}$, Duty Cycle $\leq \mathbf{2 \%}$.
For meessuing $a_{T} ; \mathrm{t}_{\mathrm{f}} \leq 10 \mathrm{nsac}, \mathrm{PW}=10 \mu \mathrm{sec}$, Duty Cycle $\leq \mathbf{1 \%} \%$.
b. Weveforms ore menitored on on escllloscepe with the following characteristics: $\mathrm{t}_{\mathrm{r}} \leq 1 \mathrm{nscx}, \mathrm{R}_{\mathrm{in}} \geq 100 \mathrm{k} \Omega, \mathrm{c}_{\mathrm{in}} \leq 7 \mathrm{pf}$.
-Indicatas JEDEC ragistered data

# TYPES 2N3458, 2N3459, 2N3460 N-CHANNEL SILICON JUNCTION FIELD-EFFECT TRANSISTORS 

## FOR INDUSTRIAL AND CONSUMER <br> SMALL-SIGNAL, LOW-NOISE <br> APPLICATIONS

*mechanical data

*absolute maximum ratings at $\mathbf{2 5}^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)
Drain-Gate Voltage ..... 50 V
Reverse Gate-Source Voltage ..... $-50 \mathrm{~V}$
Continuous Gate Current ..... 10 mA
Continuous Device Dissipation at (or below) $25^{\circ} \mathrm{C}$ Free-Air Temperature (See Note 1) ..... 300 mW
Storage Temperature Range ..... $-65^{\circ} \mathrm{C}$ to $200^{\circ} \mathrm{C}$
Lead Temperature 1/16 Inch from Case for 10 Seconds ..... $300^{\circ} \mathrm{C}$

NOTE 1: Derate linearly to $200^{\circ} \mathrm{C}$ free-air temperature at the rate of $1.71 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$.
*JEDEC registered data. This data sheet contains all applicable registered data in effect at the time of publication.

## TYPES 2N3458, 2N3459, 2N3460 N-CHANNEL SILICON JUNCTION FIELD-EFFECT TRANSISTORS

*electrical characteristics at $25^{\circ} \mathrm{C}$ free-air temperature (uniess otherwise noted)

| PARAMETER |  | TEST CONDITIONS |  | 2N3458 |  | 2N3459 |  | 2N3460 |  | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | MIN | MAX | MiN | MAX | MIN | MAX |  |
| IGSS | Gate Reverse Current |  |  | $\mathrm{V}_{\mathrm{GS}}=-30 \mathrm{~V}$, | $V_{D S}=0$ |  | -0.25 |  | -0.25 |  | -0.25 | nA |
|  |  | $\begin{aligned} & V_{G S}=-30 \mathrm{~V} \\ & T_{A}=150^{\circ} \mathrm{C} \end{aligned}$ | $V_{D S}=0,$ |  | -0.5 |  | -0.5 |  | -0.5 | $\mu \mathrm{A}$ |
| IDGO | Drain Reverse Current | $\mathrm{V}_{\mathrm{DG}}=50 \mathrm{~V}$ | $I_{S}=0$ |  | 1 |  | 1 |  | 1 | $\mu \mathrm{A}$ |
| $V_{\text {GS }}$ (off) | Gate-Source Cutoff Voltage | $\mathrm{V}_{\mathrm{DS}}=20 \mathrm{~V}$, | $\mathrm{I}_{\mathrm{D}}=1 \mathrm{nA}$ |  | -8 |  | -4 |  | -2 | V |
| $\mathrm{V}_{\mathrm{GS}}$ | Gate-Source Voltage | $V_{D S}=20 \mathrm{~V}$. | ${ }^{\prime} \mathrm{D}=1 \mu \mathrm{~A}$ |  | -7.8 |  | -3.4 |  | -1.8 | V |
| IDSS | Zero-Gate-Voltage <br> Drain Current | $\begin{aligned} & V_{D S}=20 \mathrm{~V} \\ & \text { See Note } 2 \end{aligned}$ | $V_{G S}=0,$ | 3 | 15 | 0.8 | 4 | 0.2 | 1 | mA |
| $\left\|\mathrm{Vfs}_{\mathrm{f}}\right\|$ | Small-Signal Common-Source <br> Forward Transfer Admittance | $\begin{aligned} & V_{D S}=20 \mathrm{~V}, \\ & f=1 \mathrm{kHz}, \end{aligned}$ | $V_{G S}=0,$ <br> See Note 3 | 2.5 | 10 | 1.5 | 6 | 0.8 | 4.5 | mmho |
| $\mathrm{C}_{\text {iss }}$ | Common-Source <br> Short-Circuit <br> Input Capacitance | $\begin{aligned} & V_{D S}=10 \mathrm{~V} \\ & \mathrm{f}=1 \mathrm{MHz} \end{aligned}$ | $v_{G S}=0 .$ |  | 18 |  |  |  |  | pF |
|  |  | $\begin{aligned} & V_{D S}=6 \mathrm{~V} \\ & \mathrm{f}=1 \mathrm{MHz} \end{aligned}$ | $V_{\mathbf{G S}}=0,$ |  |  |  | 18 |  |  |  |
|  |  | $\begin{aligned} & V_{\mathrm{DS}}=4 \mathrm{~V}, \\ & \mathrm{f}=1 \mathrm{MHz} \end{aligned}$ | $V_{G S}=0$, |  |  |  |  |  | 18 |  |
| $\mathrm{C}_{\text {oss }}$ | Common-Source <br> Short-Circuit <br> Output Capacitance | $\begin{aligned} & V_{D S}=30 \mathrm{~V} \\ & \mathrm{f}=1 \mathrm{MHz} \end{aligned}$ | $V_{G S}=0,$ <br> See Notes 3 and 4 |  | 5 |  | 5 |  | 5 | pF |
| gos | Small-Signal Common-Source Output Conductance | $\begin{aligned} & \mathrm{V}_{\mathrm{DS}}=30 \mathrm{~V} \\ & \mathrm{f}=1 \mathrm{MHz} \end{aligned}$ | $v_{G S}=0$ <br> See Note 3 |  | 35 |  | 20 |  | 5 | $\mu \mathrm{mho}$ |

*operating characteristics at $25^{\circ} \mathrm{C}$ free-air temperature

|  | PARAMETER | TEST CONDITIONS | 2N3458 |  | 2N3459 |  | 2N3460 |  | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  | MIN | MAX | MIN | MAX | MIN | MAX |  |
| NF | Common-Source <br> Spot Noise Figure | $\begin{array}{ll} V_{D S}=10 \mathrm{~V}, & V_{G S}=0 \\ R_{G}=1 \mathrm{M} \Omega, & f=20 \mathrm{~Hz} . \end{array}$ <br> Noise Bandwidth $=6 \mathrm{~Hz}_{z}$ |  | 6 |  | 4 |  | 4 | dB |

NOTES: 2. This parameter must be measured using pulse techniques. $t_{w}=300 \mu$ s, duty cycle $\leqslant 2 \%$.
3. These parameters must be measured with bias conditions applied for less than 5 seconds to avoid overheating.
4. Coss is defined as the imaginary part of small-signal common-source output susceptance divided by $2 \pi f$.
*JEDEC registered data

## DESIGNED FOR HIGH-SPEED CORE-DRIVER APPLICATIONS

- High Dissipation Capability ... 10 Watts af $25^{\circ} \mathrm{C}$ Case Temperature
- High V(sa)ceo ... 50 V Min (2N3245, 2N3468)
- High Speed... 60 ns Max is at $500 \mathrm{~mA}(2 N 3467,2 N 3468)$
- High Collector Current Rating... 1 A
mechanical data
THE COLLECTOR IS IN ELECTRICAL CONTACT WITH THE CASE
absolute maximum ratings at $25^{\circ} \mathrm{C}$ free-air temperature (unless othorwise noted)

|  | 2N3244 | 2N3245 | 2N3467 | 2N3468 | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: |
| Collector-Bose Voltage | $-40^{*}$ | -50* | $-40^{*}$ | $-50^{*}$ | V |
| Collector-Emitter Volioge (See Note 1) | $-40^{*}$ | $-50^{*}$ | $-40^{*}$ | $-50^{\circ}$ | $V$ |
| Emitter-Sase Voltage | -5* | -5* | -5* | -5* | $V$ |
| Continuous Collector Current | $-{ }^{*}$ | -1* | $-{ }^{*}$ | $-{ }^{*}$ | 1 |
| Conlinuous Device Dissipation at (or balow) $25^{\circ} \mathrm{C}$ Free-Air Temperature (See Note 2) | $1^{*}$ | $1 *$ | $1 *$ | $1 *$ | W |
| Continuous Device Dissipation at (or below) $25^{\circ} \mathrm{C}$ Case Temperature (See Note 3) | $\begin{gathered} 10{ }^{4} \\ 5^{\circ} \end{gathered}$ | $\begin{gathered} 101 \\ 5^{*} \\ \hline \end{gathered}$ | 10 | 10 | W |
| Storage Temperature Range | -65 $10200^{*}$ |  |  |  | ${ }^{\circ} \mathrm{C}$ |
| Lead Temperature Yo Inch from Cose for 10 Seconds |  |  | 230* |  | ${ }^{\circ} \mathrm{C}$ |
| Lead Pemperature Ko Inch from Case for 60 Seconds | $300 *$ |  | $300{ }^{+}$ |  | ${ }^{\circ} \mathrm{C}$ |

NOTES: 1. These values apply between 0 and 1 A collector current when the base-emittar diode is open-circuited.
2. Derate linearly to $200^{\circ} \mathrm{C}$ free-air temperature at the rate of $5.71 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$.
3. Derate the 10 -wate TI value linearly to $200^{\circ} \mathrm{C}$ case temperature at the rate of $57.1 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$.

Derate the 5 -watt JEDEC value linearly to $200^{\circ} \mathrm{C}$ case temperature at the rate of $28.6 \mathrm{~mW} /^{\circ} \mathrm{C}$.
The JEDEC registered outline for these devices is TO-5. TO-39 falls within TO-5 with the exception of load length.
-JEDEC registered data. This data sheet contains all applicable dats in offect at the time of publication.
${ }^{1}$ These values are quaranteed by Texas instruments in addition to the JEDEC registered values which are also shown.

## TYPES 2N3244, 2N3245, 2N3467, 2M3488 P-N-P SILICON TRANSISTORS

## *eloctrical characteristies ef $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

|  | PARAMETER | TEST CONDITIONS |  | 2N3244 | 2N3245 | 2N3467 | 2N3468 |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  | Minmax | Min max | MUN MAX | MIN MAX |  |
| $v_{\text {(m, }, \text { cos }}$ | Collector-iluse Ereckdown Volioge | $\mathrm{I}_{\mathrm{c}}=-10 \mu \mathrm{~h}, \mathrm{I}_{\mathrm{E}}=0$ |  | -40 | -50 | -40 | -50 | $v$ |
| $V_{\text {Imaceo }}$ | Colinctor-Emitter Irockdown Vohoye | $\mathrm{I}_{\mathrm{c}}=-10 \mathrm{~mA}, \mathrm{I}_{\mathrm{s}}=0$, | See Mote 4 | -40 | -50 | -40 | -50 | V |
| $V_{\text {(m) }}$ | Emititer-lase Broakdown Voltaye | $\mathrm{I}_{\mathbf{E}}=-10 \mu \mathrm{~h}, \mathrm{I}_{\mathrm{c}}=0$ |  | -5 | -5 | -5 | -5 | $V$ |
| leso | Collector Cutoff Currmit | $V_{\text {ci }}=-30 \mathrm{~V}, \mathrm{I}_{\mathrm{E}}=0$ |  | -50 |  | -100 | -100 | nA |
|  |  | $V_{C a}=-30 V_{1} \quad I_{E}=0_{i} \quad T_{A}=100^{\circ} \mathrm{C}$ |  |  |  | -15 | -15 | $\mu \mathrm{A}$ |
|  |  | $V_{C I}=-50 \mathrm{~V}, \mathrm{I}_{\mathrm{E}}=0$ |  |  | -50 |  |  | nd |
| Icer | Collactor Cutoff Current | $V_{C E}=-30 \mathrm{~V}, \boldsymbol{V}_{\text {EE }}=3 \mathbf{V}$ |  | -50 | -50 | -100 | -100 | nA |
| Inev | Base Cutoff Current | $V_{C E}=-30 \mathrm{~V}, \quad V_{\text {EE }}=3 \mathrm{~V}$ |  | 80 | 80 | 120 | 120 | ni |
| E*0 | Emitter Culofl Curnent | $V_{E D}=-4 V, \quad I_{C}=0$ |  | -30 | -30 |  |  | nA |
| $h_{\text {He }}$ | Static forword Current Trensser Ratio | $V_{C E}=-1 \mathrm{~V}, \quad \mathrm{I}_{\mathrm{C}}=-150 \mathrm{~mA}$ | $\begin{gathered} \text { Soe } \\ \text { Mote } \\ 4 \end{gathered}$ | 60 | 35 | 40 | 25 |  |
|  |  | $V_{C E}=-1 \mathrm{~V}, \quad \mathrm{I}_{\mathrm{C}}=-500 \mathrm{~mA}$ |  | 50150 | $30 \quad 90$ | $40 \quad 120$ | $25 \quad 75$ |  |
|  |  | $V_{C E}=-5 \mathrm{~V}, \quad \mathrm{I}_{\mathrm{C}}=-750 \mathrm{~mA}$ |  | 25 |  |  |  |  |
|  |  | $\mathbf{V}_{\text {CE }}=-5 \mathrm{~V}, \quad \mathrm{I}_{\mathrm{C}}=-1 \mathrm{~A}$ |  |  | 20 | 40 | 20 |  |
| $V_{\text {fe }}$ | Baso-Emitter Voltaye | $I_{1}=-15 \mathrm{~mA}, I_{c}=-150 \mathrm{~mA}$ | $\begin{gathered} \text { Soe } \\ \text { Note } \\ 4 \end{gathered}$ | -1.1 | -1.1 | -1 | -1 | $V$ |
|  |  | $\mathrm{I}_{\mathrm{s}}=-50 \mathrm{~mA}, \quad \mathrm{I}_{\mathrm{c}}=-500 \mathrm{~mA}$ |  | -0.75-1.5 | -0.75-1.5 | -0.8-1.2 | -0.8-1.2 | $V$ |
|  |  | $\mathrm{I}_{\mathrm{E}}=-75 \mathrm{~mA}, \mathrm{l}_{\mathrm{c}}=-750 \mathrm{~mA}$ |  | -2 |  |  |  | $V$ |
|  |  | $\mathrm{I}_{1}=-100 \mathrm{~mA}, \mathrm{l}_{\mathrm{c}}=-1 \mathrm{~A}$ |  |  | -2 | -1.6 | -1.6 | $v$ |
| $V_{\text {ckinal }}$ | Collector-Emitter Saturation Voltoge | $\mathrm{I}_{\mathrm{s}}=-15 \mathrm{~mA}, \quad \mathrm{Ic}_{c}=-150 \mathrm{~mA}$ | $\begin{gathered} \text { See } \\ \text { Mote } \\ 4 \end{gathered}$ | -0.3 | -0.35 | -0.3 | -0.35 | $V$ |
|  |  | $I_{1}=-50 \mathrm{~mA}, \quad I_{c}=-500 \mathrm{~mA}$ |  | -0.5 | -0.6 | -0.5 | -0.6 | $V$ |
|  |  | $\mathrm{I}_{\mathrm{c}}=-100 \mathrm{~mA}, \mathrm{I}_{\mathrm{c}}=-1 \mathrm{~A}$ |  | -1 | -1.2 | -1 | -1.2 | V |
| $f_{T}$ | Iransition Frequency | $\mathrm{V}_{\text {ce }}=-10 \mathrm{~V}, \mathrm{I}_{\mathrm{C}}=-50 \mathrm{mh}$, See Note 5 |  | 175 | 150 | 175 | 150 | MHz |
| Cobo | Common-Lase Open-Crwit Output Capacitunce | $V_{C I}=-10 \mathrm{~V}, \mathrm{I}_{\mathrm{E}}=0$, | $f=100 \mathrm{kHz}$ | 25 | 25 | 25 | 25 | pf |
| $\mathrm{C}_{\text {ibo }}$ | Common-Base Opem-Circuit Input Capocitonce | $V_{E E}=-0.5 \mathrm{~V}, \mathrm{l}_{\mathbf{c}}=0$, | $t=100 \mathrm{kHz}$ | 100 | 100 | 100 | 100 | pf |

MOTES: 4. These paramelers mest be moeswod resian puse techniques. $I_{p}=300 \mu$ s, duty cycle $\leq \mathbf{2 \%}$.

-Imdiceles JEDEC ragistomed dete
*switching characteristics at $25^{\circ} \mathrm{C}$ free-cir temperature

| PARAMETER | TEST CONDITIONS $\dagger$ | $\begin{array}{\|c\|} \hline \text { 2N3244 } \\ \hline \text { MAX } \\ \hline \end{array}$ | $\frac{2 \text { N3245 }}{\text { MAX }}$ | $\begin{array}{\|c\|} \hline \text { 2N3467 } \\ \hline \text { MAX } \\ \hline \end{array}$ | $\begin{array}{\|c\|} \hline \text { 2N3468 } \\ \hline \text { MAX } \\ \hline \end{array}$ | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| $t_{d}$ Delay Time | $\begin{aligned} & I_{C}=-500 \mathrm{~mA}, I_{\text {s(I) }}=-50 \mathrm{~mA}, \quad V_{\mathrm{ME}(\mathrm{otin}}=2 \mathrm{~V}, \\ & \mathrm{R}_{\mathrm{L}}=59 \Omega, \quad \text { See Figure } 1 \end{aligned}$ | 15 | 15 | 10 | 10 | ns |
| $t_{r}$ Rise Time |  | 35 | 40 | 30 | 30 | ns |
| ts Storage Time | $\begin{aligned} & I_{C}=-500 \mathrm{~mA}, \\ & \mathbf{I}_{\mathrm{L} 11}=-50 \mathrm{~mA}, I_{\mathrm{B}(2]}=50 \mathrm{~mA}, \\ & \mathbf{R}_{\mathbf{L}}=59, \quad \text { See Figure } 2 \end{aligned}$ | 140 | 120 | 60 | 60 | ns |
| $t_{\text {f }} \quad$ Foll Time |  | 45 | 45 | 30 | 30 | ns |
| $Q_{\text {t }} \quad$ Iotal Control Charge | $\mathrm{I}_{\mathrm{c}}=-500 \mathrm{~mA}, \mathrm{I}_{\mathrm{B}}=-50 \mathrm{~mA}, \quad$ See figure 3 | 14 | 12 | 6 | 6 | $n \mathrm{C}$ |

$\dagger$ Voltages and current values shown are nominal, exact volves vary slightly with transistar paramelers. Maminal base currant for delay and rise limes is calculoted using the minimum values of $\boldsymbol{V}_{\mathrm{BEE}}$. Naminal bose curronls for storage and fall times are colculatod using the maximum volue of $\mathbf{V}_{\mathrm{BE}}$.

## *PARAMETER MEASUREMENT INFORMATION



TEST CIRCUIT

figure 1 - delay and rise times

figure 2 - Storage and fall times


NOTES: a. The inpul waveforms hove the following characteristics:
For measuring delay ond rise times: $\mathrm{t}_{\mathrm{r}} \leq \mathbf{2 n s} \mathrm{t}_{\mathrm{p}}=\mathbf{2 0 0} \mathrm{ns}$, duty cycle $=\mathbf{2 \%}$.
For meosuring slorage and fall times: $t_{f} \leq 5 \mathrm{~ns}, \mathrm{t}_{\mathrm{p}}=2$ to $500 \mu \mathrm{~s}$, duty cycle $=2 \%$.
For measuring $0_{\mathrm{T}}: \mathrm{I}_{\mathbf{i}} \leq 10 \mathrm{~ns}, \mathrm{I}_{\mathrm{p}}=10 \mu \mathrm{~s}$, duty cycle $=\mathbf{2 \%}$.
b. Waveiorms are monitored on an oscilloscope with the following characteristics: $\mathbf{t}_{\mathbf{r}} \leq \mathbf{1} \mathrm{ns}, \mathrm{k}_{\mathrm{in}} \geq 100 \mathrm{k} \Omega, \mathrm{c}_{\mathrm{in}} \leq \mathbf{1} \mathbf{p F}$.

[^69]
# DESIGNED FOR HIGH-SPEED, MEDIUM-POWER SWITCHING AND GENERAL PURPOSE AMPLIFER APPLICATIONS <br> <br> - Electrically Identical to 2N2906, 2N2906A, 2N2907, and 2N2907A in <br> <br> - Electrically Identical to 2N2906, 2N2906A, 2N2907, and 2N2907A in Space-Saving T0-46 Package <br> - High Broakdown Voltage Combined With Vory Low Saturation Voltage 

*mechanicel deta

absolute maximum ratings at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)


2N3485 2N3483A 2N3486 2N3486A $-60 y-60 r$ $-40 \mathrm{r}-60 \mathrm{r}$ $-5 r \quad-5 v$
 $-65^{\circ} \mathrm{C}$ to $+200^{\circ} \mathrm{C}$ $\leftarrow 300^{\circ} \mathrm{C} \longrightarrow$
*electrical characteristies af $25^{\circ} \mathrm{C}$ free-air tomperature (unless otherwise noted)

| PARAMETER |  | TEST CONDITIONS |  | 2N3485 | 2N3456 | 2N3485A | 2N34E6A | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | MIN MAX | MIN MAX | MIN MAX | MJN MAX |  |
| $v_{\text {(maces }}$ | Colliector-Bose Breakdown Yohoge Colo |  |  | $l_{c}=-10 \mu \mathrm{a}, l_{1}=0$ |  | -60 | -60 | -60 | -60 | $\vee$ |
| $\boldsymbol{v}_{\text {(m) }{ }^{\text {ceo }} \text { ( }}$ | Collector-Emiltor Brakdown Voltaga | $I_{c}=-10 \mathrm{ma}, l_{s}=0$, | Soe More 4 | -40 | $-40$ | -60 | $-60$ | $v$ |
| $V_{\text {(ma) } \mathrm{EOO}}$ | Emitter-Bose Broakdown Voltage | $\mathrm{I}_{\mathrm{E}}=-10 \mu \mathrm{a}, \mathrm{I}_{\mathrm{c}}=0$ |  | -5 | -5 | -5 | -5 | $v$ |
| $\mathrm{J}_{\text {coo }} \mathbf{C}$ | Collector Cutoff Current | $V_{C I}=-50 v_{1} H_{E}=0$ |  | -20 | -20 | -10 | -10 | na |
|  |  | $V_{C B}=-50 v_{\text {c }} L_{E}=0$, | $\mathrm{r}_{\mathrm{A}}=150^{\circ} \mathrm{C}$ | -20 | -20 | $-10$ | -10 | $\mu \mathrm{a}$ |
| lay | Collector Cutoff Curremin | $V_{C E}=-30 \mathrm{v}, V_{\text {E }}=0.5 \mathrm{r}$ |  | -50 | -50 | -50 | -50 | na |
| Ingy | Base Cutoff Current | $V_{\text {cz }}=-30 \mathrm{v}, \mathrm{V}_{\text {ex }}=0.5 \mathrm{r}$ |  | 50 | 50 | 50 | 50 | na |
| hre | Static Forward Current Transfer Ratio | $V_{C E}=-10 v_{1} I_{C}=-100 \mu$ |  | 20 | 35 | 40 | 75 |  |
|  |  | $V_{C E}=-10 \mathrm{v}, \mathrm{l}_{\mathrm{c}}=-1 \mathrm{mo}$ |  | 25 | 50 | 40 | 100 |  |
|  |  | $\mathrm{V}_{\mathrm{CE}}=-10 \mathrm{v}, \mathrm{l}_{\mathrm{c}}=-10 \mathrm{ma}$ |  | 35 | 75 | 40 | 100 |  |
|  |  | $V_{C E}=-10 \mathrm{v}, \mathrm{I}_{\mathrm{c}}=-150 \mathrm{ma}$ | $\begin{gathered} \text { Soe } \\ \text { Note } \\ 4 \end{gathered}$ | $40 \quad 120$ | $100 \quad 300$ | $40 \quad 120$ | $100 \quad 300$ |  |
|  |  | $V_{C E}=-10 r_{,} \mathrm{I}_{\mathrm{c}}=-500 \mathrm{ma}$ |  | 20 | 30 | 40 | 50 |  |
|  |  | $V_{C E}=-1 v_{1} \quad I_{c}=-150 \mathrm{ma}$ |  | 20 | 50 | 20 | 50 |  |
| Ve | Rasa-Emither Voltage | $\mathrm{I}_{\mathrm{g}}=-15 \mathrm{ma}, \mathrm{l}_{\mathrm{c}}=-150 \mathrm{me}$ |  | -1.3 | -1.3 | -1.3 | -1.3 | $V$ |
|  |  | $\mathrm{I}_{8}=-50 \mathrm{mo}, \mathrm{Ic}_{c}=-500 \mathrm{me}$ |  | -2.6 | -2.6 | -2.6 | -2.6 | $V$ |
| $V_{\text {Clantl }}$ | Collector Emiftar Saturation Voltage | $\mathrm{I}_{8}=-15 \mathrm{ma}, \mathrm{I}_{\mathrm{c}}=-150 \mathrm{ma}$ |  | -0.4 | -0.4 | -0.4 | $\underline{0.4}$ | $v$ |
|  |  | $\mathrm{I}_{1}=-50 \mathrm{ma}, \mathrm{I}_{\mathrm{c}}=-500 \mathrm{mo}$ |  | -1.6 | -1.6 | -1.6 | -1.6 | v |

HOTES: 1. Thls velue appites betwoen 0 cmd 100 me cellecter curtinat when the beso-amititer dado is apmerincuited
3. Derate limenty to $200^{\circ} \mathrm{C}$ case temperative at the rete of $11.43 \mathrm{~mm} /{ }^{\circ} \mathrm{C}$.
2. Derate linaerly to $200^{\circ} \mathrm{C}$ freo-air temperaturs of the rate of $2.28 \mathrm{mw} /{ }^{\circ} \mathrm{C}$.

- JEDEC ropisternad data

4. These permetors must be moeswed wilay paisa tochiques. FW $\leq 300 \mu s \mathrm{~s}$. Buly Cylo $\leq \mathbf{2 \%}$.

## TYPES 2N3485, 2N3485A, 2N3486, 2N3486A P-N-P SILICON TRANSISTORS

*electrical characteristics of $25^{\circ} \mathrm{C}$ free-alr temperature

|  | Paramitir | TIST CONDITIONS |  |  | ALL PYPES <br> MUN MAX | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| \| $h_{\text {c }}$ \| | Small-Sional Common-Emittor Forward Curront Transfor Rotio | $V_{\mathrm{ct}}=-20 \mathrm{v}$ | $i_{c}=-50 \mathrm{ma}$ | $f=100 \mathrm{Mr}$ | 2 |  |
| Cobo | Common-base Open-Grtult Output Capadionce | $v_{\text {ci }}=-10 \mathrm{v}$ | $H_{4}=0$, | $f=100 \mathrm{kc}$ | 8 | pf |
| $C_{60}$ | Commanobese Open-Grculf Input Capacitrance | $v_{\text {Ei }}=-2 \mathrm{v}$ | $I_{c}=0$, | $f=100 \mathrm{kc}$ | 30 | pt |

*gwitching charecterisfies af $25^{\circ} \mathrm{C}$ free-air temperature

|  | PARAMIETER | TIST CONDITIONS $\dagger$ |  | $\frac{\text { AIL TYPES }}{\text { MAX }}$ | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: |
| $t_{\text {d }}$ | Dolay Time | $\mathrm{I}_{\mathrm{c}}=-150 \mathrm{ma}$, | $T_{\text {(1) }}=-15 \mathrm{ma}, V_{\text {Emom }}=0$, | 10 | nsse |
| $t_{r}$ | Rise Iime | $\mathrm{l}_{\mathrm{L}}=200 \mathrm{a}$, | See Figure ! | 40 | nsec |
| $t_{5}$ | Storage Time | $\mathrm{Ic}_{\mathrm{c}}=-150 \mathrm{ma}$, | $T_{411}=-13 \mathrm{mo}, I_{121}=17 \mathrm{mo}$ | 80 | nsek |
| H | Foll Time | $R_{L}=37 \mathrm{n}$, | See Figure 2 | 30 | nsec |

$\dagger$ Voltege and carreat values shown ere neminal; exect velues very sifighty with trensintor meremetors.
*PARAMETER MEASUREMENT INFORMATION


TEST CIRCUIT
FIGURE I-DELAY AND RISE TIMES

(See Notes a and b) VOLTAGE WAVEFORMS

FIOURE 2-sTORAGE AND FALL TIMIS



- JEBEC rogitiond drfo.

HIGH-VOLTAGE TRANSISTORS
FULLY CHARACTERIZED FOR HIGH-SPEED, LOW-NOISE, MEDIUM-POWER SWITCHING AND GENERAL PURPOSE AMPLIFIER APPLICATIONS

- hei Guaranteed from $100 \mu \mathrm{~A}$ to 100 mA
*mechanical dafa
Device types 2 N 3494 and 2 N 3495 are in JEDEC TO-5 packages. Device types 2N3496 and 2N3497 are in JEDEC TO-18 packoges.

*absolute maximum ratings af $25^{\circ} \mathrm{C}$ free-air temperature (unless ofherwise noted)

|  | 2N3494 | 2N3495 | 2N3496 | 2N3497 | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: |
| Collector-Base Voltage | -80 | -120 | -80 | -120 | $V$ |
| Collector-Emitter Voltoge (See Note 1) | -80 | -120 | -80 | -120 | $V$ |
| Emitter-Base Voltage | -4.5 | -4.5 | -4.5 | -4.5 | $V$ |
| Continuous Collector Current | -100 | -100 | -100 | -100 | mA |
| Continuous Deviee Dissipation of (or bolow) $25^{\circ} \mathrm{C}$ Fres-Air Temperature (See Notes 2 and 3) | 0.6 | 0.6 | 0.4 | 0.4 | W |
| Storage Temperature Ronge | -65 to 200 |  |  |  | ${ }^{\circ} \mathrm{C}$ |
| Lead Tempereture 1/16 Inch from Case for 10 Seconds | 300 |  |  |  | ${ }^{\circ} \mathrm{C}$ |

NOTES; 1. These values apply batwan 0 and 100 mA collecter current when the baso-wilttor diode is epon-circulted.



* JEDEC reglstored data


## TYPES 2N3494 THRU 2N3497 P-N-P SILICON TRANSISTORS

*electrical characteristics at $25^{\circ} \mathrm{C}$ free-air temperature

| PARAMETER |  | TEST CONDITIONS | $\frac{70-5 \rightarrow}{10-18 \rightarrow}$ | $\frac{2 N 3494}{2 N 3496}$ | $\frac{2 N 3495}{2 N^{3} 497}$ | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  | MIN MAX | MIN MAX |  |
|  | Collectior-Base Braakdown Volitage | $\mathrm{I}_{\mathrm{C}}=-10 \mu \mathrm{~A}, \quad \mathrm{I}_{\mathrm{E}}=0$ |  | -80 | $-120$ | V |
| $V_{\text {beplce }}$ | Collector-Emitter Breakdown Voltage | $\mathrm{I}_{\mathrm{C}}=-10 \mathrm{~mA}, \quad \mathrm{I}_{\mathrm{B}}=0$, | See Hote 4 | -80 | -120 | V |
| $V_{\text {Vak\|EBO }}$ | Emitter-Base Breakdown Voltage | $\mathrm{I}_{\mathrm{E}}=-10 \mu \mathrm{~A}, \quad \mathrm{I}_{\mathrm{C}}=0$ |  | -4.5 | -4.5 | $V$ |
| $\mathrm{I}_{\text {coo }}$ | Collactor Cutoff Current | $\mathrm{V}_{\mathrm{CB}}=-50 \mathrm{~V}, \mathrm{I}_{\mathrm{E}}=0$ |  | -0.1 |  | $\mu \mathrm{A}$ |
|  |  | $V_{C B}=-90 \mathrm{~V}, \mathrm{I}_{\mathrm{E}}=0$ |  |  | -0.1 | $\mu \mathrm{A}$ |
| EEO | Emilter Cutoff Current | $V_{E i}=-3 V, \quad I_{C}=0$ |  | -25 | -25 | nA |
| $h_{\text {fe }}$ | Static Forward Current Iransfer Ratio | $V_{C E}=-10 \mathrm{~V}, \quad \mathrm{I}_{\mathrm{C}}=-100 \mu \mathrm{~A}$ | $\begin{gathered} \text { See } \\ \text { Note } \\ 4 \end{gathered}$ | 35 | 35 |  |
|  |  | $\mathrm{V}_{\mathrm{CE}}=-10 \mathrm{~V}, \mathrm{I}_{\mathrm{C}}=-1 \mathrm{~mA}$ |  | 40 | 40 |  |
|  |  | $V_{\text {CE }}=-10 \mathrm{~V}, \quad \mathrm{I}_{\mathrm{C}}=-10 \mathrm{~mA}$ |  | 40 | 40 |  |
|  |  | $\mathrm{V}_{\mathrm{CE}}=-10 \mathrm{~V}, \mathrm{I}_{\mathrm{C}}=-50 \mathrm{~mA}$ |  | 40 | 40 |  |
|  |  | $V_{\text {CE }}=-10 \mathrm{~V}, \mathrm{I}_{\mathrm{C}}=-100 \mathrm{~mA}$ |  | 35 |  |  |
| $V_{\text {be }}$ | Base-Emittar Voltage | $\mathrm{I}_{B}=-1 \mathrm{~mA}, \quad \mathrm{I}_{C}=-10 \mathrm{~mA}$, | See Note 4 | -0.6 -0.9 | -0.6-0.9 | $V$ |
| $V_{\text {ckisat }}$ | Collector-Emitter Saturation Voltage | $\mathrm{I}_{\mathrm{B}}=-1 \mathrm{~mA}, \quad \mathrm{I}_{\mathrm{C}}=-10 \mathrm{~mA}$, | See Note 4 | -0.3 | -0.35 | $V$ |
| $h_{19}$ | Small-Signal Common-Emitter Input Impadance | $V_{C E}=-10 \mathrm{~V}$,$I_{C}=-10 \mathrm{~mA},$ | $f=1 \mathrm{kHz}$ | 0.11 .2 | $0.1 \quad 1.2$ | $\mathrm{k} \Omega$ |
| $\mathrm{h}_{6}$ | Small-Signal Common-Emilttor Forward Currant Transfer Ratio |  |  | 40300 | $40 \quad 300$ |  |
| $\mathrm{hre}^{\text {rem}}$ | Small-Signal Common-Emitter Reverse Vollage Transfer Ratio |  |  | $2 \times 10^{-4}$ | $2 \times 10^{-4}$ |  |
| $\mathrm{h}_{\infty}$ | Small-Signal Common-Emitter Output Admiltance |  |  | 300 | 300 | $\mu \mathrm{mho}$ |
| $\left\|h_{\text {for }}\right\|$ | Small-Signal Common-Emitter Forward Currant Transier Ratio | $V_{C E}=-10 \mathrm{~V}, \quad \mathrm{I}_{\mathrm{C}}=-20 \mathrm{~mA}$, | $f=100 \mathrm{mHz}$ | 2 | 1.5 |  |
| Cobo | Common-Base Open-Circuit Output Capacitance | $V_{C B}=-10 \mathrm{~V}, \quad \mathrm{I}_{\mathrm{E}}=0$, | $f=100 \mathrm{kHz}$ | 7 | 6 | pF |
| $C_{\text {b }}$ | Common-Base Open-Circuit Input Capacitante | $V_{E A}=-2 \mathrm{~V}, \quad \mathrm{I}_{\mathrm{C}}=0$, | $f=100 \mathrm{kHz}$ | 30 | 30 | pF |
| Re( $\mathrm{h}_{\text {el }}$ ) | Small-Signal Common-Emitter Input Resistance | $V_{C E}=-10 \mathrm{~V}, \quad \mathrm{I}_{\mathrm{C}}=-20 \mathrm{~mA}$, | $f=300 \mathrm{MHz}$ | 30 | 30 | $\Omega$ |

NOTE 4: Theso parametars must be measured using pulse fochniquas. $t_{p}=\mathbf{3 0 0} \mu \mathrm{s}$, duty cycle $\leq \mathbf{2 \%}$.
*switching characteristics at $25^{\circ} \mathrm{C}$ free-air temperature

|  | PARAMETER | TEST CONDITIONS $\dagger$ |  | MAX | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: |
| $t_{\text {on }}$ | Tum-On Time | $\begin{aligned} & I_{C}=-10 \mathrm{~mA}_{1} \\ & R_{L}=3 \mathrm{k} \Omega, \end{aligned}$ | $\mathrm{I}_{\mathrm{B}(1)}=-1 \mathrm{~mA}, V_{\mathrm{BE}[0 f \mathrm{f})}=0,$ <br> See Figure 1 | 300 | ms |
| $\mathrm{taHf}^{\text {Of }}$ | Tum-Off Time | $\begin{aligned} & I_{C}=-10 \mathrm{~mA}, \\ & R_{L}=3 \mathrm{k} \Omega_{1} \end{aligned}$ | $I_{[11}=-1 m A, I_{(2)}=1 m A,$ Soe Figure 2 | 1 | $\mu s$ |

*JEDEC ragistered data
†Voltage ond current values shown ere neminal; axect values vary alightly with transistor parameters. Nominal base current for turn-an time is colculated vesing a minimum walue of $\mathrm{Y}_{\mathrm{se}}$. Meminal basi currents for turn-off times are calcutated using the maximum value of $\mathrm{V}_{\mathrm{BE}}$.

PARAMETER MEASUREMENT INFORMATION

test circuit

test circuit

voltage waveforms

FIGURE I - TURN-ON TIME


FIGURE 2 - TURN-OFF TIME

MOTES: o. The Input wavaforms are supplied by a generater with $\mathbf{z}_{\text {out }}=50 \Omega$.
b. Wevoferms are memilered on an escilloscope with the follewing characteristics: $\mathrm{I}_{\mathrm{r}} \leq 10 \mathrm{~ns}, \mathbf{R}_{\text {in }} \geq 100 \mathrm{kS}$.

* JEDEC registored data

THERMAL INFORMATION


# TYPES A5T3496, A5T3497 P-N-P SILICON TRANSISTORS 

## SILECT ${ }^{\dagger}$ TRANSISTORS $\ddagger$

FOR HIGH-VOLTAGE, MEDIUM-SPEED, GENERAL PURPOSE APPLICATIONS

- High V(BR)CEO . . 80 V (A5T3496), 120 V (A5T3497)
- hfe Guaranteed from $\mathbf{1 0 0} \mu \mathrm{A}$ to $\mathbf{1 0 0} \mathbf{~ m A}$
mechanical data
These transistors are encapsulated in a plastic compound specifically designed for this purpose, using a highly mechanized process developed by Texas Instruments. The case will withstand soldering temperatures without deformation. These devices exhibit stable characteristics under high-humidity conditions and are capable of meeting MIL-STD-202C, Method 106B. The transistors are insensitive to light.

absolute maximum ratings at $\mathbf{2 5}{ }^{\circ} \mathbf{C}$ free-air temperature (unless otherwise noted)


[^70]
# TYPES A5T3496, A5T3497 P-N-P SILICON TRANSISTORS 

electrical characteristics at $25^{\circ} \mathrm{C}$ free-air temperature

| PARAMETER |  | TEST CONDITIONS | A5T3496 | A5T3497 | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | MIN MAX | MIN MAX |  |
| $V_{\text {(BR) }}$ CBO | Collector-Base Breakdown Voltage |  | $I_{C}=-10 \mu A, \quad I_{E}=0$ | -80 | -120 | V |
| $V_{(B R) C E O}$ | Colfector-Emitter Breakdown Voltage | $I_{C}=-10 \mathrm{~mA}, \mathrm{I}_{\mathrm{B}}=0, \quad$ See Note 3 | -80 | -120 | V |
| $V_{\text {(BR)EBO }}$ | Emitter-Base Breakdown Voltage | $\mathrm{I}_{\mathrm{E}}=-10 \mu A, \quad \mathrm{I}^{\prime}=0$ | -4.5 | -4.5 | V |
| I'cBo | Collector Cutoff Current | $\mathrm{V}_{C B}=-50 \mathrm{~V}, \mathrm{I}_{\mathrm{E}}=0$ | -0.1 |  | $\mu \mathrm{A}$ |
|  |  | $\mathrm{V}_{C B}=-90 \mathrm{~V}, \mathrm{I}_{\mathrm{E}}=0$ |  | -0.1 |  |
| IEBO | Emitter Cutoff Current | $V_{E B}=-3 V, I^{\prime}=0$ | -25 | -25 | nA |
| hFE | Static Forward Current Transfer Ratio | $V_{C E}=-10 \mathrm{~V}, \mathrm{I}_{\mathrm{C}}=-100 \mu \mathrm{~A}$ | 35 | 35 |  |
|  |  | $V_{C E}=-10 \mathrm{~V}, I_{C}=-1 \mathrm{~mA}$ | 40 | 40 |  |
|  |  | $V_{C E}=-10 \mathrm{~V}, \mathrm{I}^{\prime}=-10 \mathrm{~mA}$ | 40 | 40 |  |
|  |  | $\bar{V}_{C E}=-10 \mathrm{~V}, \mathrm{I}^{\prime}=-50 \mathrm{~mA}$ See Note 3 | 40 | 40 |  |
|  |  | $V_{C E}=-10 \mathrm{~V}, \mathrm{IC}^{\prime}=-100 \mathrm{~mA}$ | 35 |  |  |
| $V_{\text {BE }}$ | Base-Emitter Voltage | $\mathrm{I}_{B}=-1 \mathrm{~mA}, \quad \mathrm{I}_{\mathrm{C}}=-10 \mathrm{~mA}$, See Note 3 | -0.6 -0.9 | -0.6 -0.9 | $V$ |
| $V_{\text {CE }}$ (sat) | Collector-Emitter Saturation Voltage | $\mathrm{I}_{B}=-1 \mathrm{~mA}, \quad \mathrm{I}^{\prime}=-10 \mathrm{~mA}$, See Note 3 | -0.3 | -0.35 | V |
| $h_{i e}$ | Small-Signal Common-Emitter Input Impedance | $V_{C E}=-10 \mathrm{~V}, \mathrm{IC}=-10 \mathrm{~mA}, f=1 \mathrm{kHz}$ | 0.151 .2 | 0.11 .2 | k $\boldsymbol{\Omega}$ |
| $\mathrm{hfe}^{\text {f }}$ | Small-Signal Common-Emitter Forward Current Transfer Ratio |  | $40 \quad 300$ | $40 \quad 300$ |  |
| $h_{\text {re }}$ | Small-Signal Common-Emitter Reverse Voltage Transfer Ratio |  | $2 \times$ $10^{-4}$ | $2 \times$ $10^{-4}$ |  |
| $h_{\text {oe }}$ | Small-Signal Common-Emitter Output Admittance |  | 300 | 300 | $\mu \mathrm{mho}$ |
| Prel | Small-Signal Common-Emitter Forward Current Transfer Ratio | $V_{C E}=-10 \mathrm{~V}, \mathrm{I}^{\text {c }}=-20 \mathrm{~mA}, f=100 \mathrm{MHz}$ | 2 | 1.5 |  |
| Cobo | Common-Base Open-Circuit Output Capacitance | $V_{C B}=-10 \mathrm{~V}, \mathrm{I}_{\mathrm{E}}=0, \quad \mathrm{f}=1 \mathrm{MHz}$ | 7 | 6 | pF |
| $C_{\text {ibo }}$ | Common-Base Open-Circuit Input Capacitance | $V_{E B}=-2 \mathrm{~V}, \quad \mathrm{l}=0, \quad \mathrm{f}=1 \mathrm{MHz}$ | 30 | 30 | pF |
| $\mathrm{Re}\left(\mathrm{h}_{\text {ie }}\right)$ | Small-Signal Common-Emitter Input Resistance | $V_{C E}=-10 \mathrm{~V}, \mathrm{I} \mathrm{C}=-20 \mathrm{~mA}, \quad \mathrm{f}=300 \mathrm{MHz}$ | 30 | 30 | $\Omega$ |

NOTE 3: These paramaters must be measured using pulse techniques. $t_{w}=\mathbf{3 0 0} \mu \mathrm{s}$, duty cycle $\leqslant 2 \%$.
switching characteristics at $25^{\circ} \mathrm{C}$ free-air temperature

| PARAMETER |  | TEST CONDITIONS ${ }^{\text {t }}$ | max | UNIT |
| :---: | :---: | :---: | :---: | :---: |
| $\mathrm{t}_{\text {On }}$ | Turn-On Time | $\begin{array}{ll} \begin{array}{ll} V_{C C}=-30 V, & I_{C}=-10 \mathrm{~mA}, \\ \left.V_{B E} \text { loff }\right) & =0, \\ & \text { See Figure } 1 \end{array} \\ \hline \end{array}$ | 300 | ns |
| $\mathrm{t}_{\text {off }}$ | Turn-Off Time | $\begin{array}{ll} V_{C C}=-30 V, & I_{C}=-10 \mathrm{~mA}, \quad I_{B(1)}=-1 \mathrm{~mA}, \\ I_{B(2)}=1 \mathrm{~mA}, & \text { See Figure } 2 \end{array}$ | 1 | $\mu s$ |

[^71] calculated using the minimum value of $V_{B E}$. Nominal base currents for turn-off times are calculated using the maximum value of $V_{B E}$ -

## P-N-P SILICON TRANSISTORS

PARAMETER MEASUREMENT INFORMATION


FIGURE 1-TURN-ON TIME


FIGURE 2-TURN-OFF TIME

NOTES: a. The input waveforms are supplied by a generator with $Z_{\text {out }}=50 \Omega$.
b. Wavaforms are monitored on an oscilloscope with the following characteristics: $t_{r} \leqslant 10 \mathrm{~ns}, \mathrm{R}_{\text {in }} \geqslant 100 \mathrm{k} \Omega$.

THERMAL INFORMATION


# FULLY CHARACTERIZED FOR HICH-SPEED, LOW-NOISE, MEDIUM-POWER SWITCHING AND GENERAL-PURPOSE AMPLIFIER APPLICATIONS <br> - hre Guerenteed from $10 \mu \mathrm{~A}$ to 500 mA 

*mechanical data
Device types 2N3502 and 2N3503 are in JEDEC TO-5 packages.
Device types 2N3504 and 2N3505 are in JEDEC TO-18 packages.

absolute maximum ratings at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

|  | 2N3502 | 2N3503 | 2N3504 | 2N3505 | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: |
| ${ }^{\text {collictor-Basa Voltoge }}$ | -45 | -60 | -45 | -60 | V |
| ${ }^{*}$ Collector-Emither Voltage (Sme Mote 1) | -45 | -60 | 45 | -60 | $V$ |
| *Emittor-Ease Voltrage | -5 | -5 | -5 | -5 | V |
| ${ }^{*}$ Continuous Collictor Currment | -600 | -600 | $-600$ | -600 | mA |
| ${ }^{*}$ Continuous Device Dissipation of (or below) $25^{\circ} \mathrm{C}$ Freo-Air Tomperaturs (Sen liotes 2 and 3) | 0.7 | 0.7 | 0.4 | 0.4 | W |
| ${ }^{*}$ Continuous Devica Dissipation of (or below) $25^{\circ} \mathrm{C}$ Case Temperaturi (5en Notes 4 and 5) | 3 | 3 | 1.2 | 1.2 | W |
| *Storcye Temperature Renge | -65 to 200 |  |  |  | ${ }^{\circ} \mathrm{C}$ |
| Lood Temperature 1/16 Inch from Cose for 10 Seconds | 300 | 300 | 300 | 300 | ${ }^{\circ} \mathrm{C}$ |




4. Derats 203502 and 203503 lineerly to $280^{\circ} \mathrm{C}$ case tmaperatwe of the rate of $17.2 \mathrm{~mW} / \mathrm{deg}$.


* JEAEC majisterna diata.


## TYPES 2N3502 THRU 2N3505 <br> P-N-P SILICON TRANSISTORS

*electrical characteristles at $25^{\circ} \mathrm{C}$ freo-air tamparature (unless otherwise noted)

| PARAMITER |  | TIST CONDITIONS | $\begin{aligned} & \frac{70.5 \rightarrow}{10.18 \rightarrow} \end{aligned}$ | 2N3S04 | 2N3505 | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  | MIN MAX | MIN MAX |  |
| $V_{\text {(m) }}$ cio | Colfector-Base Braakdown Voltage |  | $l_{c}=-10 \mu A_{1} l_{1}=0$ |  | -45 | -60 | V |
| Vim)cro | Collector-Emiltar Broakdown Voltage | $\mathrm{I}_{6}=-10 \mathrm{~mA}, 1_{1}=0$, | See Note 6 | -45 | -60 | $V$ |
| $V_{\text {(0) }}$ | Emitter-Base Breakdown Valtage | $I_{1}=-10 \mu A_{1} I_{c}=0$ |  | -5 | -5 | V |
| Icro Collector Cutoff Current |  | $V_{C B}=-30 \mathrm{~V}, \mathrm{I}_{E}=0$, | $T_{A}=150^{\circ} \mathrm{C}$ | -10 |  | $\mu \mathrm{A}$ |
|  |  | $V_{C B}=-50 V_{\text {c }} L_{E}=0$, | $\mathrm{T}_{\mathrm{A}}=150^{\circ} \mathrm{C}$ |  | -10 | $\mu \mathrm{A}$ |
| Ices Collector Cutoff Current |  | $V_{C E}=-30 \mathrm{~V}, \mathrm{~V}_{\text {E }}=0$ |  | -10 |  | nA |
|  |  |  |  |  | -10 | nA |
| It Base Currant |  | $V_{C E}=-30 \mathrm{~V}, V_{\text {E }}=0$ |  | 10 |  | nA |
|  |  | $\mathrm{V}_{\text {CE }}=-50 \mathrm{~V}, \mathrm{~V}_{\text {E }}=0$ |  |  | 10 | nA |
| hef | Static Forward Current Trunsiar Ratio | $\mathrm{V}_{\mathrm{CE}}=-10 \mathrm{~V}_{1} \mathrm{l}_{\mathrm{c}}=-10 \mu \mathrm{~A}$ |  | 80 | 80 |  |
|  |  | $\mathrm{V}_{\text {CE }}=-10 \mathrm{~V}_{1} \mathrm{I}_{\mathrm{C}}=-100 \mu \mathrm{~A}$ |  | 120 | 120 |  |
|  |  | $\mathrm{V}_{\text {CE }}=-10 \mathrm{~V}, \mathrm{l}_{\mathrm{c}}=-1 \mathrm{~mA}$ |  | 135 | 135 |  |
|  |  | $V_{C E}=-10 \mathrm{~V}, \mathrm{I}_{\mathrm{C}}=-10 \mathrm{~mA}$ | $\begin{gathered} \text { See } \\ \text { Mote } \\ 6 \end{gathered}$ | 140 | 140 |  |
|  |  | $\mathrm{V}_{\text {CE }}=-10 \mathrm{~V}, \mathrm{I}_{\mathbf{C}}=-150 \mathrm{~mA}$ |  | $100 \quad 300$ | $100 \quad 300$ |  |
|  |  | $\mathrm{V}_{\mathrm{CE}}=-10 \mathrm{~V}, \mathrm{I}_{\mathrm{C}}=-500 \mathrm{~mA}$ |  | 50 | 50 |  |
|  |  | $V_{\text {CE }}=-1 \mathrm{~V}, \mathrm{I}_{\mathrm{C}}=-50 \mathrm{~mA}$ |  | 115300 | $115 \quad 300$ |  |
|  |  | $\begin{aligned} & V_{C E}=-1 V, I_{C}=-50 \mathrm{~mA} \\ & T_{A}=-55^{\circ} \mathrm{C} \end{aligned}$ |  | 50 | 50 |  |
| Vme | Baso-Emitior Voltage | $\mathrm{I}_{1}=-2.5 \mathrm{~mA}, \mathrm{I}_{\mathrm{c}}=-50 \mathrm{~mA}$ | $\begin{aligned} & \text { Soe } \\ & \text { Note } \\ & 6 \end{aligned}$ | -1 | -1 | $V$ |
|  |  | $\mathrm{I}_{\mathrm{B}}=-15 \mathrm{~mA}, \mathrm{I}_{C}=-150 \mathrm{~mA}$ |  | -1.3 | -1.3 | $V$ |
|  |  | $\mathrm{L}_{\mathrm{B}}=-30 \mathrm{~mA}, \mathrm{I}_{\mathrm{c}}=-300 \mathrm{~mA}$ |  | -2 | -2 | $V$ |
|  |  | $\mathrm{I}_{\mathrm{B}}=-50 \mathrm{~mA}, \mathrm{I}_{\mathrm{c}}=-500 \mathrm{~mA}$ |  | -2 | -2 | $V$ |
| $V_{\text {CEIat }}$ | Collector-Emittor Saturation Voltage | $\mathrm{I}_{\mathrm{s}}=-2.5 \mathrm{~mA}, \mathrm{i}_{\mathrm{c}}=-50 \mathrm{~mA}$ | $\begin{aligned} & \text { See } \\ & \text { Note } \\ & 6 \end{aligned}$ | -0.25 | -0.25 | $V$ |
|  |  | $\mathrm{I}_{\mathrm{B}}=-15 \mathrm{~mA}, \mathrm{I}_{C}=-150 \mathrm{~mA}$ |  | -0.4 | -0.4 | V |
|  |  | $\mathrm{I}_{\mathrm{s}}=-30 \mathrm{~mA}, \mathrm{I}_{\mathrm{c}}=-300 \mathrm{~mA}$ |  | -1 | -1 | $V$ |
|  |  | $\mathrm{I}_{\mathrm{B}}=-50 \mathrm{~mA}, \mathrm{I}_{\mathrm{c}}=-500 \mathrm{~mA}$ |  | -1.6 | -1.6 | $V$ |
| hie | Small-Signal Common-Emitter Input Impedance | $\mathrm{V}_{\mathrm{CE}}=-10 \mathrm{~V}$, | $f=1 \mathrm{kc} / \mathrm{s}$ | 23 | 23 | $\mathrm{k} \Omega$ |
| $\mathrm{h}_{6}$ | Small-SIgnal Common-Emitter Forword Current Trunsfer Ratio |  |  | 135420 | 135420 |  |
| hro | Small-Signal Common-Emitter Reverse Voltoge Tronsfer Ratio |  |  | $15 \times 10^{-4}$ | $15 \times 10^{-4}$ |  |
| $h_{\infty}$ | Small-Signal Common-Emitter Output Admittance |  |  | 800 | 800 | $\mu \mathrm{mho}$ |
| \| $h_{\text {re }}$ \| | Small-Signal Common-Emilter Forward Current Transfer Ratio | $V_{C E}=-20 \mathrm{~V}, \mathrm{I}_{\mathrm{C}}=-50 \mathrm{~mA},$ | $\begin{aligned} & \hline f=100 \mathrm{Mc} / \mathrm{s}, \\ & \text { See Note } 7 \\ & \hline \end{aligned}$ | 2 | 2 |  |
| Cobe | Common-Base Open-Crruift Output Capacitance | $V_{C B}=-10 \mathrm{~V}, \mathrm{I}_{\mathrm{E}}=0$, | $f=140 \mathrm{kc} / \mathrm{s}$ | 8 | 8 | pF |
| $C^{\text {b }}$ | Common-Base Open-Crruit Input Capacitance | $\mathrm{V}_{\mathrm{EB}}=-0.5 \mathrm{~V}, \mathrm{l}_{\mathrm{c}}=0$, | $\mathrm{f}=140 \mathrm{kc} / \mathrm{s}$ | 25 | 25 | pF |

MOTES: 6. These paramaters must be meesursd using pulse techniquee. $t_{p}=300 \mu s$, duty cycle $\leq 1 \%$.
7. Secause of the high leval of dissipatien invelvod, the time of appilication of collector current must be limited so that the tass temperalure does not exceod $142^{\circ} \mathrm{C}$ for the 2 M 3502 and $2 \times 3503,54^{\circ} \mathrm{C}$ for the 2 M 3504 and 2 N 3505.

- JeDEC magistorad dala.


# TYPES 2N3502 THRU 2N3505 <br> P-N-P SILICON TRANSISTORS 

*operating charateristics at $25^{\circ} \mathrm{C}$ freenair femperature

| PARAMLTER | TEST CONDITIONS | MaX | UNIT |
| :---: | :---: | :---: | :---: |
| Mf Average Nolse figure | $\begin{aligned} & V_{\mathrm{ct}}=-5 \mathrm{~V}, \mathrm{c}_{\mathrm{c}}=-30 \mu \mathrm{~h}_{1} \mathrm{R}_{\mathrm{e}}=10 \mathrm{k} \Omega, f=1 \mathrm{kc} / \mathrm{s}, \\ & \text { Nolse bandwidth }=200 \mathrm{c} / \mathrm{s} \end{aligned}$ | 4 | $d 8$ |

*awitching charactoristics at $25^{\circ} \mathrm{C}$ free-air temparature

|  | PARAMEI | TIST CONDITIONS ${ }^{\text {a }}$ | MAX | UNIT |
| :---: | :---: | :---: | :---: | :---: |
| $\mathrm{t}_{\text {d }}$ | Delay Iime | $\begin{array}{r} \mathrm{r}_{\mathrm{c}}=-300 \mathrm{~mA}, \mathrm{I}_{\text {avi }}=-30 \mathrm{~mA}, \mathrm{~V}_{\text {motorn }}=4 \mathrm{~V}, \\ \text { Seo fgure } 1 \end{array}$ | 25 | ns |
| $t_{r}$ | Rise Time |  | 35 | ns |
| $t_{\text {an }}$ | Tum-On Time |  | 40 | ns |
| $t_{1}$ | Storage Time | $I_{c}=-300 \mathrm{~mA}, I_{\text {m }}(1)=-30 \mathrm{~mA}$, See Figure 1 | 70 | ns |
| ${ }_{\text {f }}$ | Fall Time |  | 50 | ns |
| $t_{\text {eff }}$ | Turn-Off Timm |  | 100 | ns |



## *PARAMETER MEASUREMENT INFORMATION



FIGURE 1 - TURN-ON AND TURN-OFF TIMES



- JEDEC ragistorod dota.

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## SILECT ${ }^{\dagger}$ TRANSISTORS $\ddagger$

FOR HIGH-SPEED SWITCHING OR LOW-NOISE GENERAL PURPOSE AMPLIFIER APPLICATIONS

- hFE Guaranteed from $\mathbf{1 0} \mu \mathrm{A}$ to $\mathbf{5 0 0} \mathrm{mA}$
- Noise Figure . . . 4 dB Max
- Switching Characteristics Guaranteed at $\mathbf{3 0 0} \mathbf{~ m A}$


## mechanical data

These transistors are encapsulated in a plastic compound specifically designed for this purpose, using a highly mechanized process developed by Texas Instruments. The case will withstand soldering temperatures without deformation. These devices exhibit stable characteristics under high-humidity conditions and are capable of meeting MIL-STD-202C, Method 106B. The transistors are insensitive to light.

absolute maximum ratings at $\mathbf{2 5}{ }^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)


NOTES: 1. These values apply between 0 and 600 mA collector current when the base-amitter diode is open-circuited.
2. Derate linearly to $150^{\circ} \mathrm{C}$ free-air temperature at the rate of $5 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$.
3. Darate linearly to $150^{\circ} \mathrm{C}$ lead tempersture at the rate of $10 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$. Lead temperature is measured on the collector lead $1 / 16$ inch from the case.
$\dagger$ Trademark of Texas Instruments
$\ddagger$ U.S. Patent No. 3,439,238

## TYPES A5T3504, A5T3505 P-N-P SILICON TRANSISTORS

## electrical characteristics at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

| PARAMETER |  | TEST CONDITIONS | A573504 | A513505 | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | MIN MAX | MIN MAX |  |
| $V_{\text {ferlceo }}$ | Collector-Base Breakdown Voltage |  | $t_{C}=-10 \mu \hat{l}_{1} I_{E}=0$ | -45 | -60 | $V$ |
|  | Collector-Emitter Breokdown Voltage | $I_{C}=-10 \mathrm{~mA}, \mathrm{I}_{E}=0, \quad$ See Note 4 | -45 | -60 | $V$ |
| $V_{\text {(ek)EsO }}$ | Emitter-Bose Breakdown Voltuge | $\mathrm{I}_{\mathrm{E}}=-10 \mu \mathrm{~A}, \mathrm{I}_{\mathrm{C}}=0$ | -5 | -5 | $V$ |
| $\mathrm{I}_{\text {cso }}$ | Collector Cutoff Current | $V_{C E}=-30 \mathrm{~V}, \mathrm{I}_{\mathrm{E}}=0, \quad \mathrm{~T}_{\mathrm{A}}=100^{\circ} \mathrm{C}$ | -1 |  | $\mu \mathrm{h}$ |
|  |  | $V_{\text {Ce }}=-50 V_{,} \mathrm{I}_{\mathrm{E}}=0, \quad \mathrm{~T}_{\mathrm{A}}=100^{\circ} \mathrm{C}$ |  | -1 |  |
| $I_{\text {ces }}$ | Collector Cutoff Current | $V_{C E}=-30 \mathrm{~V}, V_{B E}=0$ | -10 |  | ni |
|  |  | $V_{C E}=-50 \mathrm{~V}, V_{\text {EE }}=0$ |  | -10 |  |
| $\mathrm{I}_{\mathrm{B}}$ | Bose Current | $V_{\text {CE }}=-30 \mathrm{~V}, V_{\text {be }}=0$ | 10 |  | nA |
|  |  | $V_{C E}=-50 \mathrm{~V}, V_{\text {BE }}=0$ |  | 10 |  |
| $h_{\text {fe }}$ | Slatic Forward Current Transfer Ratio | $V_{C E}=-10 \mathrm{~V}, \mathrm{I}_{\mathrm{C}}=-10 \mu \mathrm{M}$ | 80 | 80 |  |
|  |  | $V_{C E}=-10 V_{,} I_{C}=-100 \mu \mathrm{~A}$ | 120 | 120 |  |
|  |  | $\mathrm{V}_{\mathbf{C E}}=-10 \mathrm{~V}, \mathrm{I}_{\mathrm{C}}=-1 \mathrm{~mA}$ | 135 | 135 |  |
|  |  | $V_{C E}=-10 \mathrm{~V}, \mathrm{I}_{\mathbf{C}}=-10 \mathrm{~mA}$ | 140 | 140 |  |
|  |  | $\mathrm{V}_{\text {CE }}=-10 \mathrm{~V}, \mathrm{I}_{\mathbf{C}}=-150 \mathrm{~mA}$ | 100300 | $100-300$ |  |
|  |  | $V_{C E}=-10 \mathrm{~V}, \mathrm{I}_{\mathrm{C}}=-500 \mathrm{~mA} \quad$ Note | 50 | 50 |  |
|  |  | $Y_{C E}=-1 \mathrm{~V}, \mathrm{l}_{\mathrm{C}}=-50 \mathrm{~mA}$ | 115 300 | 115 300 |  |
| $V_{\text {be }}$ | Base-Emitter Voltage | $\mathrm{I}_{\mathrm{g}}=-2.5 \mathrm{~mA}, \mathrm{I}_{\mathrm{C}}=-50 \mathrm{~mA}$ | -1 | -1 | $V$ |
|  |  | $\mathrm{I}_{\mathrm{E}}=-15 \mathrm{~mA}, \mathrm{I}_{\mathrm{C}}=-150 \mathrm{~mA}$ | -1.3 | -1.3 |  |
|  |  | $\mathrm{I}_{\mathrm{E}}=-30 \mathrm{~mA}, I_{C}=-300 \mathrm{~mA} \quad 4$ | -2 | -2 |  |
|  |  | $\mathrm{I}_{\mathrm{s}}=-50 \mathrm{~mA}, \mathrm{I}_{\mathrm{C}}=-500 \mathrm{~mA}$ | -2 | -2 |  |
| $V_{\text {CE\{ } s+1]}$ | Collector-Emitter Seturation Voltage | $\mathrm{I}_{\mathrm{B}}=-2.5 \mathrm{~mA}, \mathrm{I}_{\mathrm{C}}=-50 \mathrm{~mA}$ | -0.25 | $-0.25$ | V |
|  |  | $I_{B}=-15 \mathrm{~mA}, I_{C}=-150 \mathrm{~mA}$ | -0.4 | -0.4 |  |
|  |  | $\mathrm{I}_{\mathrm{C}}=-30 \mathrm{~mA}, \mathrm{I}_{\mathrm{C}}=-300 \mathrm{~mA}$ Hele | -1 | -1 |  |
|  |  | $\mathrm{I}_{8}=-50 \mathrm{~mA}, \mathrm{l}_{\mathrm{C}}=-500 \mathrm{~mA}$ | $-1.6$ | -1.6 |  |
| $h_{\text {ie }}$ | Small-Signal Common-Emitter Input Impedance | $V_{C E}=-10 \mathrm{~V}, \mathrm{I}_{\mathrm{C}}=-10 \mathrm{~mA}, \mathrm{f}=1 \mathrm{kHz}$ | 23 | 23 | $\mathbf{k} \boldsymbol{\Omega}$ |
| $\mathrm{h}_{\text {f }}$. | Small-Signal Common-Emitier Forward Current Transfer Ratio |  | 135420 | 135420 |  |
| $h_{\text {re }}$ | Small-Signal Common-Emitter Reverse Voltoge Trunsfor Rotio |  | $15 \times 10^{-4}$ | $15 \times 10^{-4}$ |  |
| $\mathbf{h o e}_{\text {e }}$ | Small-Signal Common-Emilter Output Admittance |  | 800 | 800 | $\mu \mathrm{mho}$ |
| $\left\|h_{\text {fal }}\right\|$ | Small-Signal Common-Emitter Forward Current Tronster Ratio | $V_{C E}=-20 \mathrm{~V}, \mathrm{I}_{\mathrm{c}}=-50 \mathrm{~mA}, \mathrm{f}=100 \mathrm{mHz}$ | 2 | 2 |  |
| Cobo | Common-Base Open-Gircuit Output Capacitance | $V_{C:}=-10 \mathrm{~V}, \mathrm{l}_{\mathrm{E}}=0, \quad f=1 \mathrm{MHz}$ | 8 | 8 | pF |
| $C_{i b o}$ | Common-Base Open-Circuit Input Capacitance | $V_{E E}=-0.5 \mathrm{~V}, \mathrm{I}_{\mathrm{C}}=0, \quad f=1 \mathrm{MHz}$ | 25 | 25 | pf |

[^72]
## TYPES A5T3504, A5T3505 <br> P-N-P SILICON TRANSISTORS

operating charactoristics of $25^{\circ} \mathrm{C}$ froe-air tomperature

| PARAMETER | TEST CONDITIONS | MaX | UNIT |
| :---: | :---: | :---: | :---: |
| Spot Moise Figure | $\begin{aligned} & V_{\mathrm{ct}}=-5 \mathrm{~V}, \mathrm{~L}_{\mathrm{c}}=-30 \mu \mathrm{\mu}, \mathrm{R}_{\mathrm{G}}=10 \mathrm{k} \Omega, \mathrm{f}=1 \mathrm{kHz}, \\ & \text { Moist bromividh }=200 \mathrm{~Hz} \end{aligned}$ | 4 | ${ }_{0}$ |

swifching charactoristics af $25^{\circ} \mathrm{C}$ free-air tomperature

|  | PAItame | TEST CONDITIONSt | MAX | UNIT |
| :---: | :---: | :---: | :---: | :---: |
| $\mathrm{t}_{\mathrm{d}}$ | Delay Time | $\begin{array}{r} I_{C}=-300 \mathrm{~mA}, I_{\text {min }}=-30 \mathrm{~mA}, V_{\text {Vecooff }}=4 V, \\ \text { See Rgure } 1 \end{array}$ | 25 | ns |
| $t_{r}$ | Rise Time |  | 35 | ns |
| $t_{\text {on }}$ | Tum-On Time |  | 40 | ns |
| $t_{1}$ | Storaye Time | $\mathrm{I}_{\mathbf{C}}=\mathbf{- 3 0 0} \mathrm{mA}, \mathrm{I}_{\mathbf{m} \mid \text { I }}=\mathbf{- 3 0} \mathrm{mA}$, See Figure 1 | 70 | ns |
| $\mathrm{f}_{1}$ | Faill Time |  | 50 | ms |
| $t_{\text {oft }}$ | Turn-Off Time |  | 100 | ms |



## PARAMETER MEASUREMENT INFORMATION



FIOURE I -TURN-ON AND TURN-OFF TIMES



## DESICNED FOR HIGH-SPEED, HIGH-CURRENT SWITCHING APPLICATIONS

## mechanical detra


absolute maximum ratings at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

*electrical characteristics af $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

|  | PARAMETER | TEST CONDITIONS | MIN MAX | UNIT |
| :---: | :---: | :---: | :---: | :---: |
| $V_{\text {(ax) }} \times$ | Collector-Lasa Preakdown Yoltage | $\mathrm{l}_{\mathrm{c}}=10 \mu \mathrm{a}, l_{\mathrm{E}}=0$ | 60 | v |
| $V_{\text {(ex) }}$ ceo | Colloctor-Emilter Brookdown Vohnge | $\mathrm{Ic}_{\mathrm{c}}=30 \mathrm{ma}, \mathrm{In}=0, \quad$ See Note 4 | 30 | $v$ |
| V(ax)EO | Emitter-Base Ereokdomi Voltoge | $l_{E}=10 \mu a^{\prime} \quad l_{C}=0$ | 5 | $v$ |
| Ices | Coliector Cutoff Current | $\mathrm{V}_{\text {CE }}=40 \mathrm{~V}, \mathrm{~V}_{\text {IE }}=0$ | 0.5 | $\mu \mathrm{O}$ |
|  |  | $V_{C E}=40 v_{1} \quad V_{E E}=0, \quad T_{A}=100^{\circ} \mathrm{C}$ | 700 | $\mu$ |
| 1. | Dase Current | $V_{\text {CE }}=40 v_{1}, V_{\text {EE }}=0$ | -0.5 | $\mu 0$ |
| hre | Static Forwerd Current Iransfer Ratio | $V_{C E}=1 v_{\text {c }} \quad l_{c}=10 \mathrm{ma}$, See Mote 4 | 20 |  |
|  |  | $V_{C E}=1 \mathrm{v}, \mathrm{I}_{\mathrm{c}}=100 \mathrm{mo}$, Sae Note 4 | 25 |  |
|  |  | $V_{C E}=1 v_{1} \quad I_{C}=750$ ma, See Note 4 | $25 \quad 100$ |  |
|  |  | $V_{\text {cE }}=2 v_{1} \quad l_{c}=1 \mathrm{a}_{1}, \quad$ Seet Note 4 | 20 |  |
| $V_{\text {re }}$ | Base-Emittor Voltage | $\mathrm{I}_{\mathrm{g}}=75 \mathrm{mo}, \mathrm{l}_{\mathrm{c}}=750 \mathrm{ma}$, See Note 4 | $0.9 \quad 1.4$ | $v$ |
|  |  | $\mathrm{l}_{\mathrm{s}}=100 \mathrm{mo}, \mathrm{l}_{\mathrm{c}}=1 \mathrm{a}$, See Note 4 | $1.0 \quad 1.6$ | $v$ |
| $V_{\text {ctwot }}$ | Coltector-Emitier Saturotion Voltage | $\mathrm{I}_{8}=75 \mathrm{mo}, \mathrm{I}_{\mathrm{c}}=750 \mathrm{ma}$, See Note 4 | 0.7 | $v$ |
|  |  | $\mathrm{I}_{1}=100 \mathrm{mo}, l_{c}=1 \mathrm{c}_{\text {c }} \quad$ See Mote 4 | 1.0 | $v$ |
| \|htol | Small-Signal Common-Emittor Forword Curment Transtar Ratio | $V_{C E}=10 \mathrm{v}, \mathrm{I}_{\mathrm{C}}=50 \mathrm{ma}, f=100 \mathrm{mc}$ | 1.5 |  |
| Cobo | Common-Lase Open-Eircult Output Capacitonce | $\mathrm{V}_{\mathbf{C B}}=10 \mathrm{v}, \quad \mathrm{I}_{\mathrm{E}}=0, \quad 1=1 \mathrm{mc}$ | 25 | pf |

NOTES: 1. This value applies between 1 ma and 300 ma collector current when the base emitter diode is open-circuited. Above 300 ma
 current must not exceed 5 w for longer than $300 \mu \mathrm{sec}$.
2. Derate linearly to $200^{\circ} \mathrm{C}$ free-air temperature at the rate of $4.57 \mathrm{mw} / \mathrm{C}$.
3. Derate the 10 -watt rating linearly to $200^{\circ} \mathrm{C}$ case temperature at the rate of $57.1 \mathrm{mw} /{ }^{\circ} \mathrm{C}$. Derate the 5 -watt (JEDEC registered) rating linesty to $200^{\circ} \mathrm{C}$ case temperature at the rate of $28.6 \mathrm{mw} /{ }^{\circ} \mathrm{C}$.
4. These parameters must be measured using pulse techniques. PW $=\mathbf{3 0 0} \mu \mathrm{sec}$, Duty Cycle $<\mathbf{2 \%}$.
-The JE DEC registered outline for these devices is TO-5. TO-39 falls within TO-5 with the exception of lead length.
-JEDEC registered data. This data sheet contains all applicable registered dete in effect at the time of publication.
${ }^{T}$ This value is guaranteed by Texas Instrumants in addition to the JEDEC registered value which is also shown.
USES CHIP N13
*switching characteristics $\boldsymbol{a t} \mathbf{2 5}^{\circ} \mathrm{C}$ free-air temperature

|  | PARAMETER | TEST CONDITIONS $\dagger$ | MAX | UNIT |
| :---: | :---: | :---: | :---: | :---: |
| $\mathrm{t}_{\mathrm{d}}$ | Delay Time |  | 15 | nsec |
| $\mathrm{P}_{\mathrm{r}}$ | Rise Time |  | 35 | nsec |
| $t_{5}$ | Storage Time |  | 65 | nsac |
| ${ }_{\text {f }}$ | fall fime |  | 40 | nsec |

tVoltape and curreant values shown are nominol; oxect values vary sightly with transistor parametars.

## *PARAMETER MEASUREMENT INFORMATION


test circuit


VOLTAGE WAVEFORMS
figure
wotes: a. The input weveforms have the following cherecteristics:
For messuring doler and riso times $\mathrm{t}_{\mathrm{r}} \leq 2$ nsec, $\mathrm{PW}=450$ nser, Duty $\mathrm{C}_{\mathrm{y}} \mathrm{Cl}$ I $\leq \mathbf{2 \%}$.
Fer mosering storape and fall times $i_{i} \leq 5 \mathrm{msec}, \mathrm{PW}=1 \mu$ sec, Duty Cyele $\leq 2 \%$.


- JEDEC registerod data


# SILECT ${ }^{\dagger}$ TRANSISTOR $\ddagger$ <br> FOR HI-FI AUDIO AND GENERAL PURPOSE LOW-FREQUENCY AMPLIFIER APPLICATIONS 

- High hfe ... 150 to $\mathbf{6 0 0}$
- Plug-In Replacement for 2N3565 (TO-106)
- High Continuous Device Dissipation Rating . . . 625 mW


## mechanical data

These transistors are encapsulated in a plastic compound specifically designed for this purpose, using a highly mechanized process developed by Texas instruments. The case will withstand soldering temperatures without deformation. These devices exhibit stable characteristics under high-humidity conditions and are capable of meeting MIL-STD-202C, Method 106B. The transistors are insensitive to light.

absolute maximum ratings at $\mathbf{2 5}{ }^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)
Collector-Base Voltage ..... 30 V
Collector-Emitter Voltage (See Note 1) ..... 25 V
Emitter-Base Voltage ..... 6 V
Continuous Collector Current ..... 50 mA
Continuous Device Dissipation at (or below) $25^{\circ} \mathrm{C}$ Free-Air Temperature (See Note 2) ..... 625 mW
Storage Temperature Range ..... $-65^{\circ} \mathrm{C}$ to $150^{\circ} \mathrm{C}$
Lead Temperature 1/16 Inch from Case for 10 Seconds ..... $260^{\circ} \mathrm{C}$

NOTES: 1. This value applies whon the base-mitter diode is open-circuited.
2. Derate linearly to $150^{\circ} \mathrm{C}$ free-air temperature at the rate of $5 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$.
${ }^{\dagger}$ Trademark of Texas inatruments
FU.S. Patent No. 3,439,238

## TYPE A5T3565

N-P-N SILICON TRANSISTOR

## electrical characteristics at $25^{\circ} \mathrm{C}$ free-air temperature

| PARAMETER | TEST CONDITIONS |  | MIN | MAX | $\frac{\text { UNIT }}{V}$ |
| :---: | :---: | :---: | :---: | :---: | :---: |
| V(BR)CBO Collector-Base Breakdown Voltage | $I_{C}=100 \mu A, \quad I_{E}=0$ |  | 30 |  |  |
| $V_{\text {(BR) }}$ CEO Collector-Emitter Breakdown Voltage | $I_{C}=2 m A, \quad I_{B}=0$, | See Note 3 | 26 |  | $V$ |
| IC8O Collector Cutoff Current | $V_{C B}=25 V_{1} I_{E}=0$ |  |  | 60 | nA |
| IE8O Emitter Cutoff Current | $V_{E R}=6 \mathrm{~V}, \quad 1 \mathrm{l}=0$ |  |  | 10 | $\mu \mathrm{A}$ |
| Static Forward Current Transfer Ratio | $V_{C E}=10 \mathrm{~V}, \mathrm{I}^{\prime}=100 \mu \mathrm{~A}$ |  | 70 |  |  |
|  | $V_{C E}=10 \mathrm{~V}, I_{C}=1 \mathrm{~mA}$ |  | 150 | 600 |  |
| $\mathrm{V}_{\text {CE }}$ (sat) Collector-Emitter Saturation Voltege | $\mathrm{I}_{B}=0.1 \mathrm{~mA}, \mathrm{I}^{\prime}=1 \mathrm{~mA}$ |  |  | 0.35 | V |
| $h_{\text {ie }}$ Smali-Signal Common-Emitter <br> Input impedance | $V_{C E}=5 \mathrm{~V}, \quad I_{C}=1 \mathrm{~mA}$, | $f=1 \mathrm{kHz}$ | 2 | 20 | k $\Omega$ |
| $h_{f e}$ Small-Signal Common-Emitter <br> Forward Current Transfer Ratio  |  |  | 120 | 750 |  |
|   <br> hoe Small-Signal Common-Emitter <br> Output Admittance  |  |  | 0.5 | 100 | $\mu \mathrm{mho}$ |
| $\left\|h_{f e}\right\|$ Small-Signal Common-Emitter <br> Forward Current Transfer Ratio  | $V_{C E}=5 \mathrm{~V}, \quad \mathrm{IC}=1 \mathrm{~mA}$, | $f=20 \mathrm{MHz}$ | 2 | 12 |  |
| Cobo Common-Base Open-Circuit <br> Output Capacitance  | $V_{C B}=5 V, \quad I_{E}=0$, | $f=1 \mathrm{MHz}$ |  | 4 | pF |

NOTE 3: This parameter must be measured using pulse techniquas. $t_{w}=\mathbf{3 0 0} \mu \mathrm{s}$, duty cycle $\leqslant \mathbf{2 \%}$.

## THERMAL INFORMATION



## FOR LOW-NOISE VHF/UHF AMPLIFIER, OSCILLATOR, AND MIXER APPLICATIONS 2N3570 Features:

- Low Noise Figure . . . 7 dB Max at $1 \mathbf{~ G H z}$
- High fT . . . 1.6 GHz Min
- Low $\mathrm{rb}^{\mathbf{\prime}} \mathrm{C}_{\boldsymbol{c}}$. . . 8 ps Max


## description

These transistors are ideally suited for such applications as amplifiers, oscillators, and mixers. The guaranteed minimum gain-bandwidth products range from 1 to 1.5 GHz . Guaranteed minimum calculated $\mathrm{f}_{\text {max }}$ ranges from 1.7 to $2.7 \mathrm{GHz}^{\dagger}$. These features coupled with low noise figure ensure VHF through L-band amplifier and oscillator capability.

## *mechanical data


*absolute maximum ratings at $\mathbf{2 5}{ }^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)


NOTES: 1. Those values apply between 0 and 16 mA collector current when the bese-emitter diode is apen-circulted.
2. Derate linearly to $200^{\circ} \mathrm{C}$ fres-alr temperature at the rate of $1.14 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$.
3. Derate linearly to $200^{\circ} \mathrm{C}$ case temperature at the rate of 2 mW$)^{\circ} \mathrm{C}$.
$\dagger_{\text {Maximum }}$ Frequency of Osciltetion mav be calculated from the equation: $f_{\text {max }}(\mathrm{MHz})=200 \sqrt{\frac{\mathrm{~h}_{\mathrm{fe}} \mid \times f_{\text {maas }}(\mathrm{MHz})}{r_{b} \mathrm{C}_{\mathrm{c}}(\mathrm{Ds})}}$

## TYPES 2N3570, 2N3571, 2N3572 <br> N-P-N SILICON TRANSISTORS

*electrical characteristics at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

| PARAMETER |  | TEST CONDITIONS ${ }^{\dagger}$ | 2N3570 |  | 2N3571 |  | 2N3572 |  | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | MIN | MAX | MIN | MAX | MIN | MAX |  |
| $V_{\text {(BR) }}$ CBO | Collector-Base Breakdown Voltage |  | $I_{C}=1 \mu A, \quad I_{E}=0$ | 30 |  | 25 |  | 25 |  | V |
| $V_{\text {(BR) }}$ CEO | Collector-Emitter Breakdown Voltage | $\begin{array}{ll} I_{C}=2 \mathrm{~mA}, & \mathrm{IB}_{\mathrm{B}}=0, \\ \text { See Note } 4 & \\ \hline \end{array}$ | 15 |  | 15 |  | 13 |  | V |
| $V_{\text {(BR)EBO }}$ | Emitter-Base Breakdown Voltage | ${ }^{\prime} E=10 \mu A, ~ I C=0$ | 3 |  | 3 |  | 3 |  | $\checkmark$ |
|  |  | $V_{C B}=6 \mathrm{~V}, \mathrm{I}_{\mathrm{E}}=0$ |  | 10 |  | 10 |  | 10 | nA |
| ${ }^{1} \mathrm{CBO}$ | Collector Cutoff Current | $\begin{array}{ll} V_{C B}=6 \mathrm{~V}, & I_{E}=0, \\ T_{A}=150^{\circ} \mathrm{C} \end{array}$ |  | 1 |  | 1 |  | 1 | $\mu \mathrm{A}$ |
| hFE | Static Forward Current Transfer Ratio | $V_{C E}=6 \mathrm{~V}, \mathrm{I}^{\prime}=5 \mathrm{~mA}$ | 20 | 150 | 20 | 200 | 20 | 300 |  |
| $h_{\text {fe }}$ | Smafl-Signal Common-Emitter <br> Forward Current Transfer Ratio | $\begin{aligned} & V_{C E}=6 \mathrm{~V}, \quad \mathrm{I}^{2}=5 \mathrm{~mA}, \\ & f=1 \mathrm{kHz} \end{aligned}$ | 20 | 200 | 20 | 250 | 20 | 350 |  |
| $h_{\text {fe }}$ \| | Small-Signal Common-Emitter Forward Current Transfer Ratio | $\begin{aligned} & V_{C E}=6 \mathrm{~V}, \quad I_{C}=5 \mathrm{~mA}, \\ & f=400 \mathrm{MHz} \end{aligned}$ | 3.75 | 6 | 3 | 6 | 2.5 | 6 |  |
| $\mathrm{C}_{\mathbf{c b}}$ | Collector-Base Capacitance | $\begin{array}{ll} V_{C B}=6 \mathrm{~V}, & \mathrm{IE}_{\mathrm{E}}=0, \\ \mathrm{f}=1 \mathrm{MHz}, & \text { See Note } 5 \end{array}$ |  | 0.75 |  | 0.85 |  | 0.85 | pF |
| $r_{b}{ }^{\prime} C_{c}$ | Collector-Base Time Constant | $\begin{aligned} & V_{C B}=6 \mathrm{~V}, \quad I_{E}=-5 \mathrm{~mA}, \\ & f=79.8 \mathrm{MHz} \end{aligned}$ | 1 | 8 | 1 | 10 | 1 | 13 | ps |

*operating characteristics at $25^{\circ} \mathrm{C}$ free-air temperature

| PARAMETER | TEST CONDITIONS ${ }^{\dagger}$ | 2N3570 |  | 2N3571 |  | 2N3572 |  | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | MIN | MAX | MIN | MAX | MIN | MAX |  |
| Spot Noise Figure | $V_{C B}=6 \mathrm{~V}, \mathrm{I}_{\mathrm{E}}=-2 \mathrm{~mA}, \mathrm{R}_{\mathrm{G}}=50 \Omega, \quad f * 1 \mathrm{GHz}$ |  | 7 |  |  |  |  | dB |
|  | $V_{C B}=6 \mathrm{~V}, \mathrm{I}_{\mathrm{E}}=-2 \mathrm{~mA}, \mathrm{R}_{\mathrm{G}}=100 \Omega, f=450 \mathrm{MHz}$ |  |  |  | 4 |  | 6 | dB |

operating characteristics at $25^{\circ} \mathrm{C}$ case temperature

| PARAMETER | TEST CONDITIONS |  | 2N3670 |  |  | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  | MIN | TYP | MAX |  |
| Po Oscillator Power Output | $V_{C C}=20 \mathrm{~V}, \mathrm{l} C=15 \mathrm{~mA}, \mathrm{f}=1 \mathrm{GHz}$, | See Figure 1 |  | 60 |  | mW |

NOTES: 4. This parameter must be measured using pulse techniques. $\mathrm{t}_{\mathrm{w}}=\mathbf{3 0 0} \mu \mathrm{s}$, duty cycle $<\mathbf{2 \%}$.
5. $C_{c b}$ measurement employs a three-terminal capacitance bridge incorporating a guard circuit. The emitter and case are connected to the guard terminal of the bridge.
${ }^{\dagger}$ The fourth lead (case) is grounded for all measurements except $\mathrm{C}_{\mathrm{cb}}$ and Oscillator Power Output.
PARAMETER MEASUREMENT INFORMATION


- JEDEC registered data

FIOURE 1-1-GHz OSCILLATOR POWER OUTPUT TEST CIRCUIT

# SILECT ${ }^{\dagger}$ TRANSISTORS $\ddagger$ <br> FOR LOW-NOISE VHF/UHF AMPLIFIER, OSCILLATOR, AND MIXER APPLICATIONS 

\author{

- Minimum Calculated $\mathrm{f}_{\text {max }} \mathrm{E}^{\mathrm{I}}$. . 2.2 GHz (A5T3571) <br> - Low Noise Figure . . . 4 dB Maximum (A5T3571)
}


## mechanical data

These transistors are encapsulated in a plastic compound specifically designed for this purpose, using a highly mechanized process developed by Texas instruments. The case will withstand soldering temperatures without deformation. These devices exhibit stable characteristics under high-humidity conditions and are capable of meeting MIL-STD-202C, Method 106B. The transistors are insensitive to light.

absolute maximum ratings at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)


NOTES: 1. These values apply between 0 and 15 mA collector current when the bese-emitter diode is open-circuited.
2. Derate linearly to $150^{\circ} \mathrm{C}$ free-air temperature at the rate of $4 \mathrm{~mW} / \mathcal{C}$.
tTrademark of Texas instruments
$\ddagger$ U.S. Patent No. 3,439,238


## TYPES A5T3571, A5T3572

N-P-N SILICON TRANSISTORS
electrical characteristics at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

| PARAMETER | TEST CONDITIONS |  |  | A6T3571 |  | A5T3572 |  | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  | MIN | MAX | MIN | MAX |  |
| $\mathrm{V}_{(3 R)}$ CBO Collector-Base Breakdown Voltage | $l_{C}=1 \mu A$, | $\mathrm{IE}_{\mathrm{E}}=0$ |  | 25 |  | 25 |  | V |
| $\mathrm{V}_{(B R) C E O}$ Collector-Emitter Breakdown Voltage | $\mathrm{I}_{\mathrm{C}}=2 \mathrm{~mA}$, | $\mathrm{I}_{\mathrm{B}}=0$, | See Note 3 | 15 |  | 13 |  | V |
| $\mathrm{V}_{\text {(BR)EBO }}$ Emitter-Base Breakdown Voltage | $I_{E}=10 \mu \mathrm{~A}$, | $\mathrm{I}_{\mathrm{C}}=0$ |  | 3 |  | 3 |  | V |
| ICBO Collector Cutoff Current | $\mathrm{V}_{\mathrm{CB}}=6 \mathrm{~V}$, | $\mathrm{I}_{\mathrm{E}}=0$ |  |  | 10 |  | 10 | nA |
|  | $V_{C B}=6 \mathrm{~V}$, | $\mathrm{I}^{\prime} \mathrm{E}=0$, | $T_{A}=100^{\circ} \mathrm{C}$ |  | 200 |  | 200 |  |
| hFE Static Forward Current Transfer Ratio | $V_{C E}=6 \mathrm{~V}$, | $\mathrm{IC}^{\prime}=5 \mathrm{~mA}$ |  | 20 | 200 | 20 | 300 |  |
| h $_{\text {fe }}$ Small-Signal Common-Emitter <br>  Forward Current Transfer Ratio | $V_{C E}=6 \mathrm{~V}$, | ${ }^{\prime} \mathrm{C}=5 \mathrm{~mA}$, | $\mathrm{f}=1 \mathrm{kHz}$ | 20 | 250 | 20 | 350 |  |
| $\mathrm{H}_{\mathrm{fe}} \left\lvert\, \quad$Small-Signal Common-Emitter\right. | $V_{C E}=6 \mathrm{~V}$, | $I_{C}=5 \mathrm{~mA}$, | $\mathrm{f}=\mathbf{4 0 0 ~ M H z}$ | 3 | 6 | 2.5 | 6 |  |
| $\mathrm{C}_{\boldsymbol{c b}} \quad$ Collector-Base Capacitance | $V_{C B}=6 \bar{V},$ <br> See Note 4 | $I_{E}=0$ | $\mathrm{f}=1 \mathrm{MHz},$ |  | 0.85 |  | 0.85 | pF |
| $\mathrm{rb}^{\prime} \mathrm{C}_{\mathrm{c}} \quad$ Collector-Base Time Constant | $\mathrm{V}_{\mathrm{CB}}=6 \mathrm{~V}$, | $\mathrm{I}_{\mathrm{E}}=-5 \mathrm{~mA}$. | $f=79.8 \mathrm{MHz}$ | 1 | 10 | 1 | 13 | ps |

operating characteristics at $\mathbf{2 5} \mathbf{}{ }^{\circ} \mathbf{C}$ free-air temperature

| PARAMETER |  | TEST CONDITIONS | A5T3571 |  | A5T3572 |  | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | MIN | MAX | MIN | MAX |  |
| F | Spot Noise Figure |  | $\begin{aligned} & V_{C B}=6 \mathrm{~V}, \quad \mathrm{I}_{\mathrm{E}}=-2 \mathrm{~mA}, \quad \mathrm{R}_{\mathrm{G}}=100 \Omega, \\ & \mathrm{f}=450 \mathrm{MHz} \end{aligned}$ |  | 4 |  | 6 | dB |

NOTES: 3. This parameter must be measured using pulse techniques. $t_{w}=300 \mu \mathrm{~s}$, duty eycle $<\mathbf{2 \%}$.
4. $\mathrm{C}_{\mathrm{cb}}$ measurement employs a three-terminal capacitance bridge incorporating aguard circuit. The emitter is connected to the guard terminal of the bridge.

THERMAL INFORMATION


FIGURE 1

## DESIGNED FOR HIGH-SPEED SWITCHING APPLICATIONS

- Low Guaranteed $\mathrm{V}_{\text {CE(sat) }}$ - 0.5 v max at 100 ma
- High fit - $\mathbf{4 0 0} \mathrm{Mc}$ min at $10 \mathrm{v}, \mathbf{1 0} \mathrm{ma}$
- Low Tatal Switching Time - 80 msec max at 10 ma
*mechanical data

|  | TME COLLECTOR IS IM ELECTRICAL COMTACT WITH THE CASE <br> ALL JEDEC TO-I8 DIMENSIOMS aND WOTES ARE APPLICABLE |  |
| :---: | :---: | :---: |

*absolute maximum ratings at $25^{\circ} \mathrm{C}$ free-air temperafure (unless otherwise specified)
Collector-Base Voltage -20 v
Collector-Emitter Voltage (See Note 1) . . . . . . . . . . . . . . . . . . . . -15
Emitter-Base Voltage . . . . . . . . . . . . . . . . . . . . . . . . . -5v
Callector Current . . . . . . . . . . . . . . . . . . . . . . . . . . - 200 ma
Continuous Device Dissipation at (or below) $25^{\circ} \mathrm{C}$ Free-Air Temperature
(See Note 2)
360 mw
Continuous Device Dissipation at (or below) $25^{\circ} \mathrm{C}$ Case Temperature
(See Note 3)
Storage Temperature Range . . . . . . . . . . . . . . . . . . . $-65^{\circ} \mathrm{C}$ to $+200^{\circ} \mathrm{C}$
Lead Temperature $\mathrm{K}_{6}$ Inch from Case for 10 Second: . . . . . . . . . . . . . . . $300^{\circ} \mathrm{C}$
*electrical characteristics at $25^{\circ} \mathrm{C}$ freo-air temperature (unless otherwise specified)

| PARAMETER | TEST CONDITIONS | MIN MAX | UNIT |
| :---: | :---: | :---: | :---: |
|  | $\mathrm{I}_{\mathrm{c}}=-10 \mu \mathrm{a}, \mathrm{I}_{\mathrm{E}}=0$ | -20 | $\checkmark$ |
|  | $\mathrm{I}_{\mathrm{c}}=-10 \mathrm{mo}, \mathrm{I}_{B}=0, \quad$ See Note 4 | -15 | $v$ |
|  | $\mathrm{I}_{\mathrm{E}}=-10 \mu \mathrm{a}, \mathrm{l}_{\mathrm{c}}=0$ | -5 | V |
| Collector Cutoff Current | $V_{C E}=-15 \mathrm{v}, V_{\text {E }}=0$ | -10 | ma |
|  | $V_{C E}=-15 \mathrm{v}, \mathrm{V}_{\text {EE }}=0, \quad \mathrm{~T}_{\mathrm{A}}=150^{\circ} \mathrm{C}$ | -10 | $\mu \mathrm{C}$ |
| In Base Current | $V_{C E}=-15 \mathrm{v}, \mathrm{V}_{\text {GE }}=0$ | 10 | na |
| Static Forward Current Trensfer Rotio | $V_{C E}=-0.5 v_{1} I_{c}=-10 \mathrm{ma}$ | $40 \quad 120$ |  |
|  | $V_{C E}=-0.5 \mathrm{v}_{1} \mathrm{I}_{\mathrm{C}}=-10 \mathrm{ma}, \mathrm{I}_{\mathrm{A}}=-55^{\circ} \mathrm{C}$ | 20 |  |
|  | $V_{C E}=-1 v_{1} \quad I_{c}=-100 \mathrm{ma}_{n}$ Seo Mote 4 | 10 |  |
| Baso-Emitter Yoltage | $\mathrm{I}_{1}=-1 \mathrm{ma}, \quad I_{c}=-10 \mathrm{ma}$, Seo Mote 4 | -0.75 $-\mathbf{- 0 . 9 5}$ | $v$ |
|  | $I_{s}=-10 \mathrm{ma}, I_{c}=-100 \mathrm{ma}$, See Mote 4 | -1.1 | $v$ |
| Collector-Emither Soturation Voltray | $\mathrm{I}_{\mathrm{E}}=-1 \mathrm{ma}, \quad \mathrm{I}_{\mathrm{c}}=-10 \mathrm{ma}$, Sen Note 4 | -0.15 | $v$ |
|  | $I_{s}=-10 \mathrm{ma}, I_{c}=-100 \mathrm{ma}$, Seot Mote 4 | -0.5 | $v$ |
| \|hrol Small-Simpal Comman-Emititer | $V_{C E}=-10 \mathrm{vg} \quad \mathrm{I}_{\mathbf{C}}=-10 \mathrm{ma}, \quad f=100 \mathrm{mc}$ | 4 |  |
| $\begin{array}{ll} \hline \text { Como } & \begin{array}{l} \text { Common-Basse Open-Crait } \\ \text { Dutput Copacitence } \end{array} \\ \hline \end{array}$ | $V_{C B}=-5 \mathrm{v}, \quad \mathrm{I}_{\mathrm{E}}=0, \quad f=140 \mathrm{kc}$ | 4.5 | pf |
| $\begin{aligned} & \text { Common-Base Open-Crai't } \\ & \text { Input Capocitance } \end{aligned}$ | $V_{B s}=-0.5 \mathrm{v}, \mathrm{l}_{\mathrm{c}}=0, \quad f=140 \mathrm{kc}$ | 5 | pf |

 rots of $83.3 \mathrm{mv} / \mathrm{me}$.
2. Derate lineorly to $175^{\circ} \mathrm{C}$ fros-air immporatere at the rate of $2.4 \mathrm{~mm} / \mathrm{C}^{\circ}$.
3. Derale lineerly to $175^{\circ} \mathrm{C}$ cose tempereture at the nate of $8.0 \mathrm{~mm} / \mathrm{C}^{\circ}$.

-Indicater JEDEC mejistered delo
USES CHIP P11

## TYPE 2N3576

## P-N-P SILICON TRANSISTOR

## *switching charactoristics af $25^{\circ} \mathrm{C}$ free-air temperature

| PARAMETER | TEST CONDITIONS $\dagger$ | MAX | UNIT |
| :---: | :---: | :---: | :---: |
| Id Delor 7ime |  | 12 | msec |
| $\mathrm{tr}_{\text {r }}$ Rise Time |  | 18 | nsec |
| $t_{5}$ Storage Tlime |  | 30 | nsoc. |
| If Full Time |  | 20 | nser |


*PARAMETER MEASUREMENT INFORMATION



TEST CTRCUIT


VOLTAGE WAVEFORMS

FIGURE 2

b. Output woveforms are manitored on escillecerpe with the following charectoristiks: $\mathrm{I}_{\mathrm{r}} \leq 1$ nsec, $\mathrm{R}_{\text {in }} \geq 100 \mathrm{k} \boldsymbol{\Omega}, \mathrm{C}_{\text {in }} \leq 10 \mathrm{pf}$.
-Iadicatos JEDEC registered data

## HIGH-VOLTAGE TRANSISTORS FOR GENERAL PURPOSE AMPLIFIER AND SWITCHING APPLICATIONS

- High V(BR)CEO . . . 140 V (2N3634, 2N3635) or 175 V (2N3636, 2N3637)
- High Dissipation Capability . . . 10 W at $25^{\circ} \mathrm{C}$ Case Temperature
mechanical data
THE COLLECTOR IS IN ELECTRICAL CONTACT WITH THE CASE
absolute maximum ratings at $\mathbf{2 5}{ }^{\circ} \mathbf{C}$ free-air temperature (unless otherwise noted)


NOTES: 1. These values apply batween 0 and 10 mA collector current when the emitter-base diode is open-circuited.
2. Derate lincarly to $200^{\circ} \mathrm{C}$ free-air temperature at the rate $065.71 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$.
3. Derate the 10 -watt rating linearly to $200^{\circ} \mathrm{C}$ case temperature at the rate of $57.1 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$. Derate the 5 -watt (JEDEC registered) rating linearly to $200^{\circ} \mathrm{C}$ cese temperature at the rate of $28.6 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$.
The JEDEC registerid outiline for thene devices is TO-5. TO-39 falls within TO-5 with the exception of leed length.
-JEDEC registered data. This date theet contains all epplicable registered date in effect at the time of publication.
${ }^{\dagger}$ Thoee values are guarenteed by Texss instrumants in addition to the JEDEC registered velues which are siso shown.

## TYPES 2N3634 THRU 2N3637 <br> P-N-P SILICON TRANSISTORS

"electrical characteristics at $\mathbf{2 5}{ }^{\circ} \mathrm{C}$ free-air temperature

| PARAMETER |  | TEST CONDITION8 |  | 2N3834 |  | 2N3035 |  | 2N3030 |  | 2N3E37 |  | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | MIN | MAX | MIN | MAX | MIN | MAX | MIN | MAX |  |
| $V_{(B R) C B O}$ | Collector-Bace <br> Braakdown <br> Voltage |  |  | IC $=-100 \mu \mathrm{~A}, \mathrm{IE}=0$ |  | -140 |  | -140 |  | -175 |  | -175 |  | V |
| V(bR)CEO ${ }^{\text {B }}$ | Collector-Emitter Breakdown Voltage | $\begin{aligned} & l_{C}=-10 m A, \quad I_{B}=0, \\ & \text { See Note } 4 \end{aligned}$ |  | -140 |  | -140 |  | -176 |  | -175 |  | V |
| V(BR)EBO ${ }^{\text {B }}$ | Emitter-Bate <br> Braakdown <br> Voltage | ${ }^{\prime} E=-10 \mu A, \quad I C=0$ |  | $-5$ |  | -5 |  | -5 |  | -5 |  | V |
| ICBO $\quad$ C | Collector Cutoff Current | $V_{C B}=-100 \mathrm{~V}, \mathrm{IE}=0$ |  | -100 |  | -100 |  | -100 |  | -100 |  | nA |
| IEBO C | Emitter Cutoff Current | $V_{E B}=-3 \mathrm{~V}, \quad \mathrm{IC}=0$ |  |  | -50 |  | -50 |  | -50 |  | -50 | nA |
| hFE $\begin{array}{r}\text { S } \\ \\ \end{array}$ | Static Forward Current Transfer Ratio | $V_{C E}=-10 \mathrm{~V}, 1 \mathrm{C}=-0.1 \mathrm{~mA}$ |  | 40 |  | 80 |  | 40 |  | 80 |  |  |
|  |  | $V_{C E}=-10 \mathrm{~V}, 1 \mathrm{C}=-1 \mathrm{~mA}$ |  | 45 |  | 90 |  | 45 |  | 90 |  |  |
|  |  | $V_{\text {CE }}=-10 \mathrm{~V}, 1 \mathrm{C}=-10 \mathrm{~mA}$ | See <br> Note <br> 4 | 50 |  | 100 |  | 50 |  | 100 |  |  |
|  |  | $\mathrm{V}_{\text {CE }}=-10 \mathrm{~V}$, IC $\mathrm{IC}^{=-50 \mathrm{~mA}}$ |  | $50 \quad 150$ |  | 100 | 300 | 50 | 150 | $100 \quad 300$ |  |  |
|  |  | $\overline{V_{C E}=-10 V} \mathrm{I}^{\text {c }}=-150 \mathrm{~mA}$ |  | 25 |  | 50 |  | 25 |  | 50 |  |  |
| VBE | Base-Emitter <br> Voltage | $\mathrm{I}^{\prime} \mathrm{C}=-10 \mathrm{~mA}, \quad \mathrm{I}_{\mathrm{B}}=-1 \mathrm{~mA}$ | SeeNote4 | -0.8 |  | -0.8 |  | -0.8 |  | -0.8 |  | V |
|  |  | $\mathrm{IC}_{\mathrm{C}}=-50 \mathrm{~mA}, \mathrm{I}_{\mathrm{B}}=-5 \mathrm{~mA}$ |  | -0.65 | -0.9 | -0.65 | -0.9 | $\left[\begin{array}{ll} -0.65 & -0.9 \\ \hline \end{array}\right.$ |  | -0.65 -0.9 |  |  |
| $\mathbf{V}_{\mathbf{C E} \text { (sat) }} \mathbf{C}$ | Collector-Emitter <br> Saturation Voltage | $\mathrm{I}^{\prime} \mathrm{C}=-10 \mathrm{~mA}, \quad \mathrm{I}_{\mathrm{B}}=-1 \mathrm{~mA}$ | See <br> Note <br> 4 |  | -0.3 |  | -0.3 |  | -0.3 |  | -0.3 | v |
|  |  | $\mathrm{I}^{\prime} \mathrm{C}=-50 \mathrm{~mA}, \quad 18=-5 \mathrm{~mA}$ |  |  | -0.5 |  | -0.5 |  | -0.5 |  | -0.5 |  |
| hle ${ }^{\text {H }}$ | Small-Signal Common-Emitter Input Impedance | $\begin{aligned} & V_{C E}=-10 \mathrm{~V}, \quad I^{\prime}=-10 \mathrm{~mA}, \\ & f=1 \mathrm{kHz} \end{aligned}$ |  | 0.1 | 0.6 | 0.2 | 1.2 | 0.1 | 0.6 | 0.2 | 1.2 | $k \Omega$ |
|   <br> $n_{f e}$  <br>   <br>   <br>   <br>   <br>   <br>   <br>   | Small-Signal Common-Emitter Forwerd Current Transfer Ratio |  |  | $40 \quad 160$ |  | $80 \quad 320$ |  | $40 \quad 160$ |  | $80 \quad 320$ |  |  |
|  | Small-Signai Common-Emitter Reverse Voltage Transfer Ratio |  |  | $\begin{array}{r} 3 \times \\ 10^{-4} \end{array}$ |  | $\begin{array}{r} 3 \times \\ 10^{-4} \end{array}$ |  | $\begin{array}{r} 3 \times \\ 10^{-4} \end{array}$ |  | $3 \times$$10^{-4}$ |  |  |
|   <br>   <br>   <br>  $C$ <br>   <br>   <br>   <br>   | Small-Signal <br> Common-Emitter <br> Output <br> Admittance |  |  | 200 |  | 200 |  | 200 |  | 200 |  | $\mu \mathrm{mho}$ |
|   <br>   <br> $h_{f e} l$ S <br>  F <br>   <br>   <br>   | Small-Signal <br> Common-Emitter <br> Forward Current <br> Transfer Ratio | $\begin{aligned} & V_{C E}=-30 \mathrm{~V}, \quad \mathrm{IC}=-30 \mathrm{~mA}, \\ & \mathrm{f}=100 \mathrm{MHz} \end{aligned}$ |  | 1.5 |  | 2 |  | 1.5 |  | 2 |  |  |
| Cobo $\begin{gathered}\text { Co } \\ \\ \\ \\ \end{gathered}$ | Common-Base Open-Circuit Output Capacitance | $\begin{aligned} & V_{C B}=-20 \mathrm{~V}, \quad I E=0, \\ & f=100 \mathrm{kHz} \end{aligned}$ |  | 10 |  | 10 |  | 10 |  | 10 |  | pF |
| $c_{\text {ibo }} \quad \begin{aligned} & \text { C } \\ & \\ & \end{aligned}$ | Common-Btate <br> Open-Circuit <br> Input Capacitance | $\begin{aligned} & V_{E B}=-1 V, \quad I C=O_{1} \\ & f=100 \mathrm{kHz} \end{aligned}$ |  | 75 |  | 75 |  | 75 |  | 75 |  | pF |

NOTE 4: Thene paremetera must be measured using pulee techniques. $\mathrm{t}_{\mathrm{w}}=\mathbf{3 0 0} \boldsymbol{\mu \varepsilon}$, duty cycle $\leqslant \mathbf{2 \%}$.

# TYPES 2N3634 THRU 2N3637 <br> P-N-P SILICON TRANSISTORS 

## "operating characteristics at $25^{\circ} \mathrm{C}$ free-air temperature

|  |  | PARAMETEA | TEST CONDITIONS |  | MIN | MAX | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| F | Spot Noive Figure |  | $\begin{aligned} & V_{C E}=-10 \mathrm{~V} \\ & R_{G}=1 \mathrm{k} \Omega, \end{aligned}$ | $\begin{aligned} & \mathrm{IC}=-0.5 \mathrm{~mA}, \\ & f=1 \mathrm{kHz} \end{aligned}$ |  | 3 | dB |

*switching characteristics at $25^{\circ} \mathrm{C}$ free-air temperature

| PARAMETER | TEST CONDITIONS ${ }^{\text {t }}$ | MIN MAX | UNIT |
| :---: | :---: | :---: | :---: |
| ton Turn-On Time | VCC $=-100 \mathrm{~V}$, ic $=-50 \mathrm{~mA}$, $\mathrm{I}_{\mathrm{B}(1)}=-5 \mathrm{~mA}, \mathrm{~V}_{\mathrm{BE}(\mathrm{off})}=4 \mathrm{~V}$, <br> See Figure 1 | 400 | ns |
| toff Turn-Off Time | $\begin{aligned} & V_{C C}=-100 \mathrm{~V}, I_{C}=-50 \mathrm{~mA}, \\ & I_{B(1)}=-5 \mathrm{~mA}, I_{B(2)}=5 \mathrm{~mA}, \\ & \text { See Figure } 1 \end{aligned}$ | 600 | ns |

$\dagger$ Voltage and current values ahown are nominal; exact values vary sightly with transistor parameters.
*PARAMETER MEASUREMENT INFORMATION



VOLTAGE WAVEFORMS
FIGURE 1

NOTES: A. The input waveforms are supplled by aserator with the following eharacterletics: $Z_{\text {out }}=80 \Omega, t_{r} \leqslant 20 \mathrm{~ns}, \mathrm{t}_{\mathrm{f}}<\mathbf{2 0} \mathrm{ns}$, $t_{w} \approx 20 \mu$ s, duty eycie < $2 \%$.
B. Wavaforms are monitored on an oscillosope with the foliowing characterletles: $\mathrm{t}_{\mathrm{r}} \leqslant 10 \mathrm{~ns}, \mathrm{R}_{\text {in }}>100 \mathrm{k} \Omega, \mathrm{C}_{\text {in }} \leqslant \mathbf{5} \mathrm{pF}$.

- JEDEC ragietered date


# TYPES A5T3638, A5T3638A P-N-P SILICON TRANSISTORS 

## SILECT ${ }^{\dagger}$ TRANSISTORS $\ddagger$

 FOR HIGH-CURRENT, MEDIUM-SPEED SWITCHING APPLICATIONS\author{

- High Collector Current . . . 500 mA <br> - Electrically Identical to 2N3638, 2N3638A (TO-105) <br> - High Dissipation Capability
}


## mechanical data

These transistors are encapsulated in a plastic compound specifically designed for this purpose, using a highly mechanized process developed by Texas Instruments. The case will withstand soldering temperatures without deformation. These devices exhibit stable characteristics under high-humidity conditions and are capable of meeting MIL-STD-202C, Method 106B. The transistors are insensitive to light.

absolute maximum ratings at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)
Collector-Base Voltage . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . -25 V

Collector-Emitter Voltage (See Note 1) . . . . . . . . . . . . . . . . . . . . . . . . . . . - $\mathbf{2 5} \mathrm{V}$
Emitter-Base Voltage . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . -4 V
Continuous Collector Current . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . -500 mA
Continuous Device Dissipation at (or below) $25^{\circ} \mathrm{C}$ Free-Air Temperature (See Note 2) . . . . . . . . . 625 mW
Continuous Device Dissipation at (or below) $25^{\circ} \mathrm{C}$ Lead Temperature (See Note 3) . . . . . . . . . . 1.25 W
Storage Temperature Range . . . . . . . . . . . . . . . . . . . . . . . . . . . $-65^{\circ} \mathrm{C}$ to $150^{\circ} \mathrm{C}$
Lead Temperature $1 / 16$ Inch from Case for 10 Seconds . . . . . . . . . . . . . . . . . . . . . $260^{\circ} \mathrm{C}$

NOTES: 1. This value applies betwean 0.01 mA and 500 mA collector current when the base-emitter diode is open-circuited.
2. Derate lineariy to $150^{\circ} \mathrm{C}$ free-air temperature at the rate of $5 \mathrm{~mW} / \mathrm{C}$.
3. Derate linearly to $150^{\circ} \mathrm{C}$ lead temperature at the rate of $10 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$. Lead tempersture is measured on the callector lead $1 / 16$ inch from the case.
tTrademark of Texas instruments
\#U.S. Patent No. 3,439,238

## TYPES A5T3638, A5T3638A P-N-P SILICON TRANSISTORS

electrical characteristics at $\mathbf{2 5}^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

| PARAMETER |  | TEST CONDITIONS |  | A5T3938 | A5T3638A | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | MIN MAX | MIN MAX |  |
| $V_{\text {(BR) }} \mathrm{V}^{\text {(BRO }}$ | Collector-Base Breakdown Vottage |  |  | $I_{C}=-100 \mu A, I_{E}=0$ |  | -25 | -25 | V |
| $V_{\text {(BR)CEO }}$ | Collector-Emitter Breakdown Voltage | $\mathrm{I}_{\mathrm{C}}=-10 \mathrm{~mA}, ~ I_{B}=0$, | See Note 4 | -25 | -25 | V |
| $V_{\text {(BR)CES }}$ | Collector-Emitter Braskdown Voltage | $\bar{T}_{C}=-100 \mu A, V_{B E}=0$ |  | -25 | -25 | V |
| V(BR)EBO | Emitter-Base Breakdown Voltage | $\mathrm{I}_{\mathrm{E}}=-100 \mu \mathrm{~A}, \mathrm{I} C=0$ |  | -4 | -4 | V |
| Ices | Collector Cutoff Current | $V_{\text {CE }}=-15 \mathrm{~V}, \mathrm{~V}_{\text {BE }}=0$ |  | -35 | -35 | nA |
|  |  | $\mathrm{V}_{\text {CE }}=-15 \mathrm{~V}, \mathrm{~V}_{\text {BE }}=0$, | $\mathrm{T}_{\mathbf{A}}=65^{\circ} \mathrm{C}$ | -2 | -2 | $\boldsymbol{\mu A}$ |
| $\mathrm{I}_{8}$ | Base Current | $V_{C E}=-15 \mathrm{~V}, \mathrm{~V}_{\text {BE }}=0$ |  | 35 | 35 | nA |
| hFE | Static Forward Current Transfer Ratio | $\mathrm{V}_{\text {CE }}=-10 \mathrm{~V}, \mathrm{~T}^{\prime}=-1 \mathrm{~mA}$ | See Note 4 |  | 80 |  |
|  |  | $\mathrm{V}_{\text {CE }}=-10 \mathrm{~V}, \mathrm{I}_{\mathrm{C}}=-10 \mathrm{~mA}$ |  | 20 | 100 |  |
|  |  | $V_{C E}=-1 \mathrm{~V}, \mathrm{I}^{\prime}=-50 \mathrm{~mA}$ |  | 30 | 100 |  |
|  |  | $V_{C E}=-2 \mathrm{~V}, \mathrm{I}_{\mathrm{C}}=-300 \mathrm{~mA}$ |  | 20 | 20 |  |
| VBE | Base-Emitter Voltage | $\mathrm{I}_{\mathrm{B}}=-2.5 \mathrm{~mA}, I_{C}=-50 \mathrm{~mA}$ | See Note 4 | -1.1 | -1.1 | V |
|  |  | $\mathrm{I}_{\mathrm{B}}=-30 \mathrm{~mA}, \mathrm{I}^{2}=-300 \mathrm{~mA}$ |  | -0.8 -2 | -0.8 -2 |  |
| VCE(sat) | Collector-Emitter Saturation Voltage | $\mathrm{I}_{\mathrm{B}}=-2.5 \mathrm{~mA}, \mathrm{I}^{\prime}=-50 \mathrm{~mA}$ | See Note 4 | -0.25 | -0.25 | V |
|  |  | $\mathrm{I}_{\mathrm{B}}=-30 \mathrm{~mA}, \mathrm{IC}^{\prime}=-300 \mathrm{~mA}$ |  | -1 | -1 |  |
| $h_{\text {ie }}$ | Small-Signal Common-Emitter Input Impedance | $V_{C E}=-10 \mathrm{~V}, \mathrm{I}_{\mathrm{C}}=-10 \mathrm{~mA}, f=1 \mathrm{kHz}$ |  | 2 | 2 | $k \Omega$ |
| $\mathrm{hffe}^{\text {fe }}$ | Small-Signal Common-Emitter <br> Forward Current Transfer Ratio |  |  | 25 | 100 |  |
| $h_{\text {re }}$ | Small-Signal Common-Emitter Reverse Vortage Transfer Ratio |  |  | $\begin{array}{r} 26 \times \\ 10^{-4} \end{array}$ | $\begin{array}{r} 15 x \\ 10^{-4} \end{array}$ |  |
| $h_{\text {oe }}$ | Small-Signal Common-Emitter Output Admittance |  |  | 1.2 | 1.2 | mmho |
| $\mathrm{H}_{\text {fel }}$ | Small-Signal Common-Emitter Forward Current Transfer Ratio | $\mathrm{V}_{\text {CE }}=-3 \mathrm{~V}, \quad \mathrm{I}^{\prime}=-50 \mathrm{~mA}$, | $f=100 \mathrm{MHz}$ | 1 | 1.5 |  |
| Cobo | Common-Base Open-Circuit Output Capacitance | $\mathrm{V}_{C 8}=-10 \mathrm{~V}, \mathrm{IE}=0$, | $\mathrm{f}=1 \mathrm{MHz}$ | 20 | 10 | pF |
| Cibo | Common-Base Open Circuit Input Capacitance | $V_{E B}=-0.5 \mathrm{~V}, \mathrm{I}_{\mathrm{C}}=0$, | $f=1 \mathrm{MHz}$ | 65 | 35 | pF |

NOTE 4: These parameters must be measured using pulse techariques. $t_{w}=\mathbf{3 0 0} \mu \mathrm{s}$, duty cycle $\leq 2 \%$.

## TYPES A5T3638, A5T3638A <br> P-N-P SILICON TRANSISTORS

switching charactaristics at $\mathbf{2 5}{ }^{\circ} \mathbf{C}$ free-air temperature

| PARAMETER |  | TEST CONDITIONS ${ }^{\dagger}$ |  | MIN MAX | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: |
| d | Delay Time | $V_{C C}=-10 \mathrm{~V}$. | ${ }^{1} \mathrm{C}=\mathbf{=} \mathbf{3 0 0} \mathrm{mA}$, | 20 | ns |
| $t_{r}$ | Rise Time | $\mathrm{I}_{\mathrm{B}}(1)=-30 \mathrm{~mA}$, | $V_{\text {BE }}($ off $)=3.1 \mathrm{~V}$, | 70 | ns |
| ton | Turn-On Time | See Figure 1 |  | 75 | ns |
| $t_{s}$ | Storege Time | $\mathrm{V}_{\mathbf{C C}}=-10 \mathrm{~V}$, | IC $=-300 \mathrm{~mA}$, | 140 | ns |
| ${ }_{4}$ | Fall Time | $\mathrm{I}_{\mathrm{B}(1)}=-30 \mathrm{~mA}$, | $\mathrm{I}_{\mathrm{B}(2)}=30 \mathrm{~mA}$, | 70 | ns |
| toff | Turn-Off Time | See Figure 1 |  | 170 | ns |

[^73]
## PARAMETER MEASUREMENT INFORMATION



TEST CIRCUIT


## VOLTAGE WAVEFORMS

FIGURE 1
NOTES: a. The input wavaforms are supplied by a generator with the following characteristics: $Z_{\text {out }}=50 \Omega, t_{p} \leqslant 6 \mathrm{~ns}, \mathrm{t}_{\mathrm{f}}<\mathbf{6 n s}$, $t_{w}=500 \mathrm{~ns}$, duty cycle $<\mathbf{2 \%}$.
b. Waveforms are monitored on an oscilloscope with the following characteristics: $\mathrm{t}_{\mathrm{r}} \leqslant 1 \mathrm{~ns}, \mathrm{R}_{\mathrm{in}} \geqslant 100 \mathrm{k} \Omega, \mathrm{C}_{\mathrm{in}} \leqslant 10 \mathrm{pF}$.

# SILECT ${ }^{\dagger}$ TRANSISTORS $\ddagger$ DESIGNED FOR HIGH-SPEED, MEDIUM-POWER SWITCHING AND GENERAL PURPOSE AMPLIFIER APPLICATIONS 

- A5T2907, A5T3644, and A5T3645 Electrically Similar to 2N2907, 2N3644, and 2N3645
- TIS112 Processing Includes Operational Aging at 300 mW for 24 Hours


## mechanical data

These transistors are encapsulated in a plastic compound specifically designed for this purpose, using a highly mechanized process developed by Texas Instruments. The case will withstand soldering temperatures without deformation. These devices exhibit stable characteristics under high-humidity conditions and are capable of meeting MIL-STD-202C, Method 106B. The transistors are insensitive to light.

absolute maximum ratings at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

|  | $\begin{gathered} \text { A5T2907 } \\ \text { TIS112 } \end{gathered}$ | A5T3644 | A5T3645 |
| :---: | :---: | :---: | :---: |
| Collector-Base Voltage | -60 V | -45V | -60 V |
| Collector-Emitter Voltage (See Note 1) | -40 V | -45V | $-60 \mathrm{~V}$ |
| Emitter-Base Voltage | $-5 \mathrm{~V}$ | -5V | $-5 \mathrm{~V}$ |
| Continuous Collector Current |  | 600 m |  |
| Continuous Device Dissipation at (or below) $25^{\circ} \mathrm{C}$ Free-Air Temperature (See Note 2) |  | 625 mw |  |
| Continuous Device Dissipation at (or below) $\mathbf{2 5}{ }^{\circ} \mathrm{C}$ Case and Lead Temperature (See Note 3) |  |  |  |
| Storage Temperature Range | - -65 | $5^{\circ} \mathrm{C}$ to | $\longrightarrow$ |
| Lead Temperature 1/16 Inch from Case for 10 Seconds |  |  |  |

NOTES: 1. This value applies between 0 and 600 mA collector current when the base-amitter diode is open-circuited.
2. Derate linearly to $150^{\circ} \mathrm{C}$ free-air temperature at the rate of $5 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$.
3. This rating applies with the entire case (including the leads) maintained at $25^{\circ} \mathrm{C}$. Derate linearly to $150^{\circ} \mathrm{C}$ case-and-lead temperature at the rate of $12.8 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$.
${ }^{\dagger}$ Trademark of Texas instruments
$\ddagger$ U. S. Patent No. 3,439,238

## TYPES A5T3644, A5T3645 <br> P-N-P SILICON TRANSISTORS

electrical characteristics at $\mathbf{2 5}{ }^{\circ} \mathbf{C}$ free-air temperature (unless otherwise noted)

| PARAMETER | TEST CONDITIONS |  | A5T3644 | A5T3645 | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  | MIN MAX | MIN MAX |  |
| V(BR)CBO Collector-Base Breakdown Voltage | $I^{\prime}=-100 \mu A, \quad I_{E}=0$ |  | -45 | -60 | V |
| V(BR)CEO Collector-Emitter Breakdown Voltage | $I_{C}=-10 \mathrm{~mA}, \quad I_{B}=0$, | See Note 4 | -45 | -60 | V |
| $V_{\text {(BR)EBO }}$ Emitter-Base Breakdown Voltage | $I_{E}=-10 \mu A, \quad I_{C}=0$ |  | -5 | -5 | $V$ |
| Collector Cutoff Current | $V_{C E}=-30 \mathrm{~V}, V_{B E}=0$ |  | -35 |  | $n \mathrm{~A}$ |
|  | $V_{C E}=-50 \mathrm{~V}, V_{B E}=0$ |  |  | -35 |  |
|  | $\mathrm{V}_{\mathrm{CE}}=-30 \mathrm{~V}, \mathrm{~V}_{\mathrm{BE}}=0$, | $\mathrm{T}_{\mathrm{A}}=65^{\circ} \mathrm{C}$ | -2 |  | $\mu \mathrm{A}$ |
|  | $\mathrm{V}_{\text {CE }}=-50 \mathrm{~V}, \mathrm{~V}_{\mathrm{BE}}=0$, | $\mathrm{T}_{A}=65^{\circ} \mathrm{C}$ |  | -2 |  |
| Static Forward Current Transfer Ratio | $\mathrm{V}_{C E}=-10 \mathrm{~V}, \mathrm{I}_{\mathrm{C}}=-100 \mu \mathrm{~A}$ | See Note 4 | 40 | 40 |  |
|  | $\mathrm{V}_{\text {CE }}=-10 \mathrm{~V}$, IC $=-1 \mathrm{~mA}$ |  | 80 | 80 |  |
|  | $V_{C E}=-10 \mathrm{~V}, 1 \mathrm{C}=-10 \mathrm{~mA}$ |  | 100 | 100 |  |
|  | $\mathrm{V}_{\text {CE }}=-10 \mathrm{~V}, \mathrm{I}^{\mathrm{C}}=-150 \mathrm{~mA}$ |  | $100 \quad 300$ | $100 \quad 300$ |  |
|  | $V_{C E}=-1 \mathrm{~V}$, $\mathrm{I}^{\prime}=-50 \mathrm{~mA}$ |  | $80 \quad 240$ | $80 \quad 240$ |  |
|  | $V_{C E}=-2 \mathrm{~V}, \quad \mathrm{I}^{\prime}=-300 \mathrm{~mA}$ |  | 20 | 20 |  |
| Base-Emitter Voltage | $\mathrm{I}_{B}=-2.5 \mathrm{~mA}, \mathrm{I}^{\prime}=-50 \mathrm{~mA}$ | See Note 4 | -1 | -1 | V |
|  | $\mathrm{I}_{\mathrm{B}}=-15 \mathrm{~mA}, \quad \mathrm{I}_{\mathrm{C}}=-150 \mathrm{~mA}$ |  | -1.3 | -1.3 |  |
|  | $\mathrm{I}_{B}=-30 \mathrm{~mA}, \quad I_{C}=-300 \mathrm{~mA}$ |  | -0.8 -2 | -0.8 -2 |  |
| Collector-Emitter Saturation Voltage | $\mathrm{I}_{B}=-2.5 \mathrm{~mA}, I^{\prime}=-50 \mathrm{~mA}$ | See Note 4 | -0.25 | -0.25 | V |
|  | $\mathrm{I}_{\mathrm{B}}=-15 \mathrm{~mA}, \quad \mathrm{I}^{\prime}=-150 \mathrm{~mA}$ |  | -0.4 | -0.4 |  |
|  | $\mathrm{I}_{\mathrm{B}}=-30 \mathrm{~mA}, \mathrm{I}^{\prime}=-300 \mathrm{~mA}$ |  | -1 | -1 |  |
| $h_{i e}$ Small-Signal Common-Emitter <br> Input Impedance | $V_{C E}=-10 \mathrm{~V}, \mathrm{I}^{\prime} \mathrm{C}=-10 \mathrm{~mA}, f=1 \mathrm{kHz}$ |  | 1.8 | 1.8 | k $\boldsymbol{\Omega}$ |
| $\mathbf{h}_{\text {fe }}$ Small-Signal Common-Emitter <br> Forward Current Transfer Ratio |  |  | 100 | 100 |  |
| $h_{\text {re }}$ Small-Signal Common-Emitter <br> Reverse Voltage Transfer Ratio |  |  | $\begin{array}{r} 3 x \\ 10^{-4} \\ \hline \end{array}$ | $\begin{array}{r} 3 x \\ 10^{-4} \end{array}$ |  |
| $h_{\text {oe }}$ Small-Signal Common-Emitter <br> Output Admittance |  |  | 300 | 300 | $\mu \mathrm{mho}$ |
| $\left\|h_{\mathrm{fe}}\right\| \quad$Small-Signal Common-Emitter <br> Forward Current Transfer Ratio | $V_{C E}=-15 \mathrm{~V}, \quad \mathrm{I}^{\prime}=-20 \mathrm{~mA}$, | $f=100 \mathrm{MHz}$ | 2 | 2 |  |
| Cobo Common-Base Open-Circuit <br> Output Capacitance | $V_{C B}=-10 \vee, I_{E}=0$ | $f=1 \mathrm{MHz}$ | 8 | 8 | pF |
| Cibo Common-Base Open-Circuit <br> Input Capacitance | $\mathrm{V}_{\mathrm{EB}}=-0.5 \mathrm{~V}, \mathrm{I}^{\prime} \mathrm{C}=0$, | $f=1 \mathrm{MHz}$ | 35 | 35 | pF |

NOTE 4: These parameters must be measured using pulse techniques. $t_{w}=\mathbf{3 0 0} \mu \mathrm{s}$, duty cycle $\leqslant 2 \%$.
switching characteristics at $\mathbf{2 5}{ }^{\circ} \mathbf{C}$ free-air temperature

| PARAMETER |  | TEST CONDITIONS | A5T3644 | A5T3645 | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | MAX | MAX |  |
| $\mathrm{t}_{\mathrm{d}}$ | Delay Time |  | ${ }^{\prime} \mathrm{C}=2000 \mathrm{~mA}, \mathrm{R}_{\mathbf{L}}=98 \Omega$. See Figure 1 | 25 | 25 | ns |
| $\mathrm{t}_{\mathrm{r}}$ | Rise Time | 35 |  | 35 | ns |
| $t_{\text {on }}$ | Turn-On Time | 40 |  | 40 | ns |
| $t_{s}$ | Storage Time | 70 |  | 70 | ns |
| $t_{f}$ | Fall Time | 50 |  | 50 | ns |
| toff | Turn-Off Time | 100 |  | 100 | ns |

TYPES A5T3644, A5T3645 P-N-P SILICON TRANSISTORS

## PARAMETER MEASUREMENT INFORMATION



FIGURE i-A5T3e44 and A5T3845

NOTES: A. The input woveform te supplied by a enenarator with the following characteriatics: $Z_{\text {out }}=80 \Omega, t_{r}<6 \mathrm{~ns}, \mathrm{t}_{\mathrm{f}}<\mathbf{6 n g}, \mathrm{t}_{\mathbf{w}}=500 \mathrm{~ns}$, duty cyele $\mathbf{\leq} \mathbf{2 \%}$.
B. The output weveform is monitored on an oscitloncope with the following characteristics: $\mathrm{t}_{\mathrm{r}}<1 \mathrm{~ns}, \mathrm{~A}_{\mathrm{in}}<0.1 \mathrm{M} \Omega$, $\mathrm{C}_{\text {in }} \leqslant 4 \mathrm{pF}$.

## TYPE 2N3680 DUAL N-P-N SILICON TRANSISTOR

## RECOMMENDED FOR DIFFERENTIAL AMPLIFIERS

- Featuring Matching and Tracking Improvements over 2N2463, 2N2642, and 2N2920
- Each Triode Electrically Similar to 2N2484 and 2N930
- hFE at $1 \mu \mathrm{~A}: \mathbf{8 0}$ Min
- Matched from $-65^{\circ} \mathrm{C}$ to $125^{\circ} \mathrm{C}$
- $\frac{\Delta\left(\mathrm{V}_{B E 1}-\mathrm{V}_{B E 2}\right)}{\Delta T A}: 5 \mu \mathrm{~V} / \mathrm{C}$ Max, Averaged over Temperature Range
- Also Recommended for Low-Level Flip-Flops, High-Gain Low-Noise Audio Amplifiers, and Transducer Signal-Conditioner Amplifiers
*mechanical data

*absolute maximum ratings at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise notad)


NOTES: 1. This value applies when the base-emitter diode is open-circuited.
2. Derate linearly to $175^{\circ} \mathrm{C}$ free-alr temperature at the rates of $2 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$ for each triode and $4 \mathrm{~mW} / \mathrm{m}^{\circ} \mathrm{C}$ for total device.
3. Derate linearly to $175^{\circ} \mathrm{C}$ case temperature at the rates of $4 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$ for each triode and $8 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$ for total device.
-JEDEC registered data. This data sheet containa all applicable registered data in offect at the time of publication.

## TYPE 2N3680 DUAL N-P-N SILICON TRANSISTOR

*elactrical characteristics at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)
Individual triode characteristioe (mee note 4)

triode matching characteristica

| PARAMETER | TEST CONDITIONS |  | MIN MAX | UNIT |
| :---: | :---: | :---: | :---: | :---: |
|  | $V_{C E}=5 \mathrm{~V}, \quad \mathrm{I}^{\prime}=10 \mu \mathrm{~A}$, | See Note 6 | 0.91 |  |
| $\frac{\text { hFE1 }}{\text { hFE2 }}$ ( Static Forward-Current Gain Balance Ratio | $\begin{aligned} & V_{C E}=5 \mathrm{~V}, \quad I_{C}=100 \mu \mathrm{~A}, \\ & T_{A}=-55^{\circ} \mathrm{C} \text { to } 125^{\circ} \mathrm{C} \end{aligned}$ | See Note 6, | 0.851 |  |
|  | $V_{C E}=5 \mathrm{~V}, \quad I_{C}=10 \mu \mathrm{~A}$ |  | 3 | mV |
| Baso-Emitter-Voltage-Differential | $V C E=5 \mathrm{~V}, \mathrm{I}^{\prime} \mathrm{C}=10 \mu \mathrm{~A}$, | $\begin{aligned} & T_{A(1)}=25^{\circ} \mathrm{C}, \\ & T_{A(2)}=-55^{\circ} \mathrm{C} \end{aligned}$ | 400 | $\mu \mathrm{V}$ |
| $\left\|\Delta V_{B E 1}-V_{B E 2}{ }^{\prime} \Delta T_{A}\right\| \quad$ Change with Temperature | VCE $=5 \mathrm{~V}, \quad 1 \mathrm{C}=10 \mu \mathrm{~A}$, | $\begin{aligned} & T_{A(1)}=25^{\circ} \mathrm{C}, \\ & T_{A(2)}=125^{\circ} \mathrm{C} \end{aligned}$ | 500 |  |

*operating characteristics at $25^{\circ} \mathrm{C}$ free-air temperature
individual triode characteristics (see note 4)

| PARAMETER | TEST CONDITIONS | MIN MAX | UNIT |
| :---: | :---: | :---: | :---: |
| $\overline{\mathbf{F}} \quad$ Average Noise Figure | $\begin{array}{ll} V_{C B}=5 \mathrm{~V}, \quad I_{E}=-10 \mu \mathrm{~A}, & R_{G}=10 \mathrm{k} \Omega, \\ \text { Noise Bandwidth }=15.7 \mathrm{kHz}, & \text { See Note } 7 \end{array}$ | 3 | dB |

NOTES: 4. The terminals of the triode not under test are open-circuited for the measurement of these characteristics.
5. This parameter must be measured using pulse techniques. $\mathrm{t}_{\mathrm{w}}=\mathbf{3 0 0 \mu s}$, duty cycle $<\mathbf{2 \%}$.
6. The lower of the two $h_{F E}$ readings is taken as $h_{\text {FE1 }}$.
7. Average Noise figure is measured in an amplifier with response down 3 dB at 10 Hz and 10 kHz and a high-frequency rolloff of 6 dB/octave.
-JEDEC registered data

## SILECT ${ }^{\dagger}$ TRANSISTORS $\ddagger$

## - For Medium-Power Amplifiers, Class B Audio Outputs, Hi-Fi Drivers

- Also Available in Pin-Circle Versions . . . 2N5447, 2N5448
- For Complementary Use with 2N3704 thru 2N3706 or A8T3704 thru A8T3706
mechanical data
These transistors are encapsulated in a plastic compound specifically designed for this purpose, using a highly mechanized process developed by Texas Instruments. The case will withstand soldering temperatures without deformation. These devices exhibit stable characteristics under high-humidity conditions and are capable of meeting MIL-STD-202C, Method 106B. The transistors are insensitive to light.

absoluta maximum ratings at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)


NOTES: 1. These values apply when the base-emitter diode is open-circuited.
2. Derate the $625-\mathrm{mW}$ rating lineariy to $150^{\circ} \mathrm{C}$ free-air temperature at the rate of $5 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$. Derate the $360-\mathrm{mW}$ (JEDEC registered) rating linearly to $150^{\circ} \mathrm{C}$ free-air temperature at the rate of $2.88 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$.
3. Derate the $1.25-\mathrm{W}$ rating linearly to $150^{\circ} \mathrm{C}$ lead temperature at the rate of $10 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$. Derate the $500-\mathrm{mW}$ (JEDEC repistered) rating linearly to $150^{\circ} \mathrm{C}$ leed temperature at the rate of $4 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$. Lead temperature is measured on the collector lead $\mathbf{1 / 1 6}$ inch from the case.

[^74]
# TYPES 2N3702, 2N3703, A8T3702, A8T3703 <br> P-N-P SILICON TRANSISTORS 

*electrical characteristics at $\mathbf{2 5}{ }^{\circ} \mathbf{C}$ free-air temperature

| PARAMETER |  | TEST CONDITIONS | $\begin{gathered} \text { 2N3702 } \\ \text { A8T3702 } \\ \hline \end{gathered}$ | $\begin{gathered} \text { 2N3703 } \\ \text { A8T3703 } \\ \hline \end{gathered}$ | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | MIN MAX | MIN MAX |  |
| $V_{(B R) C B O}$ | Collector-Base <br> Breakdown Voltage |  | ${ }^{\prime} C=-100 \mu A, I^{\prime} E=0$ | -40 | -50 | V |
| $V_{(B R) C E O}$ | Collector-Emitter Breakdown Voltage | $\mathrm{I}_{\mathrm{C}}=-10 \mathrm{~mA}, \quad \mathrm{I}_{\mathrm{B}}=0, \quad$ See Note 4 | -25 | -30 | V |
| $V_{\text {(BR) }}$ EbO | Emitter-Base <br> Breakdown Voltage | $I_{E}=-100 \mu A, I_{C}=0$ | -5 | -5 | V |
| ICBO | Collector Cutoff Current | $\mathrm{V}_{C B}=-20 \mathrm{~V}, \mathrm{I}_{\mathrm{E}}=0$ | -100 | -100 | nA |
| IEBO | Emitter Cutoff Current | $V_{E B}=-3 V, I_{C}=0$ | -100 | -100 | nA |
| $h_{\text {FE }}$ | Static Forward Current Transfer Ratio | $\mathrm{V}_{\text {CE }}=-5 \mathrm{~V}, \mathrm{I}^{\text {C }}=-50 \mathrm{~mA}$, See Note 4 | $60 \quad 300$ | $30 \quad 150$ |  |
| $V_{B E}$ | Base-Emitter Voltage | $V_{C E}=-5 \mathrm{~V}, \quad \mathrm{IC}=-50 \mathrm{~mA}$, See Note 4 | -0.6 -1 | -0.6 -1 | V |
| VCE(sat) | Collector-Emitter Saturation Voltage | $\mathrm{I}_{\mathrm{B}}=-5 \mathrm{~mA}, \quad \mathrm{l}^{\prime} \mathrm{C}=-50 \mathrm{~mA}$, See Note 4 | -0.25 | -0.25 | V |
| fT | Transition Frequency | $\mathrm{V}_{\text {CE }}=-5 \mathrm{~V}, \mathrm{I}^{\text {c }}=-50 \mathrm{~mA}$, See Note 5 | 100 | 100 | MHz |
| Cobo | Common-Base Open-Circuit Output Capacitance | $V_{C B}=-10 \mathrm{~V}, \mathrm{l}_{\mathrm{E}}=0, \quad f=1 \mathrm{MHz}$ | 12 | 12 | pF |

NOTES: 4. These parameters must be measured using pulse techniques, $\mathbf{t}_{\mathbf{w}}=\mathbf{3 0 0} \mu \mathrm{s}$, duty cycle $\leqslant 2 \%$.
 at which $\left|h_{f e}\right|=1$.
*The asterisk identifies JEDEC registered data for the 2N3702 and 2N3703 only

## THERMAL INFORMATION

FREE-AIR TEMPERATURE DISSIPATION DERATING CURVE


FIGURE 1

LEAD TEMPERATURE DISSIPATION DERATING CURVE


FIGURE 2

## SILECT ${ }^{\dagger}$ TRANSISTORS ${ }^{\ddagger}$

## - For Medium-Power Amplifiers, Class B Audio Outputs, Hi-Fi Drivers

## - Also Available in Pin-Circle Versions . . . 2N5449, 2N5451

- For Complementary Use with 2N3702, 2N3703 or A8T3702, A8T3703


## mechanical data

These transistors are encapsulated in a plastic compound specifically designed for this purpose, using a highly mechanized process developed by Texas Instruments. The case will withstand soldering temperatures without deformation. These devices exhibit stable characteristics under high-humidity conditions and are capable of meeting MIL-STD-202C, Method 1068. The transistors are insensitive to light.

absolute maximum ratings at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)


# TYPES 2N3704 THRU 2N3706, A8T3704 THRU A8T3706 N-P-N SILICON TRANSISTORS 

*electrical characteristics at $\mathbf{2 5}{ }^{\circ} \mathrm{C}$ free-air temperature

| PARAMETER |  | TEST CONDITIONS | $\begin{gathered} \text { 2N3704 } \\ \text { A8T3704 } \end{gathered}$ |  | $\begin{aligned} & \text { 2N3705 } \\ & \text { A8T3705 } \end{aligned}$ |  | 2N3706 A8T3706 |  | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | MIN | MAX | MIN | MAX | MIN | MAX |  |
| $V$ (BR)CBO | Collector-Base Breakdown Voltage |  | ${ }^{\prime} C=100 \mu \mathrm{~A}, \quad \mathrm{I}_{\mathrm{E}}=0$ | 50 |  | 50 |  | 40 |  | V |
| $V_{\text {(BR) }}$ CEO | Collector-Emitter Breakdown Voltage | $I_{C}=10 \mathrm{~mA}, \quad I_{B}=0$ <br> See Note 4 | 30 |  | 30 |  | 20 |  | V |
| $V$ (BR)EBO | Emitter-Base <br> Breakdown Voltage | $I_{E}=100 \mu \mathrm{~A}, \quad I_{C}=0$ | 5 |  | 5 |  | 5 |  | V |
| ${ }^{\prime} \mathrm{CBO}$ | Collector Cutoff Current | $\mathrm{V}_{C B}=20 \mathrm{~V}, \mathrm{I}_{\mathrm{E}}=0$ |  | 100 |  | 100 |  | 100 | nA |
| IEBO | Emitter Cutoff Current | $V_{E B}=3 \mathrm{~V}, \mathrm{I}^{\prime} \mathrm{C}=0$ |  | 100 |  | 100 |  | 100 | nA |
| hfe | Static Forward Current Transfer Ratio | $V_{C E}=2 V, \quad I_{C}=50 \mathrm{~mA},$ <br> See Note 4 | 100 | 300 | 50 | 150 | 30 | 600 |  |
| VBE | Base-Emitter Voltage | $V_{C E}=2 \mathrm{~V}, \quad I C=100 \mathrm{~mA},$ <br> See Note 4 | 0.5 | 1 | 0.5 | 1 | 0.5 | 1 | V |
| $V_{C E}$ (sat) | Collector-Emitter <br> Saturation Voltage | $\begin{aligned} & I_{B}=5 \mathrm{~mA}, \quad I_{C}=100 \mathrm{~mA}, \\ & \text { See Note } 4 \end{aligned}$ |  | 0.6 |  | 0.8 |  | 1 | V |
| ${ }^{\mathbf{f}} \mathrm{T}$ | Transition Frequency | $V_{C E}=2 V, \quad I_{C}=50 \mathrm{~mA},$ <br> See Note 5 | 100 |  | 100 |  | 100 |  | MHz |
| Cobo | Common-Base Open-Circuit Output Capacitance | $\begin{aligned} & V_{C B}=10 \mathrm{~V}, \quad \mathrm{I}=0, \\ & f=1 \mathrm{MHz} \end{aligned}$ |  | 12 |  | 12 |  | 12 | pF |

NOTES: 4. These parameters must be measured using pulse techniques. $\mathrm{t}_{\mathbf{w}}=\mathbf{3 0 0} \mu \mathrm{s}$, duty cycle $\leqslant \mathbf{2 \%}$.
5. To obtain ${ }^{\dagger} \mathrm{T}$, the $\mathrm{h}_{\text {fel }}$ response with frequency is extrapolated at the rate of -6 dB per octave from $f=20 \mathrm{MHz}$ to the frequency at which $\left|h_{f e}\right|=1$.
*The asterisk identifies JEDEC registered data for the 2N3704, 2N3705, and 2N3706 only.
TYPICAL CHARACTERISTICS


FIGURE 2


FIGURE 3

## TYPES 2N3707 THRU 2N3711, A5T3707 THRU A5T3711, A8T3707 THRU A8T3711 N-P-N SILICON TRANSISTORS

BULLETIN NO. DL-S 7311965, MARCH 1973

## SILECT ${ }^{\dagger}$ TRANSISTORS $\ddagger$

- Ideal for Low-Level Amplifier Applications
- Rugged One-Piece Construction with In-Line Leads or Standard TO-18 100-mil Pin-Circle Configuration
- Recommended for Complementary Use with 2N4058 thru 2N4062, A5T4058 thru A5T4062, or A8T4058 thru A8T4062


## mechanical data

These transistors are encapsulated in a plastic compound specifically designed for this purpose, using a highly mechanized process developed by Texas Instruments. The case will withstand soldering temperatures without deformation. These devices exhibit stable characteristics under high-humidity conditions and are capable of meeting MIL-STD-202C, Method 106B. The transistors are insensitive to light.

absolute maximum ratings at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)


## 2N3707 THRU 2N37m, A5T3707 THRU A5T37m, A8T3707 THRU A8T37m N-P-N SILICON TRANSISTORS

*electrical characteristics at $25^{\circ} \mathrm{C}$ free-air temperature

| PARAMETER |  | TEST CONDITIONS | 2N3707 <br> A5T3707 <br> A8T3707 | 2N3708 A5T3708 A8T3708 | 2N3709 A5T3709 A8T3709 | 2N3710 A5T3710 A8T3710 | 2N3711 <br> A5T3711 <br> A8T3711 | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | MIN MAX | MIN MAX | MIN MAX | MIN MAX | MIN MAX |  |
| $V_{\text {(BR)CEO }}$ | Collector-Emitter Breakdown Voltage |  | $\mathrm{IC}=1 \mathrm{~mA}, \quad \mathrm{I}_{\mathrm{B}}=0$ | 30 | 30 | 30 | 30 | 30 | $\checkmark$ |
| Ісво | Collector Cutoff Current | $\mathrm{V}_{C B}=20 \mathrm{~V}, \mathrm{I}_{\mathrm{E}}=0$ | 100 | 100 | 100 | 100 | 100 | nA |
| Iebo | Emitter Cutoff Current | $\mathrm{V}_{\mathrm{EB}}=6 \mathrm{~V}, \quad \mathrm{IC}_{\mathrm{C}}=0$ | 100 | 100 | 100 | 100 | 100 | nA |
| hfe | Static Forward Current Transfer Ratio | $V_{C E}=5 \mathrm{~V}, \quad \mathrm{IC}^{\prime}=100 \mu \mathrm{~A}$ | $100 \quad 400$ |  |  |  |  |  |
|  |  | $\mathrm{V}_{\text {CE }}=5 \mathrm{~V}, \quad \mathrm{I}_{\mathrm{C}}=1 \mathrm{~mA}$ |  | $45 \quad 660$ | 45165 | $90 \quad 330$ | 180660 |  |
| $V_{\text {ge }}$ | Baso-Emitter Voltage | $V_{C E}=5 \mathrm{~V}, \quad I^{\prime}=1 \mathrm{~mA}$ | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | V |
| $\mathrm{V}_{\mathrm{CE}}$ (zat) | Collector-Emitter Saturation Voltage | $\mathrm{I}_{\mathrm{B}}=0.5 \mathrm{~mA}, \quad \mathrm{I}_{\mathrm{C}}=10 \mathrm{~mA}$ | 1 | 1 | 1 | 1 | 1 | $\checkmark$ |
| $\mathrm{hfe}^{\text {fe }}$ | Small-Signal Common-Emitter Forward Current Transfer Ratio | $\begin{aligned} & \begin{array}{l} V C E=5 \mathrm{~V}, \quad \mathrm{IC}=100 \mu \mathrm{~A}, \\ \mathrm{f}=1 \mathrm{kHz} \end{array} \\ & \hline \end{aligned}$ | 100550 |  |  |  |  |  |
|  |  | $\begin{aligned} & \begin{array}{l} V_{C E}=5 \mathrm{~V}, \\ f=1 \mathrm{kHz} \end{array} \\ & \hline \end{aligned}$ |  | 45800 | $45 \quad 250$ | 90450 | 180800 |  |

*operating characteristics at $\mathbf{2 5}{ }^{\circ} \mathrm{C}$ free-air temperature

| PARAMETER |  | TEST CONDITIONS |  | $\begin{gathered} \text { 2N3707, } \\ \text { A5T3707, A8T3707 } \\ \hline \end{gathered}$ |  |  | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | MIN | TYP | MAX |  |
| $\vec{F}$ | Average Noise Figure |  |  | $V_{C E}=5 \mathrm{~V}, \quad I_{C}=100 \mu \mathrm{~A}$ <br> Noise Bandwidth $=15.7 \mathrm{kHz}$, | $\mathrm{R}_{\mathrm{G}}=5 \mathrm{k} \Omega$ <br> See Note 3 |  | 1.9 | 5 | dB |

NOTE 3: Average Noise Figure is measured in an amplifier with response down 3 dB at 10 Hz and 10 kHz and a high-frequency rolloff of $6 \mathrm{~dB} / \mathrm{octave}$.
*The asterisk identifies JEDEC registered data for 2 N3707 through 2N3711 only.
THERMAL INFORMATION
dissipation derating curve

figure 1

## FAST, HIGH-VOLTAGE, HIGH-CURRENT CORE DRIVERS

- hFE Guaranteed from 10 mA to 1.6 A
- Guaranteed Switching Times at One Ampere (2N3724A, 2N3725A)
*mechanical dafe

THE COLLECTOR IS IN ELECTRICAL CONTACT WITH THE CASE


ALL JEDEC TO-39 DIMENSIONS AND NOTES ARE APPLICABLE
ALL DIMENSIONS AAE IN INCHES UNLESS OTHERWISE SPECIFIED
absolute maximum ratings af $25^{\circ} \mathrm{C}$ free-air temperature (unloss othorwise noted)

|  | 2N3724 | 2N3724A | 2N3725 | 2N3725A | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: |
| Collector-Baso Voltage | $50 *$ |  | 80* |  | V |
| Collector-Emither Voltage (Soee Note 1) | 30" |  | $50^{*}$ |  | $V$ |
| Emitter-Basa Voltage | $6^{\circ}$ |  | 6 " |  | V |
| Continuous Collector Current | 0.5* | 1.2* | $0.5 *$ | $1.2^{*}$ | 1 |
| Pook Collector Current (See Note 2) |  | $1.75{ }^{*}$ |  | 1.75* | 1 |
| Continuous Device Dissipation af (or bolow) $25^{\circ} \mathrm{C}$ Free-Air Temperalure (See Note 3) | $0.8{ }^{*}$ | 1* | 0.8* | 1* | W |
| Condinuous Device Dissipation of (or below) $25^{\circ} \mathrm{C}$ Case Temperature (See Note 4) | $\begin{array}{r} 10 t \\ 3.5 * \end{array}$ | $\begin{array}{r} 10 \dagger \\ 5 \\ \hline \end{array}$ | $\begin{array}{r} 10 t \\ 3.5^{\circ} \\ \hline \end{array}$ | $\begin{gathered} 10^{\dagger} \\ 5 * \\ \hline \end{gathered}$ | W |
| Storage Temperature Range | -65 to $200{ }^{\circ}$ |  | -65 $10200{ }^{\circ}$ |  | ${ }^{\circ} \mathrm{C}$ |
| Lead Temperature Ko Inch from Case for 60 Seconds | $300^{\prime \prime}$ |  | $300^{*}$ |  | ${ }^{\circ} \mathrm{C}$ |

NOTES: 1. Thase values apply batween 0.01 mA and 500 mA collector current when the base-emitter diode is opan-eircuited.
2. This value applies for squaro-wave pules. $t_{p}=\mathbf{3 0 0} \mu$, duty eyele $<\mathbf{2 \%}$.
3. For the 2 N 3724 and 2 N 372 E , derate ilneariv to $200^{\circ} \mathrm{C}$ tree-alr temparature at the rate of $4.57 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$. For the 2N3724A and 2N3728A, derate linearly to $200^{\circ} \mathrm{C}$ free-alr temperature at the rate of $\mathrm{B} .71 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$.
4. Darate the 10 -watt rating Ilneerly to $200^{\circ} \mathrm{C}$ case temperatura st the rate of $87.1 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$. Derate the JEDEC regirtered ratings linearly to $200^{\circ} \mathrm{C}$ case temparatura at the rates of $20 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$ for the 2 N 3724 and 2 N 3725 and $28.6 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$ for the 2 N 3724 A and 2N3725A.

## TYPES 2N3724, 2N3724A, 2N3725, 2N3725A <br> N-P-N SILICON TRANSISTORS

*electrical characterisfics af $25^{\circ} \mathrm{C}$ free-air tomperature (unless otherwise noted)

|  | PARAMETER | TEST CONDITIONS | $\begin{array}{\|l\|} \hline 2 \text { N } 3724 \\ \hline \text { MIN MAX } \\ \hline \end{array}$ | $\begin{array}{\|l\|} \hline \text { 2N3724A } \\ \hline \text { MIN MAX } \\ \hline \end{array}$ | $\begin{array}{\|l\|} \hline \text { 2N3725 } \\ \hline \text { MIN MAX } \\ \hline \end{array}$ | $\frac{2 \text { N372SA }}{\text { MIN MAX }}$ | UNII |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| $V_{\text {(ma)cio }}$ | Collector-Lesse Broakdown Vohtage | $l_{c}=10 \mu h_{1} t_{1}=0$ | 50 | 50 | 80 | 80 | V |
| $V_{\text {(ma)cro }}$ | Collector-Emiltor Breakdown Yoltage | $I_{c}=10 \mathrm{~mA}, I_{1}=0, \quad$ Sot Hoto 5 | 30 | 30 | 50 | 50 | V |
| $V_{\text {(majers }}$ | Collector-Emitter Brackdown Voltoge | $L_{c}=10 \mu \mathrm{~A}, V_{m}=0$ | 50 | 50 | 80 | 80 | $v$ |
| $V_{\text {(R)N\| }}$ | Emilter-Base Broakdown Vohtage | $\mathrm{I}_{\mathrm{t}}=10 \mu \mathrm{~A}, \mathrm{I}_{\mathrm{c}}=0$ | 6 | 6 | 6 | 6 | V |
| Icro | Collector Cutoff Current | $V_{\text {ct }}=40 \mathrm{~V}, \mathrm{I}_{\mathrm{E}}=0$ | 1.7 | 0.5 |  |  | $\mu \mathrm{A}$ |
|  |  | $V_{C I}=40 V_{1} T_{E}=0, \quad T_{A}=100^{\circ} \mathrm{C}$ | 120 | 50 |  |  | $\mu \mathrm{A}$ |
|  |  | $V_{C B}=60 V_{V} I_{E}=0$ |  |  | 1.7 | 0.5 | $\mu A$ |
|  |  | $V_{C B}=60 V_{1} \mathrm{I}_{\mathrm{B}}=0, \quad \mathrm{~T}_{\mathrm{A}}=100^{\circ} \mathrm{C}$ |  |  | 120 | 50 | $\mu A$ |
| Icss | Collsctor Cutoff Current | $V_{C E}=50 V_{1} V_{\text {VE }}=0$ | 10 | 10 |  |  | $\mu \mathrm{h}$ |
|  |  | $V_{C E}=80 V_{1}, V_{\text {ME }}=0$ |  |  | 10 | 10 | $\mu \mathrm{A}$ |
| Is | Base Current | $V_{\text {CE }}=50 V_{\text {, }} V_{\text {VE }}=0$ | -10 | -10 |  |  | $\mu A$ |
|  |  | $V_{C E}=80 V_{1}, \quad V_{\text {EE }}=0$ |  |  | -10 | -10 | $\mu \mathrm{A}$ |
| her | Slatic Forward Current Tronsfor Ratio | $V_{C E}=1 V_{1} \quad l_{C}=10 \mathrm{~mA}$ | 30 | 30 | 30 | 30 |  |
|  |  | $V_{\mathrm{CB}}=1 V_{1} \quad \mathrm{I}_{\mathrm{c}}=100 \mathrm{~mA}$ | $60 \quad 150$ | $60 \quad 150$ | $60 \quad 150$ | $60 \quad 150$ |  |
|  |  | $\begin{array}{ll} \hline V_{C E}=1 \mathrm{~V}, & \begin{array}{l} I_{\mathrm{C}}=100 \mathrm{~mA}, \\ T_{A} \end{array}=-55^{\circ} \mathrm{C} \\ \hline \end{array}$ | 30 | 30 | 30 | 30 |  |
|  |  | $V_{C E}=1 \mathrm{~V}, \mathrm{I}_{\mathrm{C}}=300 \mathrm{~mA}$ Se0 | 40 | 40 | 40 | 40 |  |
|  |  | $V_{C E}=1 V_{1} \quad I_{C}=500 \mathrm{~mA}$, Nete | 35 | 35 | 35 | 35 |  |
|  |  | $\begin{aligned} & V_{C E}=1 \mathrm{~V}, \mathrm{I}_{\mathrm{C}}=500 \mathrm{~mA} \\ & T_{\mathrm{A}}=-55^{\circ} \mathrm{C} \\ & \hline \end{aligned}$ | 20 | 20 | 20 | 20 |  |
|  |  | $V_{C E}=2 \mathrm{~V}, \mathrm{I}_{\mathrm{C}}=800 \mathrm{~mA}$ | 25 | 30 | 20 | 25 |  |
|  |  | $V_{C E}=5 \mathrm{~V}, \quad \mathrm{I}_{\mathrm{C}}=1 \mathrm{~A}$ | 30 | 30 | 25 | 25 |  |
|  |  | $\mathrm{V}_{\mathrm{CE}}=5 \mathrm{~V}, \quad \mathrm{l}_{\mathrm{C}}=1.5 \mathrm{~A}$ |  | 25 |  | 20 |  |
| $\boldsymbol{V}_{\text {ma }}$ | Basa-Emitter Voltage | $\mathrm{l}_{\mathrm{s}}=1 \mathrm{~mA}, \quad l_{c}=10 \mathrm{~mA}$ | 0.76 | 0.76 | 0.76 | 0.76 | V |
|  |  | $\mathrm{I}_{B}=10 \mathrm{~mA}, \mathrm{I}_{\mathrm{c}}=100 \mathrm{~mA}$ See | 0.86 | 0.86 | 0.86 | 0.86 | V |
|  |  | $\mathrm{I}_{1}=30 \mathrm{~mA}, \mathrm{IC}_{C}=300 \mathrm{~mA}$ | 1.1 | - 1 | 1.1 | 1 | $V$ |
|  |  |  | 0.8 1.1 | $0.8 \quad 1.1$ | 0.8 1.1 | $0.8 \quad 1.1$ | $V$ |
|  |  | $\mathrm{I}_{\mathrm{B}}=80 \mathrm{~mA}, \mathrm{IC}_{C}=800 \mathrm{~mA}$ | 1.5 | 1.3 | 1.5 | 1.3 | $V$ |
|  |  | $I_{1}=100 \mathrm{md}, \mathrm{I}_{\mathrm{c}}=11$ | 1.7 | 0.91 .4 | 1.7 | $0.9 \quad 1.4$ | $V$ |
| $V_{\text {cetanat }}$ | Collector-Emilter Saturation Voltage | $\mathrm{I}_{\mathrm{B}}=1 \mathrm{~mA} \quad \mathrm{I}_{\mathrm{c}}=10 \mathrm{~mA}$ | 0.25 | 0.25 | 0.25 | 0.25 | $V$ |
|  |  | $\mathrm{I}_{\mathrm{B}}=10 \mathrm{~mA}, \mathrm{l}_{\mathrm{c}}=100 \mathrm{~mA}$ sem | 0.2 | 0.2 | 0.26 | 0.26 | V |
|  |  | $\mathrm{I}_{1}=30 \mathrm{~mA}, \mathrm{I}_{C}=300 \mathrm{~mA}$ | 0.32 | 0.32 | 0.4 | 0.4 | $V$ |
|  |  | $\mathrm{I}_{5}=50 \mathrm{~mA}, \mathrm{l}_{\mathrm{c}}=500 \mathrm{~mA}$ | 0.42 | 0.42 | 0.52 | 0.52 | $V$ |
|  |  | $\mathrm{I}_{1}=80 \mathrm{~mA}, \mathrm{I}_{\mathrm{c}}=800 \mathrm{~mA}$ | 0.65 | 0.65 | 0.8 | 0.8 | $V$ |
|  |  | $\mathrm{I}_{\mathrm{B}}=100 \mathrm{~mA}, \mathrm{I}_{\mathrm{c}}=1 \mathrm{~A}$ | 0.75 | 0.75 | 0.95 | 0.9 | $V$ |
| \|hol | Small-Signal Commen-Emiftor Forward Curront Tronstor Ratio | $V_{c t}=10 \mathrm{~V}, l_{c}=50 \mathrm{~mA}, 1=100 \mathrm{mmz}$ | 3 | 3 | 3 | 3 |  |
| Cobo | Common-Sase Open-Giculif Output Capadionas | $V_{\text {ci }}=10 \mathrm{~V}, \quad \mathrm{l}_{\mathrm{t}}=0, \quad f=1 \mathrm{MHz}$ | 12 | 12 | 10 | 10 | pF |
| clbo | Common-lose Open-Crault Input Capadtanca | $V_{\text {E }}=0.5 \mathrm{~V}, \mathrm{l}_{\mathrm{c}}=0, \quad f=1 \mathrm{MHz}$ | 55 | 55 | 55 | 55 | pf |

NOTE 5: Those parcemitors must be meesured uriap pulse tacholques. $t_{p}=300 \mu$, duty cytio $\leq 1 \%$.

- JEDEC registerad data


## TYPES 2N3724, 2N3724A, 2N3725, 2N3725A N-P-N SILICON TRANSISTORS

*switching characteristics $\boldsymbol{\omega} \mathbf{2 5}{ }^{\circ} \mathrm{C}$ free-air temperafure

| PARAMETER | TEST CONDITIONS $\dagger$ | 2N3724 | 2N3724A | 2 N 3725 | 2N3725A | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| $t_{\text {d }}$ Delay Time | $\begin{array}{ll} I_{C}=500 \mathrm{~mA}, & \\ l_{\text {la1 }}=50 \mathrm{~mA}, & V_{\text {(10ty }}=-3.8 \mathrm{~V}, \\ R_{L}=58 \Omega, & \text { See Figure 1 } \end{array}$ | 10 | 10 | 10 | 10 | ns |
| $\mathrm{t}_{\mathrm{r}} \quad$ Rise Time |  | 30 | 30 | 30 | 30 | ns |
| $t_{\text {on }}$ Turn-On Time |  | 35 | 35 | 35 | 35 | ns |
| $t_{1} \quad$ Storage Time | $\begin{array}{ll} I_{C}=500 \mathrm{~mA}, & \\ I_{(x 11}=50 \mathrm{~mA}, & I_{(2,2)}=-50 \mathrm{~mA}, \\ R_{L}=58 \Omega, & \text { See Figure } 1 \\ \hline \end{array}$ | 50 | 50 | 50 | 50 | Hs |
| $t_{1}$ Fall Time |  | 25 | 25 | 30 | 30 | m |
| toth Turn-Off Time |  | 60 | 60 | 60 | 60 | ns |
| ton Turn-On Time | $\begin{array}{ll} I_{C}=1 A_{1} \\ I_{(1)}=100 \mathrm{~mA}, & v_{\text {greotf }}=-2 V, \\ R_{L}=30 \Omega, & \text { See Eligure } 2 \end{array}$ |  | 30 |  | 30 | ms |
| toff Tum-Off Sime | $\begin{aligned} & I_{c}=1 A_{1} \\ & I_{\varepsilon(1)}=100 \mathrm{~mA}, \\ & \mathrm{I}_{\mathrm{m}}=30 \Omega=-100 \mathrm{~mA}, \\ & \text { See Figure } 3 \end{aligned}$ |  | 50 |  | 50 | ms |

†Vellage and current ralees shewn ere nominal; exact velwes wery silighly with iransister parametars.
*PARAMETER MEASUREMENT INFORMATION


## FIOURE I - 500-mA SWITCHING TMMES


b. The wavaforms are menifored on on oscillescope with the followiag charecteristics: $\mathrm{I}_{\mathrm{r}} \leq 1 \mathrm{~ms}, \mathrm{k}_{\mathrm{in}} \geq 100 \mathrm{kR}, \mathrm{c}_{\mathrm{in}} \leq \mathbf{7 p}$.

- JEDEC rogisterod data


## FAST, HIGH-VOLTAGE, HIGH-CURRENT CORE DRIVERS

- hFE Guaranteed at $\mathbf{1 0 0} \mathbf{~ m A}$ and $\mathbf{5 0 0} \mathbf{~ m A}$
- $V_{\text {(BR)CEO }} . .40 \mathrm{~V}$ Min
- $V_{\text {(BR) }}$ CBO . . 60 V Min
- $V_{B E}$ and $V_{C E}$ (sat) Guaranteed at $\mathbf{1 0 0} \mathbf{~ m A}$ and $\mathbf{5 0 0} \mathbf{~ m A}$
- ton ... 35 ns Max at $\mathbf{5 0 0} \mathbf{~ m A}$
- toff . . 65 ns Max at $\mathbf{5 0 0} \mathrm{mA}$
- Monolithic Version Available . . . TIS127
mechanical data


NC-No internal connection

absolute maximum ratings at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)


NOTES: 1. This value applies between 0.01 mA and 500 mA collector current when the emitter-base diode is open-circuited.
2. Derate linearly to $150^{\circ} \mathrm{C}$ free-air temperature at the rates of $4 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$ for each triode and $12 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$ for the total device.

[^75]
## TYPE 02T3725 <br> OUAD N-P-N SILICON TRANSISTOR

electrical characteristics at $25^{\circ} \mathrm{C}$ free-air temperature

| PARAMETER | TEST CONDITIONS |  | MIN MAX | UNIT |
| :---: | :---: | :---: | :---: | :---: |
| $\mathrm{V}_{\text {(BR) }}$ CBO Collector-Base Breakdown Voltage | $\mathrm{I}^{\prime}=10 \mu \mathrm{~A}, \quad \mathrm{I}_{\mathrm{E}}=0$ |  | 60 | V |
| $\mathrm{V}_{\text {(BR) }}$ CEO Collector-Emitter Breakdown Voltage | $\mathrm{I}^{\prime}=10 \mathrm{~mA}, \quad \mathrm{I}_{\mathrm{B}}=0$, | See Note 3 | 40 | V |
| $V_{\text {(BR) }}$ CES Collector-Emitter Braakdown Voltage | $\mathrm{I}^{\prime}=10 \mu \mathrm{~A}, \quad \mathrm{~V}_{\mathrm{BE}}=0$ |  | 60 | V |
| $V_{\text {(BR)EBO }}$ Emitter-Base Breakdown Voltage | $I_{E}=10 \mu \mathrm{~A}, \quad \mathrm{I}^{2}=0$ |  | 6 | V |
| ICBO Collector Cutoff Current | $V_{C B}=40 \mathrm{~V}, \mathrm{I}_{\mathrm{E}}=0$ |  | 1 | $\mu \mathrm{A}$ |
|  | $V_{C E}=1 \mathrm{~V}, \quad I^{\prime} \mathrm{C}=100 \mathrm{~mA}$ |  | $60 \quad 200$ |  |
|  | $V_{C E}=1 \mathrm{~V}, \quad I^{\prime}=500 \mathrm{~mA}$ |  | 30 |  |
|  | $\mathrm{I}_{\mathrm{B}}=10 \mathrm{~mA}, \mathrm{IC}^{\prime}=100 \mathrm{~mA}$ | See Note 3 | 0.86 | $v$ |
|  | $\mathrm{I}_{B}=50 \mathrm{~mA}, \quad I_{C}=500 \mathrm{~mA}$ |  | 0.8 1-1 |  |
|  | $\mathrm{I}_{\mathrm{B}}=10 \mathrm{~mA}, \quad \mathrm{I}_{\mathrm{C}}=100 \mathrm{~mA}$ | See Note 3 | 0.26 | V |
|  | $\mathrm{I}_{\mathrm{B}}=50 \mathrm{~mA}, \quad \mathrm{I}_{\mathrm{C}}=500 \mathrm{~mA}$ |  | 0.52 | $\checkmark$ |
| HfelSmall-Signal Common-Emitter <br> Forward Current Transfer Ratio | $V_{C E}=10 \mathrm{~V},{ }^{\prime} \mathrm{C}=50 \mathrm{~mA}$, | $f=100 \mathrm{MHz}$ | 2.5 |  |
| Cobo Common-B ase Open-Circuit Output Capacitance | $V_{C B}=10 \mathrm{~V}, \mathrm{I}_{\mathrm{E}}=0$, | $f=1 \mathrm{MHz}$ | 10 | pF |
| Cibo Common-Base Open-Circuit Input Capacitance | $V_{E B}=0.5 \mathrm{~V}, \mathrm{I}_{\mathrm{C}}=0$, | $\mathrm{f}=1 \mathrm{MHz}$ | 70 | pF |

NOTE 3: These parameters must be measured using pulse techniques. $t_{w}=\mathbf{3 0 0} \mu \mathrm{m}$, duty cycie $\leqslant \mathbf{2 \%}$.

## switching characteristics at $25^{\circ} \mathrm{C}$ free-air temperature

|  | PARAMETER | TEST CONDITIONS ${ }^{\dagger}$ | MAX | UNIT |
| :---: | :---: | :---: | :---: | :---: |
| $t o n$ | Turn-On Time | $\begin{aligned} & I_{C}=500 \mathrm{~mA}, \\ & \mathrm{I}_{\mathrm{B}}=58 \Omega, 11=50 \mathrm{~mA}, \quad V_{B E}(o f f)=-3.8 \mathrm{~V}, \\ & \text { See Figure } 1 \end{aligned}$ | 35 | ns |
| toff | Turn-Off Time | $\begin{aligned} & I_{C}=500 \mathrm{~mA}, \\ & I_{\mathrm{B}}(1)=50 \mathrm{~mA}, I_{\mathrm{B}}(2)=-50 \mathrm{~mA}, \\ & R_{\mathrm{L}}=58 \Omega, \\ & \hline \end{aligned}$ | 65 | ns |

${ }^{\dagger}$ Voltage and current values shown are nominal; exact values vary slightly with transistor parameters.


FIGURE 1-600-mA SWITCHING TIMES
NOTES: a. The input waveforms are supplied by a generator with the following characteristics: $Z_{o u t}=50 \Omega, t_{r} \leqslant 1 \mathrm{~ns}, \mathrm{t}_{\mathrm{f}} \leqslant 1 \mathrm{~ns}, \mathrm{t}_{\mathrm{W}} \approx 1 \mu \mathrm{~m}$, duty evele $<\mathbf{2 \%}$.
b. The waveforms are monitored on an oscilloscope with the following characteristics: $t_{r} \leqslant 1 \mathrm{~ns}, \mathrm{R}_{\mathrm{in}} \geqslant 100 \mathrm{k} \Omega, \mathrm{C}_{\mathrm{in}} \leqslant 7 \mathrm{pF}$.

## FOR HIGH-CURRENT, HIGH-SPEED SWITCHING AND DRIVER APPLICATIONS

- hFE Guaranteed from $\mathbf{1 0} \mathbf{~ m A}$ to 1.5 A
- Guaranteed Switching Times at One Amp
mechanical data

| THE COLLECTOR IS IN ELECTRICAL contact WITH THE CASE |  |
| :---: | :---: | :---: |
| ALL DIMENSIONS ARE IN INCHES UNLESS OTHERWISE SPECIFIED |  |
| ALL JEDEC TO-39 DIMENSIONS AND NOTES ARE APPLICABLE* |  |

absolute maximum ratings at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)


[^76]${ }^{4}$ The JEDEC registered outline for these devices is TO-5. TO-39 falls within TO-5 with the exception of lead length.
-JEDEC registered data. This data sheet contains all applicable registered date in effect at the time of publication.
${ }^{1}$ These velues are guaranteed by Texas Instruments in addition to the JEDEC registered values which are also shown.

## TYPES 2N3734, 2N3735 N-P-N SILICON TRANSISTORS

*electrical characteristics at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

| PARAMETER |  | TEST CONDITIONS |  |  | 2N3734 |  | 2N3735 |  | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | MIN | MAX | MiN | MAX |  |
| $V_{\text {(BR) }} \mathbf{C B O}$ | Collector-Base Breakdown Voltage |  |  |  | $\mathrm{I}^{\prime} \mathrm{C}=10 \mu \mathrm{~A}$, | $I_{E}=0$ |  | 50 |  | 75 |  | V |
| V(BA)CEO | Collector-Emitter Breakdown Voltage | ${ }^{1} \mathrm{C}=10 \mathrm{~mA}$, | $I_{B}=0$ | See Note 4 | 30 |  | 50 |  | $V$ |
| $V_{\text {(BR) }}$ EBO | Emitter-Base Breakdown Voltage | $I_{E}=10 \mu \mathrm{~A}$, | $\mathrm{I}_{\mathrm{C}}=0$ |  | 5 |  | 5 |  | $V$ |
| Icev Collector Cutoff Current |  | $V_{C E}=25 \mathrm{~V}$, | $\mathrm{V}_{\mathrm{BE}}=-2 \mathrm{~V}$ |  |  | 0.2 |  |  | $\mu \mathrm{A}$ |
|  |  | $V_{C E}=25 \mathrm{~V}$, | $V_{B E}=-2 V$, | $T_{A}=100^{\circ} \mathrm{C}$ |  | 20 |  |  |  |
|  |  | $V_{C E}=40 \mathrm{~V}$, | $V_{B E}=-2 V$ |  |  |  |  | 0.2 |  |
|  |  | $V_{C E}=40 \mathrm{~V}$, | $V_{B E}=-2 V$, | $\mathrm{TA}=100^{\circ} \mathrm{C}$ |  |  |  | 20 |  |
| Ibev | Base Cutoff Current | $V_{C E}=25 \mathrm{~V}, \mathrm{~V}_{\text {BE }}=-2 \mathrm{~V}$ |  |  | 0.3 |  | 0.3 |  | $\mu \mathrm{A}$ |
|  |  | $V_{C E}=40 \mathrm{~V}, V_{B E}=-2 \mathrm{~V}$ |  |  |  |  |  |  |  |
| hFE | Static Forward Current Transfer Ratio | $V_{\text {CE }}=1 \mathrm{~V}$. | $\mathrm{IC}^{\prime}=10 \mathrm{~mA}$ | See Note 4 | 35 |  | 35 |  |  |
|  |  | $V_{C E}=1 \mathrm{~V}$, | $I_{C}=150 \mathrm{~mA}$ |  | 40 |  | 40 |  |  |
|  |  | $V_{C E}=1 \mathrm{~V}$, | $I_{C}=500 \mathrm{~mA}$ |  | 35 |  | 35 |  |  |
|  |  | $V_{C E}=1.5 \mathrm{~V}$ | $I_{C}=1 \mathrm{~A}$ |  | 30 | 120 | 20 | 80 |  |
|  |  | $V_{C E}=5 \mathrm{~V}$, | $\mathrm{I}_{\mathrm{C}}=1.5 \mathrm{~A}$ |  | 30 |  | 20 |  |  |
| VBE | Base-Emitter Voltege | $\mathrm{I}_{\mathrm{B}}=1 \mathrm{~mA}$, | $I^{\prime} \mathrm{C}=10 \mathrm{~mA}$ | See Note 4 |  | 0.8 |  | 0.8 | V |
|  |  | $\mathrm{I}_{B}=15 \mathrm{~mA}$, | $I_{C}=150 \mathrm{~mA}$ |  | 1 |  | 1 |  |  |
|  |  | $\mathrm{I}_{\mathrm{B}}=50 \mathrm{~mA}$, | $i_{C}=500 \mathrm{~mA}$ |  |  | 1.2 |  | 1.2 |  |
|  |  | $\mathrm{I}_{\mathrm{B}}=100 \mathrm{~mA}$, | $\mathrm{I}_{\mathrm{C}}=1 \mathrm{~A}$ |  | 0.9 | 1.4 | 0.9 | 1.4 |  |
| VCE(sat) | Collector-Emitter Saturation Voltage | $\mathrm{I}_{\mathrm{B}}=1 \mathrm{~mA}$, | $I^{\prime} C=10 \mathrm{~mA}$ | See Note 4 |  | 0.2 |  | 0.2 | $v$ |
|  |  | $I_{B}=15 \mathrm{~mA},$ | $I_{C}=150 \mathrm{~mA}$ |  |  | 0.3 |  | 0.3 |  |
|  |  | $\mathrm{I}_{8}=50 \mathrm{~mA}$, | $\mathrm{I}^{\mathrm{C}}=500 \mathrm{~mA}$ |  |  | 0.5 |  | 0.5 |  |
|  |  | $\mathrm{I}_{\mathrm{B}}=100 \mathrm{~mA}$, | $\mathrm{I}^{\prime}=1 \mathrm{~A}$ |  |  | 0.9 |  | 0.9 |  |
| Mfal | Small-Signal Common-Emitter Forward Current Trensfer Ratio | $v_{C E}=10 \mathrm{~V}$, | $I^{\prime} \mathrm{C}=50 \mathrm{~mA}$, | $f=100 \mathrm{MHz}$ | 3 |  | 2.5 |  |  |
| $\mathrm{C}_{\text {obo }}$ | Common-Base Open-Circuit Output Capacitance | $\mathrm{V}_{\mathrm{CB}}=10 \mathrm{~V}$, | $I_{E}=0$, | $f=100 \mathrm{kHz}$ |  | 9 |  | 9 | pF |
| $c_{\text {ibo }}$ | Common-Base Open-Circuit Input Capacitance | $\mathrm{V}_{\mathrm{EB}}=0.5 \mathrm{~V}$, | $\mathrm{I}^{\prime}=0$, | $\mathrm{f}=100 \mathrm{kHz}$ |  | 80 |  | 80 | pF |

NOTE 4: Theew pararneters must be measured using pulse techniques. $t_{w}=\mathbf{3 0 0} \mu \mathrm{s}$, dutv cycle $\leqslant \mathbf{2 \%}$.
*switching characteristics at $\mathbf{2 5}{ }^{\circ} \mathrm{C}$ free-air temperature

| PARAMETER |  | TEST CONDITIONS ${ }^{\dagger}$ |  | MAX | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: |
| $t_{0}$ | Delay Time | $\mathrm{V}_{\mathrm{CC}}=30 \mathrm{~V}, \quad \mathrm{IC}=1 \mathrm{~A}$, | $\mathrm{I}_{\mathrm{B}(1)}=100 \mathrm{~mA}$, | 8 | ns |
| $\mathrm{t}_{\mathrm{r}}$ | Rise Time | $V_{B E}$ (off) $=-2 V_{\text {, }}$ | See Figure 1 | 40 | ns |
| $t_{\text {off }}$ | Turn-Off Time | $\begin{aligned} & V_{C C}=30 \mathrm{~V}, \quad I_{C}=1 \mathrm{~A}, \\ & I_{B(2)}=-100 \mathrm{~mA} . \end{aligned}$ | $A_{B}(1)=100 \mathrm{~mA},$ <br> See Figure 2 | 60 | ns |
| $\mathrm{O}_{\mathbf{T}}$ | Total Control Charge | $\mathrm{I}_{\mathrm{C}}=1 \mathrm{~A}, \quad \mathrm{I}_{\mathrm{B}}=100 \mathrm{~mA}$, | See Figure 3 | 10 | nc |

${ }^{\dagger}$ Voltage and current values shown are nominal; exact values vary slightly with transistor parameters.

[^77]TYPES 2N3734, 2N3735
N-P-N SILICON TRANSISTORS

## PARAMETER MEASUREMENT INFORMATION



TEST CIRCUIT


VOLTAGE WAVEFORMS
FIGURE 1 -DELAY AND RISE TIMES


FIGURE 2-STORAGE AND FALL TIMES


FIGURE 3-TOTAL CONTROL CHARGE

NOTES: a. The input woveforms are supplied by a generator with the following characterlatice: $\mathbf{Z}_{\text {out }}=\mathbf{8 0 \Omega} \mathbf{\Omega}$, duty eycle $\mathbf{< 2 \%}$.


# FOR LOW-LEVEL, LOW-NOISE, HIGH-GAIN AMPLIFER APPLICATIONS <br> - Recommended for Complomentary Use with 2N2484 and 2 N 3117 <br> - Guarentoed Low-Nolse Characteristics <br> - Excollont hminearity from $10 \mu \mathrm{~A}$ to 10 mA Collector Current 

*mechanical deta

*absolute maximum rafings af $25^{\circ} \mathrm{C}$ free-air temperafure (unless otherwise noted)
Collector-Base Voltage . . . . . . . . . . . . . . . . . . . . . . . . -60 V
Collector-Emitter Voltage (See Note 1) . . . . . . . . . . . . . . . . . . . -60 V
Emitter-Base Voltage . . . . . . . . . . . . . . . . . . . . . . . . . $\mathbf{5}$ V
Continuous Collector Current . . . . . . . . . . . . . . . . . . . . . . . - 50 mA
Continuous Device Dissipation at (or below) $25^{\circ} \mathrm{C}$ Free-Air Temperature (See Note 2) . . . . 360 mW
Continuous Device Dissipation at (or below) $25^{\circ} \mathrm{C}$ Case Temperature (See Note 3) . . . . . 1.2 W
Storage Temperature Range . . . . . . . . . . . . . . . . . . . . $-65^{\circ} \mathrm{C}$ to $200^{\circ} \mathrm{C}$
Lead Temperature $\mathrm{K}_{\mathrm{a}}$ Inch from Case for 10 Seconds . . . . . . . . . . . . . . . $230^{\circ} \mathrm{C}$

2. Derate Incerly $10200^{\circ} \mathrm{C}$ Irev-alr temperature of the teto of $2.00 \mathrm{mw} / \mathrm{dan}$.
3. Derote lincerly io $200^{\circ} \mathrm{C}$ ene temperature of the rele of $\mathbf{8 . 0 6} \mathrm{m} / \mathrm{m} / \mathrm{deg}$.
*Indleater JEDEC maltored dete

## TYPES 2N3798, 2N3799

## P-N-P SILICON TRANSISTORS

*electrical characteristics at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

| PARAMETER |  | TEST CONDITIONS | 2N3798 | 2N3799 | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | MIN MAX | MIN MAX |  |
|  | Collector-Base Breakdown Yoltage |  | $\mathrm{I}_{\mathrm{c}}=-10 \mu \mathrm{~A}, \mathrm{I}_{\mathrm{E}}=0$ | -60 | -60 | $V$ |
|  | Collector-Emilter Breakdown Voltage | $I_{C}=-10 \mathrm{~mA}, I_{B}=0, \quad$ See Note 4 | -60 | -60 | $V$ |
|  | Emitter-Base Breakdown Voltage | $\mathrm{I}_{\mathrm{E}}=-10 \mu \mathrm{~A}, \mathrm{I}_{\mathrm{C}}=0$ | -5 | -5 | V |
| $\mathrm{I}_{\text {cio }}$ | Collector Culoff Current | $V_{C B}=-50 \mathrm{~V}, \mathrm{I}_{\mathrm{E}}=0$ | -10 | -10 | nA |
|  |  | $V_{C B}=-50 \mathrm{~V}, \mathrm{I}_{\mathrm{E}}=0, \quad \mathrm{~T}_{\mathrm{A}}=150^{\circ} \mathrm{C}$ | -10 | -10 | $\mu \mathrm{A}$ |
| $\mathrm{I}_{\text {EBO }}$ | Emitter Cutoft Current | $V_{E B}=-4 V_{,} \quad I_{C}=0$ | -20 | -20 | nA |
| $h_{\text {fe }}$ | Static Forward Current Transer Ratio | $V_{C E}=-5 V, I_{C}=-1 \mu \mathrm{~A}$ |  | 75 |  |
|  |  | $V_{\text {CE }}=-5 \mathrm{~V}_{1} \quad \mathrm{I}_{\mathrm{C}}=-10 \mu \mathrm{~A}$ | 100 | 225 |  |
|  |  | $V_{C E}=-5 \mathrm{~V}, \quad \mathrm{I}_{\mathrm{C}}=-100 \mu \mathrm{~A}$ | 150 | 300 |  |
|  |  | $V_{\text {CE }}=-5 \mathrm{~V}, \mathrm{I}_{\mathrm{C}}=-500 \mu \mathrm{~A}$ | $150 \quad 450$ | $300 \quad 900$ |  |
|  |  | $V_{C E}=-5 V_{1} \mathrm{l}_{\mathrm{c}}=-1 \mathrm{~mA}$ | 150 | 300 |  |
|  |  | $V_{\text {CE }}=-5 \mathrm{~V}, \quad \mathrm{I}_{\mathrm{C}}=-10 \mathrm{~mA}$ | 125 | 250 |  |
|  |  | $\mathrm{V}_{C E}=-5 \mathrm{~V}, \quad \mathrm{I}_{\mathrm{C}}=-100 \mu \mathrm{~A}, \mathrm{~T}_{\mathrm{A}}=-55^{\circ} \mathrm{C}$ | 75 | 150 |  |
| $V_{\text {EE }}$ | Base-Emitter Voltage | $V_{C E}=-5 \mathrm{~V}, \quad \mathrm{I}_{\mathrm{C}}=-100 \mu \mathrm{~A}$ | -0.7 | -0.7 | V |
|  |  | $\mathrm{I}_{\mathrm{B}}=-10 \mu \mathrm{~A}, \mathrm{I}_{\mathrm{C}}=-100 \mu \mathrm{~A}$ | -0.7 | -0.7 | $V$ |
|  |  | $\mathrm{I}_{5}=-100 \mu \mathrm{~A}, \mathrm{I}_{\mathrm{C}}=-1 \mathrm{~mA}$ | -0.8 | -0.8 | V |
| $V_{\text {cefut) }}$ | Collector-Emitter Saturation Voltage | $\mathrm{I}_{\mathrm{B}}=-10 \mu \mathrm{~A}, \mathrm{I}_{\mathrm{C}}=-100 \mu \mathrm{~A}$ | -0.2 | -0.2 | V |
|  |  | $\mathrm{I}_{\mathrm{g}}=-100 \mu \mathrm{~A}, \mathrm{I}_{\mathrm{C}}=-1 \mathrm{~mA}$ | -0.25 | -0.25 | $V$ |
| $\mathrm{h}_{\text {ie }}$ | Small-Signal Common-Emitter Input Impedance | $\mathrm{V}_{\text {CE }}=-10 \mathrm{~V}$, | $3 \quad 30$ | $10 \quad 40$ | $\mathrm{k} \Omega$ |
| $\mathrm{h}_{\text {to }}$ | Small-Signal Common-Emitter Forward Current Transfer Ratio |  | 150600 | 300900 |  |
| $h_{\text {re }}$ | Small-Signal Common-Emitter Reverse Voltage Transfer Ratio |  | $\begin{array}{r\|} 25 \\ \times 10^{-4} \\ \hline \end{array}$ | $\begin{array}{r\|} \hline 25 \\ \times 10^{-4} \\ \hline \end{array}$ |  |
| $\mathrm{h}_{\text {¢ }}$ | Small-Signal Common-Emitter Output Admittance |  | 560 | 560 | $\mu \mathrm{mha}$ |
| \| $\mathrm{hfo}_{\text {fi }}$ | Small-Signal Common-Emitter Forward Current Transfer Ratio | $V_{C E}=-5 \mathrm{~V}, \quad \mathrm{I}_{\mathrm{C}}=-500 \mu \mathrm{~A}, \mathrm{f}=30 \mathrm{MHz}$ | 1 | 1 |  |
|  |  | $\mathrm{V}_{\text {CE }}=-5 \mathrm{~V}, \quad \mathrm{I}_{\mathrm{C}}=-1 \mathrm{~mA}, \quad \mathrm{f}=100 \mathrm{mHz}$ | 15 | 15 |  |
| Cobo | Common-Sase Open-Crtuif Output Capacitance | $\mathrm{V}_{\mathrm{CB}}=-5 \mathrm{~V}, \quad \mathrm{I}_{\mathrm{E}}=0, \quad f=100 \mathrm{kHz}$ | 4 | 4 | pF |

## *operating characteristics at $25^{\circ} \mathrm{C}$ free-air temperature

|  | Parameter | TEST CONDITIONS | $\frac{2 \mathrm{~N} 3798}{\text { MAX }}$ | $\frac{2 \mathrm{~N} 3799}{\text { MAX }}$ | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: |
| NF | Spot Noise Figure | $\begin{aligned} & V_{C E}=-10 \mathrm{~V}, \mathrm{I}_{\mathrm{c}}=-100 \mu \mathrm{~A}, \mathrm{R}_{G}=3 \mathrm{k} \Omega, \\ & \mathrm{f}=100 \mathrm{~Hz}, \quad \text { Noise Bandwidth }=20 \mathrm{~Hz} \end{aligned}$ | 7 | 4 | d8 |
|  |  | $\begin{aligned} & V_{C E}=-10 \mathrm{~V}, \mathrm{I}_{\mathrm{c}}=-100 \mu \mathrm{~h}, \mathrm{R}_{G}=3 \mathrm{k} \Omega, \\ & \mathrm{f}=1 \mathrm{kHz}, \quad \text { Noise Bandwidth }=200 \mathrm{~Hz} \end{aligned}$ | 3 | 1.5 | dB |
|  |  | $\begin{aligned} & V_{\mathrm{CE}}=-10 \mathrm{~V}, \mathrm{I}_{\mathrm{c}}=-100 \mu \mathrm{~A}, \mathrm{R}_{\mathrm{G}}=3 \mathrm{k} \Omega, \\ & \mathrm{f}=10 \mathrm{kHz}, \text { Noise Bandwidth }=2 \mathrm{kHz} \end{aligned}$ | 2.5 | 1.5 | dB |
| $\overline{N F}$ | Average Noise Figure | $\begin{aligned} & V_{C E}=-10 \mathrm{~V}, I_{C}=-100 \mu \mathrm{~A}, R_{G}=3 \mathrm{k} \Omega, \\ & \text { Noise Bondwidth }=15.7 \mathrm{kHz} \text {, See Note } 5 \end{aligned}$ | 3.5 | 2.5 | dB |

NOTES: 4. Thase paramaters must be measured using pulse fachniques. $t_{p}=300 \mu s$, duty cycle $\leq \mathbf{2 \%}$.
5. Average Noise Figurs is measured in en amplifier with low-frequency rosponse down $\mathbf{3}$ dil at 10 Hz .
*Indicatos JEDEC ragistorod data

## TYPES 2N3806 THRU 2N3811 DUAL P-N-P SILICON TRANSISTORS

## TWO TRANSISTORS IN ONE PACKAGE RECOMMENDED FOR

## - Differential Amplifiers

- High-Gain, Low-Noise Amplifiers
- Low-Level Flip-Flops
- Complementary Use With 2N2913 Thru 2N2920 And 2N2639 Thru 2N2644 Dual N-P-N Transistors


## *mechanical data


quick-selection guide (for details see characteristics on pages 2 and 3)

| TYPE | MIN-MAX hFE$\left(I_{C}=-0.1 \text { to }-1 \mathrm{~mA}\right)$ |  | $\begin{gathered} \operatorname{MAX}\left\|V_{B E 1}-V_{B E 2}\right\| \\ \left(I_{C}=-100 \mu A\right) \end{gathered}$ |  | hfe MATCHING$\left(I_{C}=-100 \mu A\right)$ |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | 150-450 | 300-900 | 3 mV | 5 mV | 10\% | 20\% |
| 2N3806 | - |  |  |  |  |  |
| 2N3807 |  | - |  |  |  |  |
| 2N3808 | $\bullet$ |  |  | - |  | - |
| 2N3809 |  | - |  | - |  | - |
| 2N3810 | - |  | $\bullet$ |  | $\bullet$ |  |
| 2N3811 |  | $\bullet$ | * |  | - |  |

*absolute maximum ratings at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)
EACH
TOTAL

NOTES: 1. This value applies when the base-emitter diode is open-circuited.
2. Derate linearly to $200^{\circ} \mathrm{C}$ free-air temperature at the rates of $2.9 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$ for each triode and $3.4 \mathrm{~mW} / /^{\circ} \mathrm{C}$ for total device. See Dissipation Derating Curve, Figure 1.

[^78]
## TYPES 2N3806 THRU 2N3811

DUAL P-N-P SILICON TRANSISTORS
*electrical characteristics at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)
individual triode characteristics (see note 3)

| PARAMETER |  | TEST CONDITIONS | $\begin{aligned} & \hline \text { 2N3806 } \\ & \text { 2N3808 } \\ & \text { 2N3810 } \\ & \hline \end{aligned}$ | $\begin{aligned} & \hline \text { 2N3807 } \\ & \text { 2N3809 } \\ & \text { 2N3811 } \\ & \hline \end{aligned}$ | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | MIN MAX | MIN MAX |  |
| $V$ (BR)CBO | Collector-Base Breakdown Voltage |  | $I_{C}=-10 \mu A, \quad I_{E}=0$ | -60 | -60 | $V$ |
| $V_{\text {(BR) }} \mathrm{V}^{\text {(BRO }}$ | Collector-Emitter Breakdown Voltage | $\mathrm{I}_{\mathrm{C}}=-10 \mathrm{~mA}, \mathrm{I}_{\mathrm{B}}=0, \quad$ See Note 4 | -60 | -60 | $V$ |
| $V_{\text {(BR) }}$ EBO | Emitter-Base Breakdown Voltage | $I_{E}=-10 \mu A, I_{C}=0$ | -5 | -5 | V |
| I'CBO | Collector Cutoff Current | $V_{C B}=-50 \mathrm{~V}, \mathrm{I}_{\mathrm{E}}=0$ | -10 | -10 | nA |
|  |  | $V_{C B}=-50 \mathrm{~V}, \mathrm{I}_{\mathrm{E}}=0, \quad T_{A}=150^{\circ} \mathrm{C}$ | -10 | -10 | $\mu A$ |
| IEBO | Emitter Cutoff Current | $V_{E B}=-4 V, \quad V^{\prime}=0$ | -20 | -20 | nA |
| hFE | Static Forward Current Transfer Ratio | $V_{C E}=-5 \mathrm{~V}, \mathrm{I}^{\prime} \mathrm{C}=-10 \mu \mathrm{~A}$ | 100 | 225 |  |
|  |  | $\mathrm{V}_{C E}=-5 \mathrm{~V}, \mathrm{I}_{\mathrm{C}}=-100 \mu \mathrm{~A}$ | $150 \quad 450$ | $300 \quad 900$ |  |
|  |  | $\mathrm{V}_{\text {CE }}=-5 \mathrm{~V}, \mathrm{I}^{\prime} \mathrm{C}=-500 \mu \mathrm{~A}$ | 150450 | $300 \quad 900$ |  |
|  |  | $\mathrm{V}_{\text {CE }}=-5 \mathrm{~V}$, $\mathrm{I}_{\mathrm{C}}=-1 \mathrm{~mA}$ | 150450 | $300 \quad 900$ |  |
|  |  | $V_{C E}=-5 \mathrm{~V}, \mathrm{I}_{\mathrm{C}}=-10 \mathrm{~mA}$, See Note 4 | 125 | 250 |  |
|  |  | $V_{C E}=-5 \mathrm{~V}, \mathrm{I}^{\prime}=-100 \mu \mathrm{~A}, \mathrm{~T}_{A}=-55^{\circ} \mathrm{C}$ | 75 | 150 |  |
| $\mathbf{V}_{\mathbf{B E}}$ | Base-Emitter Voltage | $V_{C E}=-5 \mathrm{~V}, \mathrm{I}^{\prime}=-100 \mu \mathrm{~A}$ | -0.7 | -0.7 | V |
|  |  | ${ }^{1} \mathrm{~B}=-10 \mu \mathrm{~A}, \quad{ }^{\prime} \mathrm{C}=-100 \mu \mathrm{~A}$ | -0.7 | -0.7 |  |
|  |  | $\mathrm{I}_{B}=-100 \mu \mathrm{~A}, \mathrm{I}_{C}=-1 \mathrm{~mA}$ | -0.8 | -0.8 |  |
| VCE(sat) | Collector-Emitter Saturation Voltage | $\mathrm{I}_{B}=-10 \mu \mathrm{~A}, \quad \mathrm{I}_{C}=-100 \mu \mathrm{~A}$ | -0.2 | -0.2 | V |
|  |  | $\mathrm{I}_{B}=-100 \mu \mathrm{~A}, \mathrm{I}_{\mathrm{C}}=-1 \mathrm{~mA}$ | -0.25 | -0.25 |  |
| $h_{\text {ie }}$ | Small-Signal Common-Emitter Input Impedance |  | $3 \quad 30$ | $10 \quad 40$ | $\mathrm{k} \boldsymbol{\Omega}$ |
| $h_{\text {fe }}$ | Small-Signal Common-Emitter Forward Current Transfer Ratio |  | 150600 | $300 \quad 900$ |  |
| $\mathrm{hre}_{\text {re }}$ | Small-Signal Common-Emitter Reverse Voltage Transfer Ratio |  | $\begin{array}{r} 25 X \\ 10^{-4} \\ \hline \end{array}$ | $\begin{gathered} 25 \times \\ 10^{-4} \end{gathered}$ |  |
| hoe | Small-Signal Common-Emitter Output Admittance |  | $5 \quad 60$ | 560 | $\mu \mathrm{mho}$ |
| $\left\|h_{\text {fe }}\right\|$ | Small-Signal Common-EmitterForward Current Transfer Ratio | $\mathrm{V}_{\text {CE }}=-5 \mathrm{~V}, \mathrm{IC}=-500 \mu \mathrm{~A}, \mathrm{f}=30 \mathrm{MHz}$ | 1 | 1 |  |
|  |  | $V_{C E}=-5 \mathrm{~V}, \mathrm{l}_{\mathrm{C}}=-1 \mathrm{~mA}, \quad \mathrm{f}=100 \mathrm{MHz}$ | 15 | 15 |  |
| $\mathrm{C}_{\text {obo }}$ | Common-Base Open-Circuit Output Capacitance | $V_{C B}=-5 \mathrm{~V}, \quad \mathrm{l}_{\mathrm{E}}=0, \quad f=100 \mathrm{kHz}$ | 4 | 4 | pF |
| $C_{\text {ibo }}$ | Common-Base Open-Circuit Input Capacitance | $\mathrm{V}_{\mathrm{EB}}=-0.5 \mathrm{~V}, \mathrm{I} \mathrm{C}=0, \quad \mathrm{f}=100 \mathrm{kHz}$ | 8 | 8 | pF |

NOTES: 3. The terminals of the triode not under test are open-circuited for the measurement of these characteristics.
4. Thase parameters are measured using pulse techniques. $t_{w}=300 \mu \mathrm{~s}$, duty cycle $<\mathbf{1 \%}$.
-JEDEC registered data

## TYPES 2N3806 THRU 2N3811 DUAL P-N-P SILICON TRANSISTORS

"electrical characteristics at $\mathbf{2 5}{ }^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)
triode matching charactoristics

*operating characteristics at $25^{\circ} \mathrm{C}$ free-air temperature
individual triode characteristics (see note 3)

| PARAMETER |  | TEST CONDITIONS | $\begin{aligned} & \hline \text { 2N3806 } \\ & \text { 2N3808 } \\ & \text { 2N3810 } \\ & \hline \end{aligned}$ | $\begin{aligned} & \text { 2N3807 } \\ & \text { 2N3809 } \\ & \text { 2N3811 } \\ & \hline \end{aligned}$ | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | MAX | MAX |  |
| F | Spot Noise Figure |  | $\begin{aligned} & V_{C E}=-10 \mathrm{~V}, I_{C}=-100 \mu \mathrm{~A}, \mathrm{R}_{\mathrm{G}}=3 \mathrm{~kg}, \\ & \mathrm{f}=100 \mathrm{~Hz}, \\ & \text { Noise Bandwidth }=20 \mathrm{~Hz} \end{aligned}$ | 7 | 4 | dB |
|  |  | $\begin{aligned} & V_{C E}=-10 \mathrm{~V}, \\ & \mathrm{I}=1 \mathrm{kHz}=-100 \mu \mathrm{~A}, \mathrm{R}_{\mathrm{G}}=3 \mathrm{~kJ}, \\ & \text { Noise Bandwidth }=200 \mathrm{~Hz} \end{aligned}$ | 3 | 1.5 | dB |
|  |  | $\begin{aligned} & V_{\mathrm{CE}}=-10 \mathrm{~V}, \mathrm{I}_{\mathrm{C}}=-100 \mu \mathrm{~A}, \mathrm{R}_{\mathrm{G}}=3 \mathrm{k} \Omega, \\ & \mathrm{f}=10 \mathrm{kHz}, \quad \text { Noise Bandwidth }=2 \mathrm{kHz} \end{aligned}$ | 2.5 | 1.5 | dB |
| $\bar{F}$ | Average Noise Figure | $\begin{aligned} & V_{\mathrm{CE}}=-10 \mathrm{~V}, \mathrm{I}_{\mathrm{C}}=-100 \mu \mathrm{MA}, \mathrm{R}_{\mathrm{G}}=3 \mathrm{k} \Omega, \\ & \text { Noise Bandwidth }=15.7 \mathrm{kHz}, \text { See Nate } 6 \end{aligned}$ | 3.5 | 2.5 | dB |

NOTES. 3. The terminals of the triode not under test are open-circuited for the measurement of these characteristics.
5. The lower of the two MFE reading is taken as hFE1.
6. Avarage Noise Figure is measured in an amplifier with response down 3 dB at 10 Hz and 10 kHz and a high-frequency rolloff of $6 \mathrm{~dB} /$ octave.

- JEDEC registered data


## THERMAL INFORMATION



## N-CHANNEL SILICON JUNCTION FIELD-EFFECT TRANSISTOR

## SILECT ${ }^{\dagger}$ FIELD-EFFECT TRANSISTOR $\ddagger$

- For Industrial and Consumer Small-Signal Applications
- Low $\mathrm{C}_{\text {rss }} \leqslant 4 \mathrm{pf}$ - High $\mathrm{yfs} / \mathrm{C}_{\text {iss }}$ Ratio (High-Frequency Figure of Merit)
- Cross Modulation Minimized by Square-Law Transfer Characteristics
- For New Designs, 2N5949 thru 2N5953 and A5T3821 thru A5T3824

Are Recommended

## mechanical data

This transistor is encapsulated in a plastic compound specifically designed for this purpose, using a highly mechanized process developed by Texas Instruments. The case will withstand soldering temperatures without deformation. The device exhibits stable characteristics under high-humidity conditions and is capable of meeting MIL-STD-202C, Method 1068. The transistor is insensitive to light.
*ALL JEDEC TO.92 DIMENSIONS AND NOTES ARE APPLICABLE
*absolute maximum ratings at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

*electrical characteristics at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

|  | PARAMETER | TEST CONDITIONS | MIN MAX | UNIT |
| :---: | :---: | :---: | :---: | :---: |
| $V_{\text {(tap) }}$ | Gate-Source Breakdown Voltage | $\mathrm{I}_{\mathrm{G}}=-1 \mu \mathrm{a}, \mathrm{V}_{\mathrm{DS}}=0$ | -25 | V |
| $I_{\text {gSS }}$ | Gate Cutoff Current | $V_{G S}=-15 v, V_{D S}=0$ | -2 | no |
|  |  | $V_{G S}=-15 \mathrm{v}, V_{D S}=0, \mathrm{I}_{A}=100^{\circ} \mathrm{C}$ | -2 | $\mu \mathrm{a}$ |
| loss | Zero-Gate-Voltage Drain Current | $V_{D S}=15 v_{1} \quad V_{G S}=0$, See Note 2 | 220 | ma |
| $V_{\text {Gs }}$ | Gate-Source Voltage | $V_{D S}=15 \mathrm{v}, \quad l_{D}=200 \mu \mathrm{a}$ | -0.5 -7.5 | $V$ |
| $V_{\text {ES }}$ (off | Gate-Source Cutoff Voltage | $V_{\text {DS }}=15 \mathrm{v}, \quad \mathrm{I}_{\mathrm{D}}=2 \mathrm{na}$ | -8 | V |
| $\left\|y_{\text {fa }}\right\|$ | Small-Signal Common-Source Forward Transfer Admittance | $\begin{aligned} & V_{D S}=15 v, \quad V_{G S}=0, \begin{array}{l} f=1 \mathrm{kc}, \\ \text { See Note } 2 \end{array} \end{aligned}$ | 20006500 | $\mu \mathrm{mho}$ |
| $\left\|y_{0 s}\right\|$ | Small-Signal Common-Source Output Admittance | $V_{\mathrm{DS}}=15 \mathrm{v}, \quad V_{\mathrm{GS}}=0, \underset{\text { See Note } 2}{\mathrm{f}=1 \mathrm{kc},}$ | 50 | $\mu \mathrm{mho}$ |
| $C_{\text {iss }}$ | Common-Source Short-Gircuit Input Capacitance | $V_{D S}=15 \mathrm{v},$ | 8 | pf |
| $C_{\text {rss }}$ | Common-Source Short-Circuit Reverse Pransfer Capaciitance | $f=1 M c$ | 4 | pi |
| $\left\|y_{\text {fs }}\right\|$ | Small-Signal Cormmon-Source Forward Transfer Admittance | $V_{D S}=15 \mathrm{v}, \quad V_{G S}=0, f=100 \mathrm{Mc}$ | 1600 | $\mu \mathrm{mho}$ |

NOTES: 1. Derate linearly to $150^{\circ} \mathrm{C}$ free-air temperature at the rate of $2.88 \mathrm{mw} /{ }^{\circ} \mathrm{C}$.
2. These parameters must be measured pulse techniques. $t_{w} \approx 100 \mathrm{~ms}$, duty cycle $\leqslant 10 \%$.

- JEDEC registered data
${ }^{\dagger}$ Trademark of Texas Instruments
$\ddagger$ U.S. Patent No. 3,439,238


## SHECT ${ }^{\dagger}$ FIELD-EFFECT TRANSISTOR ${ }^{\ddagger}$ <br> For Industrial and Consumer Small-Signal Applications

## mechanical data

This transistor is encapsulated in a plastic compound specifically designed for this purpose, using a highly mechanized process developed by Texas Instruments. The case will withstand soldering temperatures without deformation. The device exhibits stable characteristics under high-humidity conditions and is capable of meeting MIL-STD-202C, Method 106B. The transistor is insensitive to light.
*ALL JEDEC TO-92 DIMENSIONS AND NOTES ARE APPLICABLE


WOTE A: Lead diemoter is not controlled in shis orna.

[^79]*absolute maximum ratings at $\mathbf{2 5}^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

*electrical characteristics af $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

| PARAMETER |  | TEST CONDITIONS | MIN MAX | UNIT |
| :---: | :---: | :---: | :---: | :---: |
| $V_{\text {(m) }}$ ¢ss | Gate-Source Breakdown Voltage | $\mathrm{I}_{G}=10 \mu \mathrm{O}, \mathrm{V}_{\text {DS }}=0$ | 20 | V |
| Igss | Gate Cutoff Current | $V_{G S}=10 \mathrm{v}, V_{\text {DS }}=0$ | 20 | na |
|  |  | $V_{\text {GS }}=10 \mathrm{~V}, \quad V_{\text {DS }}=0, \quad \mathrm{~T}_{\mathrm{A}}=100^{\circ} \mathrm{C}$ | 2 | $\mu \mathrm{a}$ |
| loss | Zero-Gate-Voltage Drain Current | $V_{\text {OS }}=-10 \mathrm{v}, \mathrm{V}_{G S}=0, \quad$ Soe Mote 2 | -0.3 -15 | ma |
| $V_{\text {Gs }}$ | Gate-Source Voltige | $V_{D S}=-10 v_{1} I_{D}=-30 \mu \mathrm{D}$ | $0.3-7.9$ | V |
| $V_{\text {GS } \text { ( } \text { fif }}$ | Gate-Source Cutoff Voltage | $V_{\text {DS }}=-10 \mathrm{v}, \mathrm{I}_{\mathrm{D}}=-10 \mu \mathrm{a}$ | 8 | $v$ |
| $\left\|y_{t s}\right\|$ | Small-Signol Common-Source Forward Transfer Admittance | $V_{D S}=-10 \mathrm{~V}, \mathrm{~V}_{G S}=0, \quad \begin{aligned} & \mathrm{f}=1 \mathrm{lkc}, \\ & \text { Seat Note } 2\end{aligned}$ | 8005000 | $\mu \mathrm{mho}$ |
| \|Yos| | Small-Signal Common-Sourte Output Admithance | $\begin{array}{lll}V_{D S}=-10 \\ V, V_{G S}=0, & f=1 \mathrm{kc}, \\ & \text { Soe Note } 2\end{array}$ | 200 | $\mu \mathrm{mho}$ |
| $\mathrm{C}_{\mathbf{i s}}$ | Common-Source Shori-Ciruvit Input Capacitance | $V_{D S}=-10 v,$ | 32 | pf |
| $\mathrm{C}_{\text {rss }}$ | Common-Source Shorl-Grcult Reverse Iransfer Capacitance | , $f=1 \mathrm{Mc}$ | 16 | pf |
| $\left\|y_{f s}\right\|$ | Small-Signal Common-Source Forward Transfer Admittance | $V_{D S}=-10 \mathrm{v}, \mathrm{V}_{\mathrm{GS}}=0, \quad f=10 \mathrm{Mc}$ | 700 | $\mu \mathrm{mho}$ |

NOTES: 1. Derate linearly to $150^{\circ} \mathrm{C}$ free-air temperature at the rate of $2.88 \mathrm{mw} /{ }^{\circ} \mathrm{C}$.
2. Thase parameters must be measured using pulse techniques. $t_{w} \approx 100 \mathrm{~ms}$, dury cycle $\leqslant \mathbf{1 0 \%}$.

## JEDEC registered data

trademark of Texas Instruments
$\ddagger$ U.S. Patent No. 3,439,238

# TYPES 2N3821 THRU 2N3824 N-CHANNEL SILICON JUNCTION FIELD-EFFECT TRANSISTORS <br> BULLETIN NO, DL- $7311910, \mathrm{MARCH} 1973$ 

## 2N3821, 2N3822

FOR SMALL-SIGNAL APPLICATIONS

- Low loss: <100 pA
- Low Ciss: <8 pF
- High Yfs/Ciss Ratio (High-Frequency Figure-of-Merit)

2N3823
FOR VHF AMPLIFIER AND MIXER APPLICATIONS

- Low Noise Figure: $\boldsymbol{\leqslant 2 . 5} \mathbf{d B}$ at $\mathbf{1 0 0} \mathbf{~ M H z}$
- Low Crss: <2 pF
- High Yfs/Ciss Ratio (High-Frequency Figure-of-Merit)

2N3824
FOR HIGH-SPEED COMMUTATOR AND CHOPPER APPLICATIONS

- Low rds(on): <250 $\Omega$
- Low ID(off): <100 pA
- Low Crss $^{\text {: }} \mathbf{~} \mathbf{3} \mathrm{pF}$
*mechanical data

-JEDEC regiatered dete. This dete sheet conteins all applicable registered data in affact at the time of publication.


## TYPES 2N3821 THRU 2N3824 N-CHANNEL SILICON JUNCTION FIELD-EFFECT TRANSISTORS

## *absolute maximum ratings at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)



2N3821, 2N3822
"electrical characteristics at $25^{\circ} \mathbf{C}$ free-air temperature (unless otherwise noted)

| PARAMETER |  | TEST CONDITIONS ${ }^{\boldsymbol{t}}$ |  |  | 2N3821 | 2N3822 | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | MIN MAX | MIN MAX |  |
| $V$ (BR)Gss | Gate-Source Brackdown Voltepe |  |  |  | $1_{G}=-1 \mu A$, | $V_{D S}=0$ |  | -50 | -50 | V |
| ${ }^{1} \mathrm{GSS}$ | Gate Cutoff Currant | $V_{\text {GS }}=-30 \mathrm{~V}$ | $V_{D S}=0$ |  | -0.1 | -0.1 | nA |
|  |  | $V_{\text {GS }}=-30 \mathrm{~V}$ | VOS $=0$, | $T_{A}=150^{\circ} \mathrm{C}$ | -0.1 | -0.1 | $\mu \mathrm{A}$ |
| $V_{\text {GS }}$ (off) | Gate-Sourca Cutoff Voltage | $V_{\text {DS }}=15 \mathrm{~V}$, | $\mathrm{I}_{\mathrm{D}}=0.5 \mathrm{n}$ |  | -4 | -6 | $V$ |
| $V_{G S}$ | Gate-Source Voltage | VDS $=16 \mathrm{~V}$, | ${ }^{1} \mathrm{D}=50 \mu \mathrm{~A}$ |  | -0.5 -2 |  | $V$ |
|  |  | VDS $=15 \mathrm{~V}$ | $T_{D}=200 \mu$ |  |  | -1 -4 |  |
| IDSS | Zero-Gate-Voltage Drain Current | $V_{D S}=15 \mathrm{~V}$. | $\mathrm{V}_{\text {GS }}=0$, | See Note 2 | 0.6-2.5 | $2 \quad 10$ | ma |
| $\left\|V_{f s}\right\|$ | Smell-Signal Common-Source Forward Transfer Admittance | $V_{D S}=16 \mathrm{~V}$ <br> See Note 2 | $\mathbf{V}_{\mathbf{G S}}=0,$ | $\mathrm{f}=1 \mathrm{kHz}$ | 15004500 | 30006500 | $\mu \mathrm{mho}$ |
| \|Vosl | Small-Signal Common-Source Output Admittance | $V_{D S}=15 \mathrm{~V}$ <br> See Note 2 | $V_{G S}=0$ | $f=1 \mathrm{kHz} \text {, }$ | 10 | 20 | $\mu \mathrm{mho}$ |
| $\mathrm{C}_{\text {iss }}$ | Common-Source Short-Circuit Input Capecitance | $V_{\text {DS }}=15 \mathrm{~V}$, | $V_{\text {GS }}=0$, | $f=1 \mathrm{MHz}$ | 6 | 6 | pF |
| Cres | Common-Source Short-Circuit Reverse Transfer Capecitance |  |  |  | 3 | 3 | pF |
| \|Vfs $\mid$ | Small-Signal Common-Source Forward Transfor Admittance | $V_{D S}=15 \mathrm{~V}$ | $V_{G S}=0$, | $f=100 \mathrm{MHz}$ | 1500 | 3000 | $\mu \mathrm{mho}$ |

*operating characteristics at $25^{\circ} \mathrm{C}$ free-air temperature

| PARAMETER |  | TEST CONDITIONSt | 2N3821 2N3822 | UNIT |
| :---: | :---: | :---: | :---: | :---: |
|  |  | MAX |  |
| $\bar{F}$ | Averege Noise Figure |  | $\begin{aligned} & V_{D S}=15 \mathrm{~V}, \quad \mathrm{~V}_{G S}=0, \quad \mathbf{R}_{G}=1 \mathrm{M} \Omega, \quad f=10 \mathrm{~Hz}, \\ & \text { Noise Bandwidth }=5 \mathrm{~Hz} \end{aligned}$ | 5 | dB |
| $V_{n}$ | Equivalent Input Noise Voltage | $V_{D S}=15 V, \quad V_{G S}=0, \quad f=10 \mathrm{~Hz},$ <br> Noise B andwidth $=5 \mathrm{~Hz}$ | 200 | $n \mathrm{~V} / \sqrt{\mathrm{Hz}}$ |

NOTES: 1. Derate linearly to $175^{\circ} \mathrm{C}$ freo-air temperature at the rate of $2 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$.
2. These parametars must be measured using pulse techniques. $\mathbf{t}_{w}=\mathbf{1 0 0} \mathbf{m s}$, duty cycie $<\mathbf{1 0 \%}$.

[^80]*electrical characteristics at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

| PARAMETER |  | TEST CONDITIONS ${ }^{\dagger}$ |  |  | 2N3823 | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | MIN MAX |  |
| V(BR)GSS | Gate-Source Breakdown Voltage |  |  |  | ${ }^{\prime} G=-1 \mu A$, | $V_{D S}=0$ |  | $-30$ | $V$ |
| 'GSS | Gate Cutoff Current | $\mathrm{V}_{\text {GS }}=-20 \mathrm{~V}$ | $V_{D S}=0$ |  | -0.5 | nA |
|  |  | $\mathrm{V}_{\mathrm{GS}}=-20 \mathrm{~V}$, | $V_{D S}=0$, | $T_{A}=150^{\circ} \mathrm{C}$ | -0.5 | $\mu \mathrm{A}$ |
| $V_{\text {GS }}$ (off) | Gate-Source Cutoff Voltage | $\mathrm{V}_{\mathrm{DS}}=15 \mathrm{~V}$, | $\mathrm{I}_{\mathrm{D}}=0.5 \mathrm{nd}$ |  | -8 | V |
| VGS | Gate-Source Voltage | $V_{\text {DS }}=15 \mathrm{~V}$, | ${ }^{1} D^{\prime}=400$ |  | -1 -7.5 | V |
| IDSS | Zero-Gate-Voltage Drain Current | $V_{\text {DS }}=15 \mathrm{~V}$, | $\mathrm{V}_{\mathbf{G S}}=0$, | See Note 2 | 4.20 | mA |
| $\left\|y_{\text {fs }}\right\|$ | Small-Signal Common-Saurce <br> Forward Transfer Admittance | $V_{D S}=15 \mathrm{~V}$ <br> See Note 2 | $V_{\mathbf{G S}}=0,$ | $f=1 \mathrm{kHz}$, | 35006500 | $\mu \mathrm{mho}$ |
| \|Yos| | Small-Signal Common-Source Output Admittance | $V_{D S}=15 \mathrm{~V} .$ <br> See Note 2 | $V_{G S}=0,$ | $\mathrm{f}=1 \mathrm{kHz},$ | 35 | $\mu \mathrm{mho}$ |
| $\mathrm{C}_{\text {iss }}$ | Common-Source Short-Circuit Input Capacitance | $V_{D S}=15 \mathrm{~V}$, | $V_{G S}=0 . \quad f=1 M H z$ |  | 6 | pF |
| $\mathrm{Crss}^{\text {r }}$ | Common-Source Short-Circuit Reverse Transfer Capacitance |  |  |  | 2 | pF |
| $\left\|y_{\text {fs }}\right\|$ | Small-Signal Common-Source Forward Transfer Admittance | $V_{D S}=15 \mathrm{~V}$ | $V_{G S}=0$, | $f=200 \mathrm{MHz}$ | 3200 | $\mu \mathrm{mho}$ |
| $\mathrm{g}_{\text {is }}$ | Small-Signal Common-Source Input Conductance |  |  |  | 800 | $\mu \mathrm{mho}$ |
| gos | Small-Signal Common-Source Output Conductance |  |  |  | 200 | $\mu \mathrm{mho}$ |

*operating characteristics at $25^{\circ} \mathrm{C}$ free-air temperature

| PARAMETER |  | TEST CONDITIONS ${ }^{\dagger}$ | 2N3823 | UNIT |
| :---: | :---: | :---: | :---: | :---: |
|  |  | MAX |  |
| F | Cammon-Source Spot Noise Figure |  | $V_{D S}=15 \mathrm{~V}, \mathrm{~V}_{\mathrm{GS}}=0, \mathrm{R}_{\mathrm{G}}=1 \mathrm{k} \Omega, f=100 \mathrm{MHz}$ | 2.5 | dB |

2N3824
electrical characteristics at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

| PARAMETER |  | TEST CONDITIONS ${ }^{\dagger}$ |  |  | 2N3824 | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | MIN MAX |  |
| ${ }^{*} V_{\text {(BR)GSS }}$ | Gate-Source Breakdown Voltage |  |  |  | ${ }^{\prime} \mathrm{G}^{\prime}=-1 \mu \mathrm{~A}$, | $V_{D S}=0$ |  | -50 | V |
| ${ }^{*}$ IGSS | Gate Cutoff Current | $\mathrm{V}_{\mathrm{GS}}=-30 \mathrm{~V}$, | $V_{D S}=0$ |  | -0.1 | nA |
|  |  | $\mathrm{V}_{\mathrm{GS}}=-30 \mathrm{~V}$, | $V_{D S}=0$, | $T_{A}=150^{\circ} \mathrm{C}$ | -0.1 | $\mu \mathbf{A}$ |
| *ID(off) | Drain Cutoff Current | $V_{D S}=15 \mathrm{~V}$, | $V_{G S}=-8 \mathrm{~V}$ |  | 0.1 | nA |
|  |  | $V_{\text {DS }}=15 \mathrm{~V}$, | $\mathrm{V}_{\text {GS }}=-8 \mathrm{~V}$, | $\mathrm{TA}=150^{\circ} \mathrm{C}$ | 0.1 | $\mu \mathrm{A}$ |
| IDSS | Zero-Gate-Voltage Drain Current | $\mathrm{V}_{\mathrm{DS}}=15 \mathrm{~V}$, | $V_{G S}=0$, | See Note 2 | $12 \quad 24$ | $m A$ |
| * rods(on) | Small-Signal Drain-Source On-State Resistance | $V_{G S}=0$, | $\mathrm{I}_{\mathrm{D}}=0$, | $f=1 \mathrm{MHz}$ | 250 | $\Omega$ |
| ${ }^{*} \mathrm{C}_{\text {iss }}$ | Common-Source Short-Circuit Input Capacitance | $V_{D S}=15 \mathrm{~V}$, | $V_{G S}=0$, | $\mathrm{f}=1 \mathrm{MHz}$ | 6 | pF |
| ${ }^{*} \mathrm{C}_{\text {rss }}$ | Common-Source Short-Circuit Reverse Transfer Capacitance | $V_{D S}=0$, | $V_{G S}=-8 V_{\text {, }}$ | $\mathrm{f}=\mathrm{t} \mathbf{M H z}$ | 3 | pF |

NOTE 2: These paramaters must be maasured using pulse techniques. $t_{w}=100 \mathrm{~ms}$, duty cycle $\leqslant 10 \%$.
JEDEC registered data
${ }^{\dagger}$ The fourth lead (case) is connected to the source for all measurements.

## TYPES A5T3821 THRU A5T3824 N-CHANNEL SILICON JUNCTION FIELD-EFFECT TRANSISTORS

## SILECT ${ }^{\dagger}$ FIELD-EFFECT TRANSISTORS $\ddagger$

- Rugged, One-Piece Construction with Standard TO-18 100-mil Pin-Circle

A5T3821, A5T3822
FOR SMALL-SIGNAL APPLICATIONS

- Low Igss: $\leqslant \mathbf{1 0 0} \mathrm{pA}$
- Low Ciss: $\leqslant 6 \mathbf{p F}$
- High Yfs $/ C_{i s s}$ Ratio (High-Frequency Figure-of-Merit)


## A5T3823 <br> FOR VHF AMPLIFIER AND MIXER APPLICATIONS

- Low Noise Figure: $\leqslant \mathbf{2} .5 \mathbf{d B}$ at $100 \mathbf{~ M H z}$
- Low Crss: $\leqslant 2 \mathrm{pF}$
- High Yfs $/ \mathrm{C}_{\text {iss }}$ Ratio (High-Frequency Figure-of-Merit)

A5T3824 FOR HIGH-SPEED COMMUTATOR AND CHOPPER APPLICATIONS

- Low rds(on): $\leqslant 250 \Omega$
- Low ID(off): $\leqslant 100 \mathrm{pA}$
- Low Crss: $\leqslant 3$ pF
mechanical data
These transistors are built using the same chip type as for the metal-case types 2N3821 through 2N3824 and 2N5358 through 2N5364 and the Silect types 2N5949 through 2N5953.

Silect transistors are encapsulated in a plastic compound specifically designed for this purpose using a highly mechanized process developed by Texas Instruments. The case will withstand soldering temperatures without deformation. These devices exhibit stable characteristics under high-humidity conditions and are capable of meeting MIL-STD-202C, Method 106B. Silect transistors are insensitive to light.


[^81]
## TYPES A5T3821 THRU A5T3824 <br> N-CHANNEL SILICON JUNCTION FIELD-EFFECT TRANSISTORS

absolute maximum ratings at $\mathbf{2 5}{ }^{\circ} \mathbf{C}$ free-air temperature (unless otherwise noted)
A5T3821
A5T3822
A5T3823

A5T3821, A5T3822
electrical characteristics at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

| PARAMETER |  | TEST CONDITIONS |  |  | A5T3821 |  | A5T3822 |  | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | MIN | MAX | MIN | MAX |  |
| $V_{\text {(BR)GSS }}$ | Gate-Source Breakdown Voltage |  |  |  | $\mathrm{I}_{\mathbf{G}}=-1 \mu \mathrm{~A}$, | $V_{\text {DS }}=0$ |  | -50 |  | -50 |  | V |
|  |  | $\mathrm{V}_{\mathrm{GS}}=-30 \mathrm{~V}$ | $V_{D S}=0$ |  |  | -0.1 |  | $-0.1$ | nA |
|  |  | $V_{\text {GS }}=-30 \mathrm{~V}$ | $V_{\text {DS }}=0$, | $\mathrm{T}_{\mathrm{A}}=150^{\circ} \mathrm{C}$ |  | -0.1 |  | -0.1 | $\mu \mathrm{A}$ |
| $V_{\text {GS }}$ aff) | Gate-Source Cutoff Voltage | $\mathrm{V}_{\text {DS }}=15 \mathrm{~V}$, | $I_{D}=0.5 \mathrm{nA}$ |  |  | -4 |  | -6 | V |
| $V_{G S}$ |  | $\mathrm{V}_{\mathrm{DS}}=15 \mathrm{~V}$, | $I_{D}=50 \mu \mathrm{~A}$ |  | -0.5 | -2 |  |  |  |
| GS |  | $V_{\text {DS }}=15 \mathrm{~V}$, | $I_{D}=200$ |  |  |  | -1 | -4 |  |
| Ioss | Zero-Gate-Voltage Drain Current | $\mathrm{V}_{\text {DS }}=15 \mathrm{~V}$, | $\mathrm{V}_{\mathrm{GS}}=0$, | See Note 2 | 0.5 | 2.5 | 2 | 10 | mA |
| $\left\|y_{f s}\right\|$ | Small-Signal Common-Source Forward Transfer Admittance | $V_{D S}=15 \mathrm{~V},$ <br> See Note 2 | $V_{G S}=0,$ | $f=1 \mathrm{kHz},$ | 1500 | 4500 | 3000 | 6500 | $\mu \mathrm{mho}$ |
| Vos | Small-Signal Common-Source Output Admittance | $V_{D S}=15 \mathrm{~V} .$ <br> See Note 2 | $V_{G S}=0$ | $f=1 \mathrm{kHz},$ |  | 10 |  | 20 | $\mu \mathrm{mho}$ |
| $\mathrm{C}_{\text {iss }}$ | Common-Source Short-Circuit Input Capacitance | $V_{D S}=15 \mathrm{~V}$, | S $=0$ |  |  | 6 |  | 6 | pF |
| Crss | Common-Source Short-Circuit <br> Reverse Transfer Capacitance |  |  | $\mathrm{f}=1 \mathrm{MHz}$ |  | 3 |  | 3 | pF |
| $\left\|y_{f s}\right\|$ | Small-Signal Common-Source Forward Transfer Admittance | $V_{D S}=15 \mathrm{~V}$, | $V_{G S}=0$, | $f=100 \mathrm{MHz}$ | 1500 |  | 3000 |  | $\mu \mathrm{mho}$ |

operating characteristics at $\mathbf{2 5}{ }^{\circ} \mathrm{C}$ free-air temperature

| PARAMETER |  | TEST CONDITIONS | $\begin{aligned} & \hline \text { A5T } 3821 \\ & \text { A5T3822 } \\ & \hline \end{aligned}$ | UNIT |
| :---: | :---: | :---: | :---: | :---: |
|  |  | MAX |  |
| $\bar{F}$ | Average Noise Figure |  | $V_{D S}=15 \mathrm{~V}, \quad V_{G S}=0, \quad R_{G}=1 \mathrm{M} \Omega, \quad f=10 \mathrm{~Hz},$ <br> Noise Bandwidth $=5 \mathrm{~Hz}$ | 5 | dB |
| $V_{n}$ | Equivalent Input Noise Voltage | $\begin{aligned} & V_{D S}=15 \mathrm{~V}, \mathrm{~V}_{\mathrm{GS}}=0, \quad \mathrm{f}=10 \mathrm{~Hz}, \\ & \text { Noise Bandwidth }=5 \mathrm{~Hz} \end{aligned}$ | 200 | $\mathrm{nV} / \sqrt{\mathrm{Hz}}$ |

NOTES: 1. Derate linearly to $150^{\circ} \mathrm{C}$ free-air temperature at the rate of $2.4 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$.
2. These parameters must be measured using pulse techniques. $t_{w}=300 \mu \mathrm{~s}$, duty cycle $\leqslant \mathbf{2} \%$.

## TYPES A5T3821 THRU A5T3824 N-CHANNEL SILICON JUNCTION FIELD-EFFECT TRANSISTORS

electrical characteristics at $\mathbf{2 5}{ }^{\circ}$ C free-air temperature (unless otherwise noted)

operating characteristics at $\mathbf{2 5}{ }^{\boldsymbol{\circ}} \mathbf{C}$ free-air temperature

| PARAMETER |  | TEST CONDITIONS | A5T3823 | UNIT |
| :---: | :---: | :---: | :---: | :---: |
|  |  | MAX |  |
| F | Common-Source Spot Noise Figure |  | $V_{\text {DS }}=15 \mathrm{~V}, \mathrm{~V}_{\mathrm{GS}}=0, \mathrm{R}_{\mathrm{G}}=1 \mathrm{k} \Omega, \mathrm{f}=100 \mathrm{MHz}$ | 2.5 | dB |



NOTE 2: These parameters must be measured using pulse techniques. $t_{w}=\mathbf{3 0 0} \mu \mathrm{s}$, duty cycle $\leqslant \mathbf{2 \%}$.

## DESIGNED FOR HIGH-SPEED SWITCHING APPLICATIONS

- High $f_{T}$ : $\mathbf{3 5 0} \mathbf{~ M e ~ m i n ~ a t ~} \mathbf{1 0} \mathrm{v}, \mathbf{3 0} \mathrm{ma}$
- Low Guaranteed $\mathrm{V}_{\text {CE(sat) }}$ : 0.18 v at $\mathbf{3 0} \mathrm{ma}$
*mechanical data

*absolute maximum ratings at $\mathbf{2 5}{ }^{\circ} \mathbf{C}$ free-air temperature (unless otherwise noted)
Collector-Base Voltage . .
Collector-Emitter Voltage (See Note 1) . . . . . . . . . . . . . . . . . . . . .
$\mathbf{- 3 5} \mathbf{v}$
$\mathbf{- 3 5} \mathbf{v}$
Collector-Emitter Voltage (See Note 1) . . . . . . . . . . . . . . . . . . . .
Collector-Emitter Voltage (See Note 2) . . . . . . . . . . . . . . . . . . . . . . . .
Emitter-Base Voltage . . . . . . . . . . . . . . . . . . . . . . . . . . -5 r
Continuous Collector Current . . . . . . . . . . . . . . . . . . . . . . $\mathbf{- 2 0 0} \mathbf{~ m a}$
Peak Collector Current (See Note 3) . . . . . . . . . . . . . . . . . . . . -500 ma
Continuous Device Dissipation at (or below) $25^{\circ} \mathrm{C}$ Free-Air Temperature (See Note 4) . . . . . 360 mw
Continuous Device Dissipation at (or below) $25^{\circ} \mathrm{C}$ Case Temperature (See Note 5) . . . . . . 1.2 w
Storage Temperature Range . . . . . . . . . . . . . . . . . . . $-65^{\circ} \mathrm{C}$ to $+200^{\circ} \mathrm{C}$
Lead Temperature $1 / 10$ Inch from Case for 10 Seconds . . . . . . . . . . . . . . . . $300^{\circ} \mathrm{C}$
*electrical characteristics at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

| PARAMETER |  | TEST CONDITIONS |  | MIN MAX | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: |
| $V_{\text {Eracrao }}$ Collector-Base Breakdown Voltage |  | $\mathrm{I}_{\mathrm{C}}=-100 \mu \mathrm{a}, \mathrm{I}_{\mathrm{E}}=0$ |  | -35 | $v$ |
| $V_{\text {Pr\|ceo }}$ | Collector-Emitter Breakdown Voltage | $T_{c}=-10 \mathrm{ma}, \mathrm{C}_{\mathrm{B}}=0$, | See Note 6 | -20 | $v$ |
| Varajces | Collertor-Emitter Breakdown Voltage | $\mathrm{I}_{\mathrm{C}}=-100 \mu \mathrm{a}, \mathrm{V}_{\mathrm{BE}}=0$ |  | -35 | $v$ |
| V ${ }_{\text {Lar) }}$ | Emitter-Base Breakdown Voltage | $\mathrm{I}_{\mathrm{E}}=-100 \mu \mathrm{a}, \mathrm{I}_{\mathbf{c}}=0$ |  | -5 | $v$ |
| Ices | Collector Cutoff Current | $\mathrm{V}_{\text {CE }}=-20 \mathrm{v}, \quad \mathrm{V}_{\text {BE }}=0$ |  | -0.3 | $\mu \mathrm{O}$ |
|  |  | $\mathrm{V}_{\text {CE }}=-20 \mathrm{v}, \mathrm{V}_{\mathrm{EE}}=0, \quad \mathrm{~T}_{\mathrm{A}}=125^{\circ} \mathrm{C}$ |  | -40 | $\mu \mathrm{a}$ |
| $\mathrm{I}_{\mathrm{B}}$ | Base Current | $V_{\text {CE }}=-20 \mathrm{v}, \mathrm{V}_{\text {低 }}=0$ |  | 0.3 | $\mu \mathrm{O}$ |
| hre | Static Forward Current Transfer Ratio | $V_{\text {CE }}=-0.4 \mathrm{v}_{1} \mathrm{I}_{\mathrm{C}}=-10 \mathrm{ma}$ | $\begin{gathered} \text { See } \\ \text { Note } \\ 6 \end{gathered}$ | 25 |  |
|  |  | $V_{C E}=-0.4 v_{1}, I_{C}=-30 \mathrm{ma}$ |  | $30 \quad 120$ |  |
|  |  | $V_{C E}=-1 v_{1} \quad I_{C}=-100 \mathrm{ma}$ |  | 25 |  |
|  |  | $\begin{aligned} & V_{\mathrm{CE}}=-0.4 \mathrm{v}, \mathrm{I}_{\mathrm{C}}=-30 \mathrm{ma}, \\ & \mathrm{~T}_{\mathrm{A}}=-55^{\circ} \mathrm{C} \\ & \hline \end{aligned}$ |  | 12 |  |
| $V_{\text {fe }}$ | Base-Emitter Voltage | $\mathrm{I}_{\mathrm{B}}=-1 \mathrm{mo}, \mathrm{I}_{\mathrm{C}}=-10 \mathrm{ma}$ | $\begin{gathered} \hline \text { See } \\ \text { Note } \\ 6 \\ \hline \end{gathered}$ | -0.75-0.85 | $v$ |
|  |  | $\mathrm{I}_{\mathrm{B}}=-3 \mathrm{ma}, \quad \mathrm{I}_{\mathrm{C}}=-30 \mathrm{ma}$ |  | -0.75-0.95 | $v$ |
|  |  | $\mathrm{I}_{\mathrm{B}}=-10 \mathrm{ma}, \mathrm{I}_{\mathrm{c}}=-100 \mathrm{ma}$ |  | - 1.20 | $v$ |
| $\mathbf{V}_{\text {CI\{at) }}$ | Collector-Emitter Saturation Voltage | $\mathrm{I}_{\mathrm{B}}=-1 \mathrm{ma}, \quad \mathrm{I}_{\mathrm{c}}=-10 \mathrm{ma}$ | See <br> Note <br> 6 | -0.18 | $v$ |
|  |  | $\mathrm{I}_{\mathrm{B}}=-3 \mathrm{ma}, \quad \mathrm{I}_{\mathrm{C}}=-30 \mathrm{ma}$ |  | -0.18 | v |
|  |  | $\mathrm{l}_{\mathrm{B}}=-10 \mathrm{ma}, \mathrm{l}_{\mathrm{c}}=-100 \mathrm{mo}$ |  | -0.35 | $v$ |
|  |  | $\begin{aligned} & \mathrm{I}_{\mathrm{B}}=-3 \mathrm{ma}, \quad \mathrm{I}_{\mathrm{C}}=-30 \mathrm{ma}, \\ & \mathrm{I}_{\mathrm{A}}=125^{\circ} \mathrm{C} \end{aligned}$ |  | -0.25 | $v$ |

NOTES: 1. This value applias when the base-emitier diode is shan-circuited.
2. This value applies between 0 and 10 ma collestor current when the base-amitter diode is apen-circuited.
3. This value applies for $\mathrm{PW} \leq 10 \mu \mathrm{sec}$, Duly Cycle $\leq 40 \%$.
4. Derate linearly $10.175^{\circ} \mathrm{C}$ free-air femperature of the rais of $2.4 \mathrm{~mm} / \mathrm{C}^{\circ}$.
5. Derate linearly to $175^{\circ} \mathrm{C}$ case temperature at the rate of $8 \mathrm{mw} / \mathrm{C}^{\circ}$.
6. These parameters must be measured using pulse tectiniques. $\mathrm{PW}=300 \mu \mathrm{sec}$, Duty Cyde $\leq \mathbf{2 \%}$.
*indicates JEDEC registered data
*electrical characteristics at $25^{\circ} \mathrm{C}$ free-air temperature (unless ofherwise nofed)

| PARAMETER |  | TEST CONDITIONS |  | MIN max | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: |
| $\left\|h_{60}\right\|$ | Small-Signal Commen-Emititor Forword Curront Tromsfer Ratio | $V_{\text {CE }}=-10 \mathrm{v}, \mathrm{I}_{\mathbf{c}}=-30$ | $1=100 \mathrm{Mc}$ | 3.5 |  |
| $C_{60}$ | Common-Base Open-Grait Output Copocitance | $V_{C t}=-5 \mathrm{v}, \quad \mathrm{l}_{\mathrm{E}}=0$, | $f=140 \mathrm{kc}$ | 6 | pf |
| $4{ }_{6} 6$ | Common-Baso Open-Gircuit Input Capocitance | $v_{\text {Et }}=-0.5 \mathrm{v}, \mathrm{t}_{\mathrm{c}}=0$, | $i=140 \mathrm{kc}$ | 10 | pf |

*operating charactoristics of $\mathbf{2 5}^{\circ} \mathrm{C}$ free-air temperafure

| PARAMETER | TEST CONDITIONS $\dagger$ | MIN MAX | UNIT |
| :---: | :---: | :---: | :---: |
| Id Delay Time | $\mathrm{Ic}_{\mathrm{c}}=-30 \mathrm{mo}, \quad I_{\text {mil }}=-3 \mathrm{ma}, V_{\text {melom }}=0$, | 10 | nsec |
| $\mathrm{I}_{\mathbf{r}}$ Rise Time | $\mathrm{R}_{\mathrm{L}}=94 \Omega, \quad$ See Figure 1 | 15 | nsec |
|  | $I_{c}=-30 \mathrm{mo}, \quad I_{\text {m }}(1)=-I_{\text {m } 21}=-3 \mathrm{mo}$, | 50 | nsec |
| \% Foll Time | $\mathrm{R}_{2}=94 \Omega, \quad$ Seef Figure 1 | 15 | nsec |
| $\mathrm{V}_{\text {ctomul }} \ddagger$ Collector-Emitior Monlaching Voltage |  | -20 | $v$ |

[^82] - $\mathbf{2 0 0} \mathrm{mm}$.

## *PARAMETER MEASUREMENT INFORMATION



FIGURE 2 - COLLECTOR-EMITTER NONLATCHING VOLTAGE TEST CIRCUIT
 Owh Cyclo $\leq \mathbf{2 \%}$.

c. The inpul waviown in Figme 2 thes the following cherecteistics: PW $\leq 10 \mu$ sec, Dvity Cycle $\leq \mathbf{~} \%$.
d. Tond sellecter shume cepesilemses $\mathrm{C}_{\mathrm{T}} \leq 15 \mathrm{pf}$.
-Indicates JEDEC ragisterved deto

## DESIGNED FOR COMPLEMENTARY MEDIUM-POWER, HIGH-SPEED SWITCHING AND GENERAL PURPOSE AMPLIFIER APPLICATIONS

- Electrically Similar to 2N2222/2N2907
- D.C Bota - Guarantood from $100 \mu \mathrm{a}$ to 150 ma
- Miniature Flatpack Facilitates High-Density Packaging
mechanleal data

*absolute maximum ratings at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted) $\dagger$


NOTES: I. This valun applies between 0 and 10 ma when the beso-amilter diode is apen-eireuitod.
2. Derafe line arly to $115^{\circ} \mathrm{C}$ lroe-ale temparalure of the rate of $1.67 \mathrm{~mm} / \mathrm{C}^{\circ}$ for sach triode and $2.34 \mathrm{mw} / \mathrm{C}^{\circ}$ for lotal device.
3. Derate linsarily to $175^{\circ} \mathrm{C}$ case temperalure at the rate of $4.67 \mathrm{~mm} / \mathrm{C}^{\circ}$ for each triode and $9.34 \mathrm{~mm} / C^{\circ}$ for tetal devies.
-Indicates JEOEC roghtiored deta
tYellages and currents apply to the N.P-N trlode. For the P.M.P Itreds, the values ore the same, but the signs are revared.

## electrical characteristics at $25^{\circ} \mathrm{C}$ free-air temperature (unless othorwise noted) ${ }^{\dagger}$

*individual triode characteristics (see note 4)

| PARAMETELR |  | TEST COMDITIONS |  |  | MIN | MAX | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| $V_{\text {(m)cro }}$ Colloctor-Lase Breokdown Voltage |  | $\mathrm{I}_{\mathrm{C}}=10 \mu \mathrm{a}$, | $\mathrm{I}_{\mathrm{E}}=0$ |  | 60 |  | $\checkmark$ |
| Vimjeso Collector-Emitter Breakdown Voltoge |  | $\mathrm{Ic}_{\mathrm{c}}=10 \mathrm{ma}$, | $10=0$, | Seo Note 5 | 40 |  | $v$ |
| $\mathrm{V}_{\text {(ma)ue }}$ Emitior-Bose Freakdown Voltrage |  | $\mathrm{I}_{\mathrm{E}}=10 \mu \mathrm{O}$, | $\mathrm{l}_{\mathrm{c}}=0$ |  | 5 |  | $v$ |
| Icev | Collector Cutoff Current | $V_{\text {Ci }}=50 \mathrm{v}$ | $V_{\text {m }}=-0.5 \mathrm{~V}$ |  |  | 10 | no |
|  |  | $V_{\text {CE }}=50 \mathrm{v}_{1}$ | $V_{\text {E }}=-0.5 v_{\text {, }}$ | $\mathrm{T}_{\mathrm{A}}=150^{\circ} \mathrm{C}$ |  | 10 | $\mu \mathrm{a}$ |
| Imv | Base Cutoff Current | $V_{C E}=50 \mathrm{v}_{1}$ | $V_{\text {m }}=-0.5 \mathrm{~V}$ |  |  | -10 | nu |
| \$100 | Emifter Cutolf Currant | $V_{E 1}=3 v_{\text {, }}$ | $\mathrm{I}_{\mathbf{c}}=0$ |  |  | 10 | no |
| $h_{\text {re }}$ | Static Forword Currant Transfar Ratio | $V_{C E}=1 v_{\text {, }}$ | $\mathrm{lc}_{\mathrm{c}}=150 \mathrm{ma}$, | Seet Mote 5 | 50 |  |  |
|  |  | $V_{C E}=10 r_{\text {r }}$ | $I_{C}=100 \mu 0$ |  | 35 |  |  |
|  |  | $V_{C E}=10 \mathrm{r}$, | $\mathrm{l}_{\mathrm{c}}=1 \mathrm{ma}$ |  | 50 |  |  |
|  |  | $V_{\text {CE }}=10 v_{\text {r }}$ | $\mathrm{l}_{\mathrm{c}}=10 \mathrm{ma}$, | See Mote 5 | 75 |  |  |
|  |  | $V_{C t}=10 v_{1}$ | $\mathrm{Ic}_{\mathrm{c}}=150 \mathrm{mo}, \mathrm{s}$ | See Motu 5 | 100 | 300 |  |
| V1 | Base-Emifter Voltage | $\mathrm{I}_{1}=15 \mathrm{ma}$, | $\mathrm{l}_{\mathrm{c}}=150 \mathrm{ma}$, | Seen Hote 5 | 0.85 | 1.3 | $v$ |
| $V_{\text {cantil }}$ | Colloctor-Emitter Saluration Voltage | $\mathrm{I}_{1}=15 \mathrm{ma}$, | $\mathrm{I}_{\mathrm{c}}=150 \mathrm{ma}, \mathrm{s}$ | See Moto 5 |  | 0.4 | $v$ |
| $h_{10}$ | Small-Signal Commen-Emitter Input Impedanco | $v_{\text {CE }}=10 \mathrm{v}$, | $\mathrm{I}_{\mathrm{c}}=1 \mathrm{ma}$, | $f=1 \mathrm{kc}$ | 1.5 | 9 | k $\Omega$ |
| $h_{6}$ | Small-signal Forward Currant Trunster Rotio |  |  |  | 60 | 300 |  |
| $h_{0}$ | Small-Signol Comman-Emitter Output Admiftonce |  |  |  |  | 50 | $\mu \mathrm{mho}$ |
| $\left\|h_{6}\right\|$ | Small-Signal Common-Emittor Forword Curremt Trunsfer Ratio | $V_{\text {ct }}=10 \mathrm{v}$, | $\mathrm{I}_{\mathrm{c}}=20 \mathrm{ma}$, | $f=100 \mathrm{Mc}$ | 2 |  |  |
| $C_{\text {abo }}$ | Common-Lase Open-Qrtelt Output Copoditance | $V_{\text {ct }}=10 \mathrm{v}$, | $\mathrm{l}_{\mathrm{E}}=0, \quad 1$ | $1=140 \mathrm{kc}$ |  | 8 | pf |

## operating characteristics of $25^{\circ} \mathrm{C}$ free-air temperature $\dagger$

*individual triode characteristics (see note 4)

| PARAMITER | TEST CONDITIONS | MIN MAX | UNIT |
| :---: | :---: | :---: | :---: |
| td Dolay Time | $\begin{array}{ll} I_{C}=150 \mathrm{ma}, & I_{\text {Ril }}=15 \mathrm{ma}, \\ V_{\text {IEl\|off }}=0, \\ R_{L}=64 \Omega, & \text { Soe Figure } 1 \\ \hline \end{array}$ | 10 | nsor |
| tr Rise Time |  | 40 | nsat |
| $\mathrm{t}_{2}$ Storage Time | $\begin{array}{ll} I_{C}=150 \mathrm{ma}, & I_{x_{1}(1)}=-I_{(\alpha) 1}=15 \mathrm{ma}, \\ R_{L}=64 \Omega, & \text { See Figure 2 } \end{array}$ | 250 | nsot |
| th Foll Ilime |  | 90 | nsec |
| $V_{\text {ceoinle }}$ Collector-Emittor Nonlothing Voltages |  | 40 | $v$ |
| MF Spot Nolse Flgure | $\begin{array}{ll} V_{C E}=10 \mathrm{v}, & \mathrm{I}_{\mathrm{C}}=100 \mu \mathrm{a}, \\ R_{G}=1 \mathrm{k} \mathrm{\Omega}, & f=1 \mathrm{kc} \end{array}$ | 8 | db |

MOTES: 4. The torminels of the triade not under test ere open-sircwitod for the muesurement of these characteristics.
5. These parameten must be mossured utiat pulse Iockniquos. PW $=\mathbf{3 0 0} \mu \mathrm{soc}$, Duly Cycto $\leq \mathbf{1 \%}$.
-Indicriter JEBEC regisiond dele
tyoliages end currents apply th the M-P-N tridel. For the P-N-P triode, the values are the seme, but the sigas are revernod.
\#Valtages and currunt velues shown are neminal; axect values vory with dovice perameters.


## N-P-N, P-N-P DUAL SILICON TRANSISTOR



Floune :

figunt 2

 for Figure $2, \mathrm{z}_{\text {out }}=50 \Omega, \mathrm{t}_{\mathrm{r}} \leq 10 \mathrm{nsec}, \mathrm{PW}=10 \mu \mathrm{sex}$, Duly Cyclo $\leq \mathbf{2 \%}$.
 $\mathrm{t}_{\mathrm{r}} \leq 5 \mathrm{nsec}, R_{\text {in }} \geq 100 \mathrm{k} \Omega, \mathrm{C}_{\text {in }} \leq 12 \mathrm{pf}$.
c. The input woveforn in Figure 3 has the follewing characteristics: PW $\leq 10 \mu \mathrm{sec}$, Duty Cycle $\leq 2 \%$.
d. The signs and polarity symbels shown are for the M.P-N triede; the sigms and polerity symbols are reversed ter the P-M.P triede.

- Indicales jedec rajistered dato


# TYPES 2N3903, 2N3904, A5T3903, A5T3904 N-P-N SILICON TRANSISTORS 

BULLETIN NO. DL-S 7311576, NOVEMBER 1971-REVISED MARCH 1973

## SILECT ${ }^{\dagger}$ TRANSISTORS $\ddagger$

FOR GENERAL PURPOSE SATURATED-SWITCHING AND AMPLIFIER APPLICATIONS

- For Complementary Use with P-N-P Types 2N3905, 2N3906, A5T3905, and A5T3906
- Rugged One-Piece Construction with In-Line Leads or Standard TO-18 100-mil Pin-Circle Configuration


## mechanical data

These transistors are encapsulated in a plastic compound specifically designed for this purpose, using a highly mechanized process developed by Texas Instruments. The case will withstand soldering temperatures without deformation. These devices exhibit stable characteristics under high-humidity conditions and are capable of meeting MIL-STD-202C, Method 106B. The transistors are insensitive to light.


## absolute maximum ratings at $\mathbf{2 5}{ }^{\circ} \mathbf{C}$ free-air temperature (unless otherwise noted)



NOTES 1. This value applies between $10 \mu \mathrm{~A}$ and 200 mA collector current when the base-emitter diode is open-circuited.
2. Derate the $625-\mathrm{mW}$ rating linearly to $150^{\circ} \mathrm{C}$ free-air temperature at the rate of $5 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$. Derate the $310-\mathrm{mW}$ (JEDEC registered) rating linearly to $135^{\circ} \mathrm{C}$ free-air temperature at the rate of $2.81 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$.
*The asterisk identifies JEDEC registered data for the 2 N3903 and 2 N3904 only. This data sheet contains all applicable registered data in effect at the time of publication.
${ }^{\dagger}$ Trademark of Texas Instruments
$\ddagger$ U.S. Patent No. 3,439,238
USES CHIP N 14
§ Texas Instruments guarantees these values in addition to the JEDEC registered values which are also shown.

## TYPES 2N3903, 2N3904, A5T3903, A5T3904 N-P-N SILICON TRANSISTORS

*electrical characteristics at $\mathbf{2 5}{ }^{\circ} \mathrm{C}$ free-air temperature

| PARAMETER |  | TEST CONDITIONS |  | 2N3903, A5T3903 |  | 2N3904, A5T3904 |  | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | MIN | MAX | MIN | MAX |  |
| $V_{(B R)}$ CBO | Collector-Base <br> Breakdown Voltage |  |  | ${ }^{\prime} C=10 \mu A, \quad I_{E}=0$ |  | 60 |  | 60 |  | V |
| $V_{\text {(BR) }}$ CEO | Collector-Emitter Breakdown Voltage | ${ }^{\prime} \mathrm{C}=1 \mathrm{~mA}, \quad \mathrm{I}_{\mathrm{B}}=0$, | See Note 3 | 40 |  | 40 |  | V |
| $V_{\text {(BR)EBO }}$ | Emitter-Base <br> Breakdown Voltage | $I^{\prime}=10 \mu A, \quad I^{\prime} \times 0$ |  | 6 |  | 6 |  | $V$ |
| ICEV | Collector Cutoff Current | $V_{C E}=30 \mathrm{~V}, V_{B E}=-3 \mathrm{~V}$ |  |  | 50 |  | 50 | nA |
| IBEV | Base Cutoff Current | $V_{C E}=30 \mathrm{~V}, V_{\text {BE }}=-3 \mathrm{~V}$ |  |  | -50 |  | -50 | nA |
| hFE | Static Forward Current Transfer Ratio | $\mathrm{V}_{\text {CE }}=1 \mathrm{~V}, \mathrm{I}^{\text {C }}=100 \mu \mathrm{~A}$ |  | 20 |  | 40 |  |  |
|  |  | $\mathrm{V}_{\text {CE }}=1 \mathrm{~V}, \mathrm{I}_{\mathrm{C}}=1 \mathrm{~mA}$ |  | 35 |  | 70 |  |  |
|  |  | $V_{C E}=1 \mathrm{~V}, \quad \mathrm{I}_{\mathrm{C}}=10 \mathrm{~mA}$ | See Note 3 | 50 | 150 | 100 | 300 |  |
|  |  | $V_{C E}=1 \mathrm{~V}, \mathrm{I}^{\prime}=50 \mathrm{~mA}$ |  | 30 |  | 60 |  |  |
|  |  | $V_{C E}=1 \mathrm{~V}, l_{\text {, }} \mathrm{C}=100 \mathrm{~mA}$ |  | 15 |  | 30 |  |  |
| $V_{B E}$ | Base-Emitter Voltage | $\mathrm{I}_{\mathrm{B}}=1 \mathrm{~mA} . \quad \mathrm{I}_{\mathrm{C}}=10 \mathrm{~mA}$ | See Note 3 | 0.65 | 0.85 | 0.65 | 0.85 | V |
|  |  | $\mathrm{I}_{\mathrm{B}}=5 \mathrm{~mA}, \quad \mathrm{I}_{\mathrm{C}}=50 \mathrm{~mA}$ |  |  | 0.95 |  | 0.95 |  |
| $V_{C E}$ (sat) | Collector-Emitter | $I_{B}=1 \mathrm{~mA}, \quad I_{C}=10 \mathrm{~mA}$ | See Note 3 |  | 0.2 |  | 0.2 | V |
|  | Saturation Voltage | $\mathrm{I}_{\mathrm{B}}=5 \mathrm{~mA}, \quad \mathrm{I}^{\prime}=50 \mathrm{~mA}$ |  |  | 0.3 |  | 0.3 |  |
| $h_{\text {ie }}$ | Small-Signal Common-Emitter Input Impedance |  |  | 1 | 8 | 1 | 10 | $\mathrm{k} \Omega$ |
| $h_{\text {fe }}$ | Small-Signal Common-Emitter Forward Current Transfer Ratio |  |  | 50 | 200 | 100 | 400 |  |
| $h_{\text {re }}$ | Small-Signal Common-Emitter Reverse Voltage Transfer Ratio |  |  | $\begin{aligned} & 0.1 x \\ & 10^{-4} \end{aligned}$ | $\begin{array}{r} 5 x \\ 10^{-4} \end{array}$ | $\begin{gathered} 0.5 \times \\ 10^{-4} \end{gathered}$ | $\begin{array}{r} 8 \times \\ 10^{-4} \end{array}$ |  |
| $h_{\text {oe }}$ | Small-Signal Common-Emitter Output Admittance |  |  | 1 | 40 | 1 | 40 | $\mu \mathrm{mho}$ |
| $\left\|h_{\text {fe }}\right\|$ | Small-Signal Common-Emitter Forward Current Transfer Ratio | $V_{C E}=20 \mathrm{~V}, \mathrm{I}^{\prime} \mathrm{C}=10 \mathrm{~mA}, \quad f=100 \mathrm{MHz}$ |  | 2.5 |  | 3 |  |  |
| ${ }_{T}$ | Transition Frequency | $\mathrm{V}_{\text {CE }}=20 \mathrm{~V}, \mathrm{I}^{\prime}=10 \mathrm{~mA}$, See Note 4 |  | 250 |  | 300 |  | MHz |
| Cobo | Common-Base Open-Circuit Output Capacitance | $\begin{aligned} & V_{C B}=5 \mathrm{~V}, \quad I_{E}=0, \\ & f=100 \mathrm{kHz} \text { to } 1 \mathrm{MHz} \end{aligned}$ |  | 4 |  | 4 |  | pF |
| $C_{\text {ibo }}$ | Common-Base Open-Circuit Input Capecitance | $\begin{aligned} & V_{E B}=0.5 \mathrm{~V} . \mathrm{I}^{\mathrm{C}}=0, \\ & \mathrm{f}=100 \mathrm{kHz} \text { to } 1 \mathrm{MHz} \end{aligned}$ |  | 8 |  | 8 |  | pF |

NOTES: 3. These parameters must be measured using puise techniques. $t_{w}=300 \mu \mathrm{~s}$, duty cycle $\leqslant 2 \%$
4. To obtain $f_{T}$, the $\left|h_{f}\right|$ response with frequency is extrapolated at the rate of -6 dB per octave from $f=100 \mathrm{MHz}$ to the frequency at which $\left|h_{f e}\right|=1$.
*operating characteristics at $\mathbf{2 5}{ }^{\circ} \mathrm{C}$ free-air temperature

| PARAMETER |  | TEST CONDITIONS | $\begin{aligned} & \text { 2N3903 } \\ & \text { A5T3903 } \end{aligned}$ |  | $\begin{aligned} & \text { 2N3904 } \\ & \text { A5T3904 } \end{aligned}$ |  | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | MIN | MAX | MIN | MAX |  |
| $\overline{\mathbf{N F}}$ | Average Noise Figure |  | $\begin{aligned} & V_{C E}=5 \mathrm{~V}, \quad \mathrm{I}_{\mathrm{C}}=100 \mu \mathrm{~A}, \quad \mathrm{R}_{\mathrm{G}}=1 \mathrm{k} \Omega, \\ & \text { Noise Bandwidth }=15.7 \mathrm{kHz}, \\ & \text { See Note } 5 \end{aligned}$ |  | 6 |  | 5 | dB |

NOTE 5: Average Noise Figure is measured in an amplifier with response down 3 dB at 10 Hz and 10 kHz and a high-frequency rolloff of 6 dB/octave.
*The asteriak identifies JEDEC registered data for the 2N3903 and 2N3904 only.
*switching characteristics at $25^{\circ} \mathrm{C}$ free-air temperature

| PARAMETER | TEST CONDITIONS ${ }^{\dagger}$ |  |  | $\begin{aligned} & \text { 2N3903 } \\ & \text { A5T3903 } \end{aligned}$ | $\begin{array}{r} 2 N 3904 \\ \text { A5T3904 } \end{array}$ | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  | MAX | MAX |  |
| $t_{\text {d }}$ Delay Time | $\begin{aligned} & I_{C}=10 \mathrm{~mA} . \\ & R_{L}=275 \Omega . \end{aligned}$ | $l_{B(1)}=1 \mathrm{~mA}$, | $V_{\mathrm{BE}(\mathrm{off})}=-0.5 \mathrm{~V}$ <br> See Figure 1 | 35 | 35 | ns |
| $t_{\text {r }}$ R ${ }^{\text {ase Time }}$ |  |  |  | 35 | 35 | ns |
| $\mathrm{t}_{\text {s }}$ Storage Time | $\begin{aligned} & I C=10 \mathrm{~mA}, \\ & R_{L}=275 \Omega \end{aligned}$ | $\mathrm{I}_{\mathrm{B}}(1)=1 \mathrm{~mA}$, | $\mathrm{I}_{\mathrm{B}(2)}=-1 \mathrm{~mA} \text {. }$ <br> See Figure 2 | 175 | 200 | ns |
| $t_{f}$ Fall Time |  |  |  | 50 | 50 | ns |

${ }^{\dagger}$ Voltage and current values shown are nominal; exact values vary slightly with transistor parameters. Nominal base current for delay and rise times is calculated using the minimum value of $V_{B E}$. Nominal base currents for storage and fall times are calculated using the maximum value of $V_{B E}$.
-The asterisk identifies JEDEC registered data for the 2N3903 and 2N3904 only.
PARAMETER MEASUREMENT INFORMATION


TEST CIRCUIT


VOLTAGE WAVEFORMS

FIGURE 1-DELAY AND RISE TIMES


FIGURE 2-STORAGE AND FALL TIMES

NOTES: a. The input waveforms are supplied by a generator with the following characteristics: $Z_{\text {out }}=50 \Omega$, duty cycle $=\mathbf{2 \%}$.
b. Waveforms are monitored on an oscilloscope with the following characteristics: $\mathrm{t}_{\mathrm{r}} \leqslant 1 \mathrm{~ns}, \mathrm{R}_{\text {in }}=10 \mathrm{M} \Omega, \mathrm{C}_{\mathrm{in}} \leqslant 4 \mathrm{pF}$.

## TYPES 2N3905, 2N3906, A5T3905, A5T3906 P-N-P SILICON TRANSISTORS

BULLETIN NO. DL.S 7311577, NOVEMBER 1971-REVISED MARCH 1973

## SILECT ${ }^{\dagger}$ TRANSISTORS ${ }^{\ddagger}$ <br> FOR GENERAL PURPOSE SATURATED-SWITCHING AND AMPLIFIER APPLICATIONS

- For Complementary Use with N-P-N Types 2N3903, 2N3904, A5T3903, and A5T3904
- Rugged One-Piece Construction with In-Line Leads or Standard TO-18 100-mil Pin-Circle Configuration
mechanical data
These transistors are encapsulated in a plastic compound specifically designed for this purpose, using a highly mechanized process developed by Texas Instruments. The case will withstand soldering temperatures without deformation. These devices exhibit stable characteristics under high-humidity conditions and are capable of meeting MIL-STD-202C, Method 106B. The transistors are insensitive to light.

| 2N3905, 2N3906 <br> NOTES: A. Lead diameter is not controlled in this area. <br> B. All dimensions are in inches. <br> *ALL JEDEC TO-92 DIMENSIONS AND NOTES ARE APPLICABLE |  |
| :---: | :---: |
| A5T3905, A5T3906 <br> NOTES: <br> A. Lead diameter is not controlled in this area. <br> B. Leads having maximum diameter ( 0.019 ) shall be within 0.007 of their true positions measured in the gaging plane 0.054 below the seating plane of the device relative to a maximumdiameter package. <br> C. All dimensions are in inches. |  |

absolute maximum ratings at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)


NOTES: 1. This value applies between $10 \mu \mathrm{~A}$ and 200 mA collector current when the base-emitter diode is open-circuited.
2. Derate the $625-\mathrm{mW}$ rating linearly to $150^{\circ} \mathrm{C}$ free-air temperature at the rate of $5 \mathrm{~mW} /^{\circ} \mathrm{C}$. Derate the $310-\mathrm{mW}$ (JEDEC registered) rating linearly to $135^{\circ} \mathrm{C}$ free-air temperature at the rate of $2.81 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$.
*The asterisk identifies JEDEC registered data for the 2 N3905 and 2 N 3906 only. This data sheet contains all applicable registered data in effect at the time of publication.
$\dagger$ Trademark of Texas Instruments
キU.S. Patent No. 3,439.238
§ Texas Instruments guarantees these values in addition to the JEDEC registered values which are also shown.

## TYPES 2N3905, 2N3906, A5T3905, A5T3906 P-N-P SILICON TRANSISTORS

## *electrical characteristics at $25^{\circ} \mathrm{C}$ free-air temperature

| PARAME TER |  | TEST CONDITIONS |  | $\begin{gathered} 2 \mathrm{~N} 3905 \\ \text { A5T3906 } \\ \hline \end{gathered}$ | $\begin{gathered} \text { 2N3906 } \\ \text { A5T } 3906 \end{gathered}$ | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | MIN MAX | MIN MAX |  |
| V(BR)CBO | Collector-Base Breakdown Voltage |  |  | $I_{C}=-10 \mu A, \quad I_{E}=0$ |  | -40 | -40 | $V$ |
| $V_{\text {(BR) }}$ CEO | Collector-Emitter Breakdown Voltage | $\mathrm{I}^{\prime} \mathrm{C}=-1 \mathrm{~mA}, \quad \mathrm{I}^{\prime}=0$, | See Note 3 | -40 | -40 | $V$ |
| $V_{\text {(BA) EBO }}$ | Emitter-Base Breakdown Voltage | $I_{E}=-10 \mu A, \quad I C=0$ |  | -5 | -5 | V |
| ICEV | Collector Cutoff Current | $\mathrm{V}_{\text {CE }}=-30 \mathrm{~V}, \quad \mathrm{~V}_{\text {BE }}=3 \mathrm{~V}$ |  | -50 | -50 | nA |
| IBEV | Bese Cutoff Current | $V_{C E}=-30 \mathrm{~V}, V_{B E}=3 \mathrm{~V}$ |  | 50 | 50 | nA |
| $h_{\text {fe }}$ | Static Forward Current Transfer Ratio | $V_{C E}=-1 \mathrm{~V}, \quad \mathrm{I}^{\prime}=-100 \mu \mathrm{~A}$ |  | 30 | 60 |  |
|  |  | $\mathrm{V}_{\text {CE }}=-1 \mathrm{~V}, \quad 1 \mathrm{C}=-1 \mathrm{~mA}$ |  | 40 | 80 |  |
|  |  | $\mathrm{V}_{\text {CE }}=-1 \mathrm{~V}, 1 \mathrm{C}=-10 \mathrm{~mA}$ | See Note 3 | $50 \quad 150$ | $100 \quad 300$ |  |
|  |  | $\mathrm{V}_{\text {CE }}=-1 \mathrm{~V}$, I $\mathrm{I}^{\text {C }}=-50 \mathrm{~mA}$ |  | 30 | 60 |  |
|  |  | $V_{C E}=-1 \mathrm{~V}, \quad \mathrm{I}_{\mathrm{C}}=-100 \mathrm{~mA}$ |  | 15 | 30 |  |
| VBe | Base-Emitter Voltage | $I_{B}=-1 \mathrm{~mA}, \quad I_{C}=-10 \mathrm{~mA}$ | See Note 3 | -0.65-0.85 | -0.65-0.85 | V |
|  |  | $\mathrm{I}^{1}=-5 \mathrm{~mA}, \quad{ }^{1} \mathrm{C}=-50 \mathrm{~mA}$ |  | -0.95 | -0.95 |  |
| VCE (sat) | Collector-Emitter Saturation Voltage | $\mathrm{I}_{B}=-1 \mathrm{~mA}, \quad \mathrm{I}^{\prime}=-10 \mathrm{~mA}$ | See Note 3 | -0.25 | -0.25 | V |
|  |  | $\mathrm{I}_{B}=-5 \mathrm{~mA}, \quad \mathrm{I}^{\prime} \mathrm{C}=-50 \mathrm{~mA}$ |  | -0.4 | -0.4 |  |
| $h_{\text {ie }}$ | Small-Signal Common-Emitter Input Impedance | $V_{C E}=-10 \mathrm{~V}$,$1 \mathrm{C}=-1 \mathrm{~mA},$ |  | 0.58 | 212 | $\mathrm{k} \Omega$ |
| $n_{\text {fe }}$ | Small-Signal Common-Emitter Forward Current Transfer Ratio |  |  | $50 \quad 200$ | 100400 |  |
| $\mathrm{h}_{\text {re }}$ | Small-Signal Cormmon-Emitter Reverse Voltage Transfer Ratio |  |  | $\begin{array}{\|lr} \hline 0.1 \times & 5 \times \\ 10^{-4} & 10^{-4} \\ \hline \end{array}$ | $\begin{array}{lc} \hline 0.1 \times 10 \times \\ 10^{-4} & 10^{-4} \\ \hline \end{array}$ |  |
| $h_{\text {oe }}$ | Small-Signal Common-Emitter Output Admittance |  |  | 140 | 360 | $\mu \mathrm{mho}$ |
| $\mid h_{\text {fe }} \mathbf{l}$ | Smali-Signal Common-Emitter Forwerd Current Transfer Ratio | $V_{C E}=-20 \mathrm{~V}, I^{\prime}=-10 \mathrm{~mA}$, | $f=100 \mathrm{MHz}$ | 2 | 2.5 |  |
| ${ }_{\text {f }}$ | Transition Frequency | $V_{C E}=-20 \mathrm{~V}, \mathrm{I}^{\text {c }}=-10 \mathrm{~mA}$, | See Note 4 | 200 | 250 | MHz |
| $C_{\text {cbo }}$ | Common-Base Open-Circuit Output Capacitance | $\begin{aligned} & V_{C B}=-5 \mathrm{~V}, \quad I_{E}=0, \\ & I=100 \mathrm{kHz} \text { to } 1 \mathrm{MHz} \end{aligned}$ |  | 4.5 | 4.5 | pF |
| Cibo | Common-Base Open-Circuit Input Capacitance | $\begin{aligned} & V_{E B}=-0.5 V, I^{\prime}=0, \\ & f=100 \mathrm{kHz} \text { to } 1 \mathrm{MHz} \end{aligned}$ |  | 10 | 10 | pF |

NOTES: 3. These parameters must be measured using puise techniques. $\mathrm{t}_{\mathbf{w}}=\mathbf{3 0 0} \mu \mathrm{s}$, duty cycle $\leqslant \mathbf{2 \%}$.
4. To obtain $f_{T}$, the $\left.\right|_{h f e} \mid$ response is extrapolated at the rate of -6 dB per octave from $f=100 \mathrm{MHz}$ to the frequency at which $\left|h_{\text {fe }}\right|=1$.
*operating characteristics at $25^{\circ} \mathrm{C}$ free-air temperature

| PARAMETER |  | TEST CONDITIONS | $\begin{aligned} & \text { 2N3905 } \\ & \text { A5T3905 } \\ & \hline \end{aligned}$ |  | $\begin{gathered} \text { 2N3906 } \\ \text { A5T } 3906 \\ \hline \end{gathered}$ |  | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | MIN | MAX | MIN | MAX |  |
| $\overline{N F}$ | Average Noise Figure |  | $\begin{array}{ll} V_{C E}=-5 \mathrm{~V}, & \mathrm{I}_{\mathrm{C}}=-100 \mu \mathrm{~A}, \\ R_{G}=1 \mathrm{k} \Omega, & \text { Noise Bandwidth }=15.7 \mathrm{kHz}, \\ \text { See Note } 5 & \\ \hline \end{array}$ |  | 5 |  | 4 | dB |

NOTE 5: Average Noise Figure is measured in an amplifier with responise down 3 dB at 10 Hz and 10 kHz and a high-frequency rolloff of 6 dB/octave.
-The asterigk identifies JEDEC regiatered data for the 2N3905 and 2N3906 only.

## TYPES 2N3905, 2N3906, A5T3905, A5T3906 P-N-P SILICON TRANSISTORS

"switching characteristics at $25^{\circ} \mathrm{C}$ free-air temperature

| PARAMETER |  | TEST CONDITIONS ${ }^{\dagger}$ | $\begin{gathered} \text { 2N3905 } \\ \text { A5T3905 } \end{gathered}$ | $\begin{gathered} \text { 2N3806 } \\ \text { AST3906 } \end{gathered}$ | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | MAX | MAX |  |
| $\mathrm{t}_{\mathrm{d}}$ | Delay Time |  | $\begin{array}{ll} I_{C}=-10 \mathrm{~mA}, & \mathrm{I}_{\mathrm{B}}(1)=-1 \mathrm{~mA}, \\ \mathrm{R}_{\mathrm{L}}=275 \Omega, & \text { See Figure } 1 \\ \hline \end{array}$ | 35 | 35 | ns |
| $\mathrm{t}_{\mathrm{r}}$ | Rise Time | 35 |  | 35 | ns |
| $\mathrm{t}_{\mathrm{s}}$ | Storage Time | $\begin{array}{ll} I_{C}=-10 \mathrm{~mA}, & I_{B}(1)=-1 \mathrm{~mA}, \\ I_{\mathrm{B}}(2)=1 \mathrm{~mA}, \\ R_{L}=275 \Omega, & \text { See Figure } 2 \end{array}$ | 200 | 225 | ns |
| $t_{f}$ | Fall Time |  | 60 | 75 | ns |

TVoltage and current values shown are nominal; exact values vary slightly with transistor parametars. Nominal base current for delav and rise times is calculated using the minimum value of $\mathrm{V}_{\mathrm{BE}}$. Nominal base currente for storage and fall times are calculated using the maximum value of $V_{\mathrm{BE}}$.
*The asterisk ldentifies JEDEC registered date for the 2N3905 and 2N3906 only.

## PARAMETER MEASUREMENT INFORMATION



FIGURE 2-STORAGE AND FALL TIMES
NOTES: a. The input waveforms are supplied by a genarator with the following characteristics: $Z_{\text {out }}=\mathbf{m 0} \Omega$, duty cycle $=\mathbf{2 \%}$,
b. Waveforms are monitored on an oscilloscope with the following characteriatics: $t_{r} \leq 1 \mathrm{~ns}, \mathrm{R}_{\mathrm{in}}=10 \mathrm{M} \Omega, \mathrm{C}_{\mathrm{in}} \leqslant 4 \mathrm{pF}$.

## ELECTRICALLY SIMILAR TO 2N2386 AND 2N2386A <br> FOR AUDIO- TO HIGH-FREQUENCY SMALL-SIGNAL AMPLIFIERS 2N3909A offiers groatly improved $\left|y_{m}\right| / \mathbf{C}_{\text {m }}$ ratio resulting from process innovation: <br> - $\left|y_{f}\right|$ Min Raised from 1 mmho to 2.2 mmho <br> - Cm Max Lowered from 16 pF to 3 pF

*mechanicel defen

*absolute maximum ratings at $25^{\circ} \mathrm{C}$ free-air tomperature (unless othorwise noted)

*electrical characteristics at $25^{\circ} \mathrm{C}$ free-air temporature (unless otherwise noted)

|  | PARAMETER | TEST CONDITIONS $\ddagger$ | 2N3909 | 2N3909A | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: |
| $V_{\text {cexpess }}$ | Gato-Sourcu Breakdown Voltage | $1_{0}=10 \mu h, V_{D S}=0$ | 20 | 20 | V |
| lass | Gate Revarse Curront | $V_{\text {es }}=10 V_{1}, V_{\text {DS }}=0$ | 10 | 10 | nA |
|  |  | $V_{\text {GS }}=10 \mathrm{~V}, \quad V_{\text {DS }}=0, \quad \mathrm{~T}_{A}=100^{\circ} \mathrm{C}$ | 1 | 1 | $\mu \mathrm{N}$ |
| Vestofn | Gato-Sourte Cutoff Voltape | $V_{D S}=-10 \mathrm{~V}, \mathrm{I}_{0}=-10 \mu \mathrm{~A}$ | 8 | 8 | $V$ |
| Yes | Gata-Source Voltage | $V_{D S}=-10 \mathrm{~V}, I_{0}=-30 \mu \mathrm{~A}$ | $0.3 \quad 7.9$ | $0.3 \quad 7.9$ | $V$ |
| loss | Zero-Gate-Voltage Drain Current | $V_{\text {DS }}=-10 \mathrm{~V}, \mathrm{~V}_{\text {SS }}=0$ | $\begin{array}{ccc}-0.3 & -15\end{array}$ | -1 -15 | mA |
| $\left\|\boldsymbol{y}_{\boldsymbol{H}}\right\|$ | Small-Signal Common-Sourca Formard Transfor Admittance |  | 1 | 2.2 | mmho |
| \|Yos] | Small-Signal Common-Source Output Admiltance |  | 0.1 | 0.1 | mmho |
| $\mathrm{C}_{30}$ | Common-Source Short-CIrtult Input Capadtances |  | 32 | 9 | pF |
| Crss | Commen-Source Shori-Cirult Reverse Transfer Capacitance |  | 16 | 3 | pF |
| $\left\|y_{t s}\right\|$ | Small-Signal Common-Source Forward Transfor Admittance | $\mathrm{V}_{\mathrm{Os}}=-10 \mathrm{~V}, \mathrm{~V}_{\mathrm{ss}}=0, \quad 1=10 \mathrm{mHz}$ | 0.9 | 2 | mmho |

NOTE $1:$ Derate linearly to $175^{\circ} \mathrm{C}$ frec-ale temperature at the rate of $2 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$.
$\ddagger$ The fourth leed (cese) is connected to the neurce for all measuraments.
*Indicater JEDEC raglaterad date
USES CHIP JP7 1

## FOR LOW-LEVEL, LOW-NOISE, HIGH-GAIN, SMALL-SIGNAL AMPLIFIER APPLICATIONS

- Guaranteed hfe at $10 \mu \mathrm{~A}, \mathrm{TA}_{\mathrm{A}}=-55^{\circ} \mathrm{C}$ and $25^{\circ} \mathrm{C}$
- Guaranteed Low-Noise Characteristics at $20 \mu \mathbf{A}$
*merhanical data

*absolute maximum ratings at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)


MOTES: 1. Theso valwes apply betwoen $10 \mu \mathrm{~A}$ and 5 mA cellector currant when the bese-tmititer diode is apen-circuited.
2. Derate Itinearly to $200^{\circ} \mathrm{C}$ fros-air temperature at the rate of $2.06 \mathrm{~mW} / \mathrm{dog}$. See Figure 1 .
3. Derate linenty to $200^{\circ} \mathrm{C}$ case temperature al the rate of $6.85 \mathrm{mw} / \mathrm{deg}$. Seet figure 2 .
*electrical characteristics at $25^{\circ} \mathbf{C}$ free-air temperature (unless otherwise noted)


MOTE 4: These parameters must be measured using pulse fechniques. $t_{p}=300 \mu s$, duty cycle $\leq 1 \%$.
*Indicates JEDEC registered data
*operating characteristics at $25^{\circ} \mathrm{C}$ free-air temperature

| PARAMETER |  | TEST CONDITIONS | $\begin{aligned} & 2 N 3962 \\ & 2 N 3963 \\ & \hline \end{aligned}$ | $\begin{aligned} & \text { 2N3964 } \\ & \text { 2N3965 } \\ & \hline \end{aligned}$ | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | MAX | MAX |  |
| MF | Spot Moiso Figure |  | $\begin{aligned} & Y_{C E}=-5 V, I_{C}=-20 \mu \mathrm{~A}, \mathrm{I}_{6}=10 \mathrm{kQ}, \\ & \mathrm{f}=10 \mathrm{~Hz}, \text { Moise Bondwidth }=2 \mathrm{~Hz} \end{aligned}$ |  | 1 | d |
|  |  | $\begin{aligned} & y_{C E}=-5 v, \mathrm{I}_{c}=-20 \mu A_{1} \mathrm{R}_{G}=10 \mathrm{kQ}, \\ & \mathrm{f}=100 \mathrm{~Hz} \text {, Molse Bandwidth }=15 \mathrm{~Hz} \end{aligned}$ | 10 | 4 | d |
|  |  |  | 3 | 2 | ${ }^{4}$ |
|  |  | $\begin{aligned} & V_{C E}=-5 \mathrm{~V}, \mathrm{I}_{\mathrm{c}}=-20 \mu \mathrm{~A}_{\mathrm{c}} \mathbf{E}_{\mathrm{s}}=10 \mathrm{k} \mathrm{\Omega}, \\ & 1=10 \mathrm{kHz} \text {, Meiss landwidh }=1.5 \mathrm{kHz} \end{aligned}$ | 3 | 2 | 4 |
| WF | Average Moiss Figure | $\begin{aligned} & V_{\mathrm{CE}}=-5 \mathrm{~V}, \mathrm{I}_{\mathrm{C}}=-20 \mu \mathrm{~A}, \quad \mathrm{M}_{\mathrm{G}}=10 \mathrm{k} \mathrm{\Omega}, \\ & \text { Moiss, Bandwidh }=15.7 \mathrm{kHz}, \text { So0 Mols } 5 \end{aligned}$ | 3 | 2 | $d$ |

more s: Averaga Moise Figure is massured in an amplifier with response down 3 dt of 10 Hz and 10 kHz and a high-froquency rolloff of 6 de/octave.
*Indicotes JEDEC registerod data

## THERMAL INFORMATION



FIGURE 1

CASE TEMPERATURE

figure 2

## FOR HIGH-SPEED COMMUTATOR AND CHOPPER APPLICATIONS

- Low rds(on) . . . $220 \Omega$ Max
- Low ID(off) . . . 1 nA Max
- Low Crss . . . 1.5 pF Max


## *mechanical data



## *absolute maximum ratings at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)


*electrical characteristics at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

| PARAMETER |  | TEST CONDITIONSt |  |  | MIN MAX | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| $V_{\text {(BR) }}$ GSS | Gate-Source Breakdown Voltage | $\mathrm{I}_{\mathrm{G}}=-1 \mu \mathrm{~A}$, | $V_{D S}=0$ |  | -30 | $V$ |
| IGSS | Gate Reverse Current | $\mathrm{V}_{\mathrm{GS}}=-20 \mathrm{~V}$, | $V_{D S}=0$ |  | -0.1 | nA |
| IDGO | Drain Reverse Current | $V_{\text {DG }}=20 \mathrm{~V}$. | IS $=0$ |  | 0.1 | nA |
|  |  | $V_{\text {DG }}=20 \mathrm{~V}$. | $I_{S}=0$, | $\mathrm{T}_{\mathrm{A}}=150^{\circ} \mathrm{C}$ | 0.2 | $\mu \mathrm{A}$ |
| ${ }^{\prime} \mathrm{D}$ (off) | Drain Cutoff Current | $V_{\text {DS }}=10 \mathrm{~V}$. | $\mathrm{V}_{\text {GS }}=-7 \mathrm{~V}$ |  | 1 | nA |
|  |  | $\mathrm{V}_{\mathrm{DS}}=10 \mathrm{~V}$ | $\mathrm{V}_{\text {GS }}=-7 \mathrm{~V}$, | $\mathrm{T}_{\mathrm{A}}=150^{\circ} \mathrm{C}$ | 2 | $\mu \mathrm{A}$ |
| $V_{\text {GS }}$ (off) | Gate-Source Voltage | $V_{\text {DS }}=10 \mathrm{~V}$. | $I_{D}=10 \mathrm{nA}$ |  | -4 -6 | V |
| IDSS | Zero-Gate-Voltage Drain Current | $\mathrm{V}_{\text {DS }}=20 \mathrm{~V}$, | $V_{G S}=0$ |  | 2 | mA |
| VDS(on) | Drain-Source On-State Voltage | $V_{G S}=0$, | $\mathrm{I}_{\mathrm{D}}=1 \mathrm{~mA}$ |  | 0.25 | V |
| rds(on) | Small-Signal Drain-Source On-State Resistance | $V_{G S}=0$, | $\mathrm{I}_{\mathrm{D}}=0$, | $\mathbf{t}=1 \mathrm{kHz}$ | 220 | $\Omega$ |
| $C_{\text {iss }}$ | Common-Source Short-Circuit Input Capacitance | $V_{D S}=20 \mathrm{~V}$ | $V_{G S}=0$, | $\mathrm{f}=1 \mathrm{MHz}$ | 6 | pF |
| $C_{\text {rss }}$ | Common-Source Short-Circuit Reverse Transfer Capacitance | $V_{D S}=0$, | $V_{G S}=-7 \mathrm{~V}$, | $\mathrm{f}=1 \mathrm{MHz}$ | 1.5 | pF |

[^83]USES CHIP JN51

## TYPE 2N3966 <br> N-CHANNEL SILICON JUNCTION FIELD-EFFECT TRANSISTOR

*switching characteristics at $\mathbf{2 5}{ }^{\circ} \mathrm{C}$ free-air temperature

| PARAMETER |  | TEST CONDITIONS ${ }^{\dagger}$ |  | MAX | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: |
| ${ }^{\text {d }}$ d(on) | Turn-On Delay Time | $V_{D D}=1.5 \mathrm{~V}$, $I_{D(o n)} \simeq 1 \mathrm{~mA}$, <br> $V_{G S(o n)}=0$, $V_{G S(o f f)}=-6 \mathrm{~V}$. <br> See Figure 1  <br> See Figure 1 |  | 20 | ns |
| $\mathrm{t}_{\boldsymbol{r}}$ | Rise Time |  |  | 100 | ns |
| ${ }_{\text {toff }}$ | Turn-Off Time |  |  | 100 | ns |

${ }^{\dagger}$ The fourth lead (case) is connected to the source for all measurements.
*PARAMETER MEASUREMENT INFORMATION


NOTES: A. The input waveforms are supplied by a generator with the following characteristics: $Z_{\text {out }}=50 \Omega$, duty cycle $\leqslant 50 \%$.
B. Waveforms are monitored on an oscilloscope with the following characteristics: $\mathrm{t}_{\mathrm{r}} \leqslant 10 \mathrm{~ns}, \mathrm{R}_{\mathrm{in}} \geqslant 5 \mathrm{M} \Omega, \mathrm{C}_{\mathrm{in}} \leqslant 10 \mathrm{pF}$

- JEDEC registered data


## TYPES 2N3970 THRU 2N3972 N-CHANNEL SILICON JUNCTION FIELD-EFFECT TRANSISTORS

# SYMMETRICAL N-CHANNEL FIELD-EFFECT TRANSISTORS FOR HIGH-SPEED COMMUTATOR AND CHOPPER APPLICATIONS 

\author{

- Low ID(off) . . . 0.25 nA Max <br> - Low rds(on) Ciss Product
}


## *mechanical data


*absolute maximum ratings at $\mathbf{2 5}{ }^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)


NOTE 1: Darate linearly to $200^{\circ} \mathrm{C}$ case temperature at the rate of $10.3 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$
-JEDEC registered data. This data sheet contains all applicable registered data in effect at the time of publication.

## TYPES 2N3970 THRU 2N3972 <br> N-CHANNEL SILICON JUNCTION FIELD-EFFECT TRANSISTORS

*electrical characteristics at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

| PARAMETER |  | TEST CONDITIONS | 2N3970 | 2N3971 | 2N3972 | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | MIN MAX | MIN MAX | MIN MAX |  |
| $V_{\text {BRIGSS }}$ | Gate-Source Breakdown Voltage |  | $\mathrm{I}_{6}=-1 \mu \mathrm{~A}, V_{\text {DS }}=0$ | -40 | -40 | -40 | V |
| logo | Drain Reverse Current | $V_{D G}=20 \mathrm{~V}, \mathrm{I}_{5}=0$ | 0.25 | 0.25 | 0.25 | nA |
|  |  | $V_{D G}=20 \mathrm{~V}, \mathrm{I}_{S}=0, \quad \mathrm{~T}_{\mathrm{A}}=150^{\circ} \mathrm{C}$ | 0.5 | 0.5 | 0.5 | $\mu \mathrm{A}$ |
| IDOTH1 | Droin Cutoff Current | $V_{D S}=20 \mathrm{~V}, \quad \mathrm{~V}_{G S}=-12 \mathrm{~V}$ | 0.25 | 0.25 | 0.25 | nA |
|  |  | $V_{\text {DS }}=20 \mathrm{~V}, \quad V_{G S}=-12 \mathrm{~V}, \mathrm{~T}_{\mathrm{A}}=150^{\circ} \mathrm{C}$ | 0.5 | 0.5 | 0.5 | $\mu \mathrm{A}$ |
| $V_{6 S(0+f)}$ | Gate-Source Cutoff Voltage | $V_{\text {DS }}=20 \mathrm{~V}, \mathrm{I}_{\mathrm{D}}=1 \mathrm{nA}$ | -4 -10 | -2 -5 | $\begin{array}{ll}-0.5 & -3\end{array}$ | $\checkmark$ |
| loss | Zero-Gate-Voltage Droin Current | $V_{D S}=20 \mathrm{~V}, \quad V_{G S}=0, \quad$ See Note 2 | $50 \quad 150$ | $25 \quad 75$ | $5 \quad 30$ | mA |
| $V_{\text {DSion) }}$ | Drain-Sourte On-State Voltage | $V_{G S}=0, \quad I_{0}=20 \mathrm{~mA}$ | 1 |  |  | V |
|  |  | $V_{G S}=0, \quad I_{D}=10 \mathrm{~mA}$ |  | 1.5 |  |  |
|  |  | $V_{G S}=0, \quad I_{D}=5 \mathrm{~mA}$ |  |  | 2 |  |
| ros(on) | Static Drain-Source On-State Resistance | $V_{G S}=0, \quad I_{0}=1 \mathrm{~mA}$ | 30 | 60 | 100 | $\Omega$ |
| $\mathrm{P}_{\mathrm{ds}(\mathrm{om})}$ | Small-Signal Droin-Source On-State Resistance | $V_{G S}=0, \quad I_{D}=0, \quad f=1 \mathrm{kHz}$ | 30 | 60 | 100 | $\Omega$ |
| $C_{103}$ | Common-Sourte Short-Circuit Input Capacitance | $V_{D S}=20 \mathrm{~V}, \quad V_{G S}=0, \quad \begin{aligned} & f=1 \mathrm{MHz}, \\ & \text { See Note } 3\end{aligned}$ | 25 | 25 | 25 | pF |
| $\mathrm{C}_{\text {ss }}$ | Common-Source Short-Circuif Reverse Transfer Capacitance | $V_{D S}=0, \quad V_{G S}=-12 \mathrm{~V}, \mathrm{f}=1 \mathrm{MHz}$ | 6 | 6 | 6 | pF |

*switching characferistics at $\mathbf{2 5}^{\mathbf{\circ}} \mathbf{C}$ free-air temperature

| PARAMETER |  | TEST CONDITIONS |  | 2N3970 |  | 2N3971 |  | 2N3972 |  | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | TYP | MAX | TYP | MAX | TYP | MAX |  |
| ${ }_{\text {dal(on) }}$ | Turn-On Delay Time |  |  |  |  |  | 10 |  | 15 |  | 40 | ns |
| $\mathrm{t}_{\mathrm{r}}$ | Rise Time |  | 10 |  |  |  | 15 |  | 40 | ns |
| toth | Turn-Off Time |  | 30 |  |  |  | 60 |  | 100 | ns |
| $\mathrm{t}_{\mathrm{r}}$ | Rise Time | $V_{D D}=10 \mathrm{~V}, \quad I_{D(o n)} \dagger=\left\{\begin{array}{r}12 \mathrm{~mA}(2 \mathrm{~N} 3970) \\ 6 \mathrm{~mA}(2 \mathrm{N3971}) \\ 3 \mathrm{~mA}(2 \mathrm{~N} 3972) \\ -12 \mathrm{~V}(2 \mathrm{N3970}) \\ -7 \mathrm{~V}(2 \mathrm{~N} 3971) \\ -5 \mathrm{~V}(2 \mathrm{~N} 3972)\end{array}\right.$$V_{G S(\text { onl }}=0$, |  | 2 |  | 3 |  | 4 |  | ns |
| $t_{\text {on }}$ | Tum-On Time |  |  | 5.5 |  | 6.5 |  | 8 |  | ns |
| ${ }_{\text {f }}$ | Fall Time |  |  | 7 |  | 13 |  | 27 |  | ns |
| $\mathrm{t}_{\text {oth }}$ | Turn-Off Time |  |  | 10 |  | 18 |  | 31 |  | ns |

NOTES: 2. This paramater must be masured using pulse tachniques, $\mathbf{t}_{w}=300 \mu \mathrm{~s}$, duty cycle $\leq 3 \%$.
3. This paramater must be mieasured with bias voltages applied for less than 5 seconds to avoid ovarheating.
†These are nominal values; exact volues vary slighily with transistor parameters.

* JEDEC registored dato (typleal data exeluded).


# TYPES 2N3970 THRU 2N3972 <br> N-CHANNEL SILICON JUNCTION FIELD-EFFECT TRANSISTORS 

PARAMETER MEASUREMENT INFORMATION


NOTES: a. The Input waveforms are mpplied by a genarator with the following characteristics: $\mathbf{Z}_{\text {out }}=\mathbf{8 0} \boldsymbol{\Omega}$, duty cycle $\approx 2 \%$.
b. Waveforms are monitored on an oscilloscope with the following eharacterietics: $\mathrm{t}_{\mathrm{r}}<0.4 \mathrm{~ns}, \mathrm{R}_{\mathrm{ln}}=10 \mathrm{M} \Omega, \mathrm{C}_{\mathrm{in}}=1.5 \mathrm{pF}$.


NOTE a: An equivalent generator and oscilloscope may be used. The oscilloscope must have a $50-\Omega$ input impedance.
FIOURE 2

## PLANAR UNIJUNCTION TRANSISTORS SPECIFICALLY CHARACTERIZED FOR A WIDE RANGE OF MILITARY, SPACE, AND INDUSTRIAL APPLICATIONS:

2N3980 for General-Purpose UJT Applications<br>2N4947 for High-Frequency Relaxation-Oscillator Circuits<br>2N4948 for Thyristor (SCR) Trigger Circuits<br>2N4949 for Long-Time-Delay Circuits

## - Planar Process Ensures Extremely Low Leakage, High Performance with Low Driving Currents, and Greatly Improved Reliability

## *mechanical data

Package outline is same as JEDEC TO-18 except for lead position. All TO-18 registration notes also apply to this outline.

*absolute maximum ratings at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)


NOTES: 1. Interbase voltoge is limited solely by power dissipation, $\mathbf{V}_{B 2-B 1}=\sqrt{r_{B B}{ }^{*} P_{T}}$
2. This value applies for a capacitor discharge through the emitter-basa-one diode. Currant must fall to 0.31 a within $\mathbf{3} \mathbf{m s}$ and pulsa-roporition rafe must not exceed 10 pps.
3. Derate linearly to $175^{\circ} \mathrm{C}$ free-air temperature at the rate of $2.4 \mathrm{~mW} / \mathrm{deg}$.

[^84]
# TYPES 2N3980, 2N4947 THRU 2N4949 P-N PLANAR SILICON UNLUNCTION TRANSISTORS 

*electrical characteristics at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

| PARAMETER |  | TEST CONDITIONS | 2N3980 | $2 N 4947$ | 2N4948 | 2N4949 | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | MIN MAX | MIN MAX | MIN MAX | MIN MAX |  |
| $\mathrm{r}_{88}$ | Static Interbase Resistence |  | $\mathbf{V}_{\mathbf{8 2}-\mathrm{B} 1}=3 \mathbf{V}, \quad \mathrm{t}_{\mathbf{E}}=0$ | 48 | 49.1 | 412 | 412 | $\mathrm{k} \Omega$ |
| $\alpha_{\text {r }}{ }_{\text {B }}$ | Interbase Resistance Temperature Coefficient | $\begin{aligned} & V_{B 2-B 1}=3 V, \quad I_{E}=0, \\ & T_{A}=-65^{\circ} \mathrm{C} \text { to } 100^{\circ} \mathrm{C}, \quad \text { See Note } 4 \end{aligned}$ | 0.40 .9 | 0.10 .9 | 0.10 .9 | 0.10 .9 | \%/deg |
| $\eta$ | Intrinsic Standoff Ratio | $V_{\text {e2-bl }}=10 \mathrm{~V}$, See Figure 1 | 0.680 .82 | 0.510 .69 | 0.550 .82 | 0.740 .86 |  |
| ${ }^{13}$ [mod) | Modulated Interhase Current | $V_{\text {B2-81 }}=10 \mathrm{Y}, \quad \mathrm{I}_{\mathrm{E}}=50 \mathrm{~mA}$, See Mote 5 | 12 | 12 | 12 | 12 | ma |
|  |  | $\mathrm{V}_{\mathrm{EB2} 2}=-30 \mathrm{~V}_{\text {\% }} \quad \mathrm{I}_{\mathrm{B1}}=0$ | $-10$ | -10 | $-10$ | -10 | nA |
| $\mathrm{IER2O}^{\circ}$ | Emitter Reverse Current | $V_{\mathrm{EB2} 2}=-30 \mathrm{~V}, \quad \mathrm{I}_{\mathrm{B} 1}=0, \quad \mathrm{~T}_{\mathrm{A}}=125^{\circ} \mathrm{C}$ | - | -1 | -1 | -1 | $\mu \mathrm{A}$ |
| Ip | Peak-Point Emitter Cerrent | $\mathbf{v}_{\mathbf{B 2}-\mathrm{B1}}=25 \mathrm{v}$ | 2 | 2 | 2 | 1 | $\mu \cdot /$ |
| $V_{\text {Ealisat] }}$ | Emitter - Base-One <br> Saturation Voltage | $\mathbf{v}_{\text {B2-B1 }}=10 \mathrm{~V}, \mathrm{I}_{\mathrm{E}}=50 \mathrm{~mA}, \mathrm{~S}_{\text {se }}$ Note 5 | 3 | 3 | 3 | 3 | V |
| $\mathrm{I}_{\mathrm{v}}$ | Valley-Point Emither Current | $\mathrm{V}_{\mathrm{B2}-\mathrm{B1}}=20 \mathrm{~V}$ | 110 | 4 | 2 | 2 | min |
| $V_{\text {ces }}$ | Base-One Peak Puise Voltoge | See Figure 2 | 6 | 3 | 6 | 3 | $Y$ |

NOTES: 4. Femperature coefficient $a_{r B 8}$ is determined by the following formula: $a_{r B B}=\left[\frac{\left(r_{\mathrm{BB}} @ 100^{\circ} \mathrm{G}-\left(\mathrm{f}_{\mathrm{BB}} @-65^{\circ} \mathrm{C}\right)\right.}{\left(\mathrm{r}_{\mathrm{BE}} @ 25^{\circ} \mathrm{C}\right)}\right] \frac{100 \%}{165 \mathrm{deg}}$
To oblain ${ }_{B B}$ for $a$ given tamperature $T_{A(2)}$, wse the following formule:

$$
\begin{aligned}
& \mathrm{a}: \\
& x_{\mathrm{rBB}} \\
& \text { ule: }
\end{aligned}=\left[\frac{\left(r_{\mathrm{BB}} @ 100^{\circ} \mathrm{G}-\mathrm{f}_{\mathrm{BB}} @-65^{\circ} \mathrm{C}\right)}{\left.\mathrm{r}_{\mathrm{BB}} @ 15^{\circ} \mathrm{C}\right)}\right] \frac{100 \%}{165 \mathrm{deg}}
$$

$$
r_{\mathrm{BB}(2]}=\left[\mathrm{r}_{\mathrm{BB}} @ 25^{\circ} \mathrm{C}\right]\left[1+\left(\alpha_{\mathrm{rBB}} / 100 \%\right)\left(\mathrm{T}_{\mathrm{A}(2)}-25^{\circ} \mathrm{C}\right)\right]
$$

5. These parometers are measured using pulse techniques. $t_{p}=300 \mu s$, duty cycle $\leq \mathbf{2 \%}$.

## *PARAMETER MEASUREMENT INFORMATION


$\eta$-Intrinsic Standoff Ratio - This parameter is defined in terms
figure 1 - test circuit for intrinsic standoff raito ( $\eta$ )


$$
\begin{gathered}
\text { EMITTER-BASE-ONE VOLTAGE } \\
\text { VS } \\
\text { EMITTER CURRENT }
\end{gathered}
$$


figure 3-general static emitter characteristic culve

## TYPES 2N3993, 2N3993A, 2N3994, 2N3994A P-CHANNEL SILICON JUNCTION FIELD-EFFECT TRANSISTORS

## FOR HIGH-SPEED COMMUTATOR AND

## CHOPPER APPLICATIONS

- Low $r_{d s(o n)} . . .150 \Omega \operatorname{Max}(2 N 3993,2 N 3993 A)$
- High $\mid \mathrm{y}_{\mathrm{fs}} / / \mathrm{C}_{\mathrm{iss}}$ Ratio (High-Frequency Figure-of-Merit)
- Low Leakage
- Low Crss . . . 3 pF Max (2N3993A)
*mechanical data

*absolute maximum ratings at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)


[^85]
## TYPES 2N3993, 2N3993A, 2N3994, 2N3994A P-CHANNEL SILICON JUNCTION FIELD-EFFECT TRANSISTORS

*electrical characteristics at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

| PARAMETER |  | TEST CONDITIONS $\dagger$ |  | $\begin{array}{\|l\|} \hline \text { 2N3993 } \\ \hline \text { MINMAX } \\ \hline \end{array}$ | $\begin{array}{\|l\|} \hline \text { 2N3993A } \\ \text { MIN WAX } \\ \hline \end{array}$ | $\begin{array}{\|l\|} \hline \text { 2N3994 } \\ \text { ININ MAX } \\ \hline \end{array}$ | $\begin{array}{\|l\|} \hline \text { 2N3994A } \\ \hline \text { IIN MAX } \\ \hline \end{array}$ | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| V(BR)GSS | Gate-Source Breakdown Voltage | $\mathrm{I}_{G}=1 \mu \mathrm{~A}$, | $V_{D S}=0$ | 25 | 25 | 25 | 25 | V |
|  |  | $V_{D G}=-15 \mathrm{~V}$. | $\mathrm{I}_{5}=0$ | -1.2 | -1.2 | -1.2 | -1.2 | nA |
| İgo | Drain Reverse Current | $V_{\text {DG }}=-15 \mathrm{~V}$, | $\begin{aligned} & T_{S}=0, \\ & T_{A}=150^{\circ} \mathrm{C} \end{aligned}$ | -1.2 | -1.2 | -1.2 | -1.2 | $\mu \mathrm{A}$ |
| $\mathrm{I}_{\text {DSS }}$ | Zero-Gate-Voltage Drain Current | $V_{D S}=-10 \mathrm{~V}$ | $\begin{aligned} & V_{\mathrm{GS}}=0, \\ & \text { See Note } 2 \end{aligned}$ | -10 | -10 | -2 | -2 | mA |
| ${ }^{\prime}$ D(off) | Drain Cutoff Current | $V_{\text {DS }}=-10 \mathrm{~V}$, | $V_{G S}=6 \mathrm{~V}$ |  |  | -1.2 | -1.2 | nA |
|  |  | $V_{0 S}=-10 V$ | $\begin{aligned} & V_{G S}=6 \mathrm{~V} \\ & T_{A}=150^{\circ} \mathrm{C} \end{aligned}$ |  |  | -1 | -1 | $\mu \mathrm{A}$ |
|  |  | $V_{D S}=-10 \mathrm{~V}$, | $V_{G S}=10 \mathrm{~V}$ | -1.2 | -1.2 |  |  | nA |
|  |  | $V_{D S}=-10 \mathrm{~V}$, | $\begin{aligned} & V_{G S}=10 \mathrm{~V}, \\ & T_{A}=150^{\circ} \mathrm{C} \end{aligned}$ | -1 | -1 |  |  | $\mu \mathrm{A}$ |
| $\mathbf{V}_{\mathbf{G S}}$ | Gate-Source Voltaga | $\mathrm{V}_{\mathrm{DS}}=-10 \mathrm{~V}$. | $I_{D}=-1 \mu A$ | 49.5 | 49.5 | 15.5 | 1.5 .5 | V |
| rosion) | Small-Signal Drain-Source On-State Resistance | $\begin{aligned} & V_{\mathrm{GS}}=0, \\ & \mathrm{f}=1 \mathrm{kHz} \end{aligned}$ | ${ }^{\prime} \mathrm{D}=0$, | 150 | 150 | 300 | 300 | $\boldsymbol{\Omega}$ |
| $\left\|y_{\text {fs }}\right\|$ | Small-Signal Common-Source Forward Transfer Admittance | $\begin{aligned} & V_{\mathrm{DS}}=-10 \mathrm{~V}, \\ & \mathrm{f}=1 \mathrm{kHz}, \end{aligned}$ | $V_{\mathrm{GS}}=0$ <br> See Note 2 | $6 \quad 12$ | $7 \quad 12$ | $4 \quad 10$ | 510 | mmho |
| $C_{\text {iss }}$ | Common-Source Short-Circuit Input Capacitance | $\begin{aligned} & V_{D S}=-10 \mathrm{~V}, \\ & f=1 \mathrm{MHz} \end{aligned}$ | $v_{G S}=0,$ <br> See Note 3 | 18 | 12 | 16 | 12 | pF |
| $\mathrm{C}_{\text {rss }}$ | Common-Source Short-Circuit Reverse Transfer Capacitance | $\begin{aligned} & V_{D S}=0, \\ & f=1 \mathrm{MHz} \end{aligned}$ | $V_{G S}=6 \mathrm{~V}$, |  |  | 5 | 3.5 | pF |
|  |  | $\begin{aligned} & V_{D S}=0, \\ & f=1 \mathrm{MHz} \end{aligned}$ | $\mathrm{V}_{\mathrm{GS}}=10 \mathrm{~V}$ | 4.5 | 3 |  |  | pF |

NOTES: 2. These parameters must be measured using puise techniques. $t_{p}=\mathbf{1 0 0} \mathbf{m s}$, duty cycle $\leq \mathbf{1 0 \%}$.
3. This parameter must be measured with bias voltages applied for tess than 5 seconds to avoid overheating.

- Indicates JEDEC registered data

FThe fourth lead (case) is connected to the source for all measurements.

## THERMAL INFORMATION



## FAST, HIGH-VOLTAGE, HIGH-CURRENT CORE DRIVERS

- hFE Guaranteed from $\mathbf{1 0} \mathbf{~ m A}$ to 1 A
- Guaranteed Switching Times at $\mathbf{5 0 0} \mathrm{mA}$
- Also Available in TO-39 as 2N3724, 2N3725


## *mechanical data


*absolute maximum ratings at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

|  | 2N4013 | 2N4014 | UNIT |
| :--- | :---: | :---: | :---: |
| Collector-Base Voltage | 50 | 80 | V |
| Collector-Emitter Voltage (See Note 1) | $\mathbf{3 0}$ | 50 | V |
| Emitter-Base Voltage | 6 | 6 | V |
| Continuous Collector Current | 0.5 | 0.5 | A |
| Continuous Device Dissipation at (or below) 25 ${ }^{\circ} \mathrm{C}$ Free-Air Temperature (See Note 2) | 360 | 360 | mW |
| Continuous Device Dissipation at (or below) $25^{\circ} \mathrm{C}$ Case Temperature (See Note 3) | 1.2 | 1.2 | W |
| Storage Temperature Range | -65 to 200 | -65 to 200 | ${ }^{\circ} \mathrm{C}$ |
| Lead Temperature 1/16 Inch from Case for 60 Seconds | 300 | 300 | ${ }^{\circ} \mathrm{C}$ |

NOTES: 1. These values apply between 0.01 mA and 500 mA collector current when the base-emitter diode is open-circuited.
2. Derate linearly to $200^{\circ} \mathrm{C}$ free-air temperature at the rate of $2.06 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$.
3. Derate linearly to $200^{\circ} \mathrm{C}$ case temperature at the rate of $6.85 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$.
*JEOEC registered data. This data sheet contains all applicable registered data in effect at the time of publication.

## TYPES 2N4013, 2N4014 N-P-N SILICON TRANSISTORS

*electrical characteristics at $\mathbf{2 5}{ }^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

| PARAMETER |  | TEST CONDITIONS |  | 2N4013 |  | 2N4014 |  | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | MIN | MAX | MIN | MAX |  |
| $V_{(B R) C B O}$ | Collector-Base Breakdown Voltage |  |  | $I^{\prime} C=10 \mu A ; \quad I_{E}=0$ |  | 50 |  | 80 |  | $v$ |
| V(BR)CEO | Collactor-Emitter Breakdown Voltage | $I_{C}=10 \mathrm{~mA}, \quad I_{B}=0, \quad$ See Note 4 |  | 30 |  | 50 |  | V |
| $V_{\text {(BR) CES }}{ }_{\text {B }}$ | Collector-Emitter Breakdown Voltage | $\mathrm{I}^{\prime} \mathrm{C}=10 \mu \mathrm{~A}, \quad \mathrm{~V}_{\mathrm{BE}}=0$ |  | 50 |  | 80 |  | V |
| $V_{\text {(BR) }}{ }^{\text {b }}$ ( | Emitter-Base <br> Braakdown Voltage | $\mathrm{I}_{\mathrm{E}}=10 \mu \mathrm{~A}, \quad \mathrm{IC}=0$ |  | 6 |  | 6 |  | V |
| ICBO | Collector Cutoff Current | $\mathrm{V}_{C B}=40 \mathrm{~V}, \mathrm{IE}^{2}=0$ |  |  | 1.7 |  |  | $\mu \mathrm{A}$ |
|  |  | $\mathrm{V}_{C B}=40 \mathrm{~V}, \mathrm{I}_{\mathrm{E}}=0$, | $T_{A}=100^{\circ} \mathrm{C}$ |  | 120 |  |  |  |
|  |  | $V_{C B}=60 \mathrm{~V}, \mathrm{IE}=0$ |  |  |  |  | 1.7 |  |
|  |  | $V_{C B}=60 \mathrm{~V}, \mathrm{I}_{\mathrm{E}}=0$, | $\mathrm{T}_{\mathrm{A}}=100^{\circ} \mathrm{C}$ |  |  |  | 120 |  |
| ICES | Collector Cutoff Current | $\mathrm{V}_{\mathrm{CE}}=50 \mathrm{~V}, \mathrm{~V}_{\mathrm{BE}}=0$ |  |  | 10 |  |  | $\mu \mathrm{A}$ |
|  |  | $V_{C E}=80 \mathrm{~V}, V_{\text {BE }}=0$ |  |  |  | 10 |  |  |
| $I_{B}$ | Base Current | $V_{C E}=50 \mathrm{~V}, V_{\text {BE }}=0$ |  |  | -10 | -10 |  | $\mu \mathrm{A}$ |
|  |  | $V_{C E}=80 \mathrm{~V}, \mathrm{~V}_{\text {BE }}=0$ |  |  |  |  |  |  |
| hFE | Static Forward Current Transfer Ratio | $V_{C E}=1 \mathrm{~V}, \mathrm{I}_{\mathrm{C}}=10 \mathrm{~mA}$ | See <br> Note <br> 4 | 30 |  | 30 |  |  |
|  |  | $V_{C E}=1 \mathrm{~V}, \quad I^{\prime}=100 \mathrm{~mA}$ |  | 60 | 150 | 60 | 150 |  |
|  |  | $\begin{array}{ll} V_{C E}=1 \mathrm{~V}, & I_{C}=100 \mathrm{~mA} \\ & T_{A}=-55^{\circ} \mathrm{C} \end{array}$ |  | 30 |  | 30 |  |  |
|  |  | $V_{C E}=1 \mathrm{~V}, \quad I_{C}=300 \mathrm{~mA}$ |  | 40 |  | 40 |  |  |
|  |  | $V_{C E}=1 \mathrm{~V}, \quad I^{\prime}=500 \mathrm{~mA}$ |  | 35 |  | 35 |  |  |
|  |  | $\begin{array}{ll}V_{C E}=1 \mathrm{~V}, & \mathrm{I}_{\mathbf{C}}=500 \mathrm{~mA}, \\ & T_{A}=-55^{\circ} \mathrm{C}\end{array}$ |  | 20 |  | 20 |  |  |
|  |  | $V_{C E}=2 \mathrm{~V}, \quad I^{\prime}=800 \mathrm{~mA}$ |  | 25 |  | 20 |  |  |
|  |  | $V_{C E}=5 \mathrm{~V}, I_{C}=1 \mathrm{~A}$ |  | 30 |  | 25 |  |  |
| VBE | Base-Emitter Voltage | $I_{B}=1 \mathrm{~mA}, \quad I_{C}=10 \mathrm{~mA}$ | See <br> Note <br> 4 |  | 0.76 |  | 0.76 | V |
|  |  | $I_{B}=10 \mathrm{~mA}, \quad I_{C}=100 \mathrm{~mA}$ |  |  | 0.86 |  | 0.86 |  |
|  |  | $\mathrm{I}_{B}=30 \mathrm{~mA}, \quad I_{C}=300 \mathrm{~mA}$ |  |  | 1.1 |  | 1.1 |  |
|  |  | $\mathrm{I}_{B}=50 \mathrm{~mA}, \quad I_{C}=500 \mathrm{~mA}$ |  | 0.8 | 1.1 | 0.8 | 1.1 |  |
|  |  | $\mathrm{I}_{B}=80 \mathrm{~mA}, \mathrm{I}_{\mathrm{C}}=800 \mathrm{~mA}$ |  |  | 1.5 |  | 1.5 |  |
|  |  | $\mathrm{I}_{B}=100 \mathrm{~mA}, \mathrm{I}^{\prime}=1 \mathrm{~A}$ |  |  | 1.7 |  | 1.7 |  |
| $V_{C E}(\mathrm{sat})$ | Collector-Emitter Saturation Voltage | $I_{B}=1 \mathrm{~mA}, \quad I_{C}=10 \mathrm{~mA}$ | See <br> Note <br> 4 |  | 0.25 |  | 0.25 | $v$ |
|  |  | $\mathrm{I}_{B}=10 \mathrm{~mA}, \quad I_{C}=100 \mathrm{~mA}$ |  |  | 0.2 |  | 0.26 |  |
|  |  | $\mathrm{I}_{B}=30 \mathrm{~mA}, \mathrm{I}_{C}=300 \mathrm{~mA}$ |  |  | 0.32 |  | 0.4 |  |
|  |  | $\mathrm{I}_{B}=50 \mathrm{~mA}, \quad \mathrm{I}^{\prime}=500 \mathrm{~mA}$ |  |  | 0.42 |  | 0.52 |  |
|  |  | $\mathrm{I}_{B}=80 \mathrm{~mA}, \mathrm{I}^{\prime}=800 \mathrm{~mA}$ |  |  | 0.65 |  | 0.8 |  |
|  |  | $\mathrm{I}_{\mathrm{B}}=100 \mathrm{~mA}, \mathrm{I}^{\prime}=1 \mathrm{~A}$ |  |  | 0.75 |  | 0.95 |  |
| hfel | Small-Signal Common-Emitter <br> Forward Current Transfer Ratio | $V_{C E}=10 \mathrm{~V}, \mathrm{I}^{\prime}=50 \mathrm{~mA}, \mathrm{f}=100 \mathrm{MHz}$ |  | 3 |  | 3 |  |  |
| Cobo | Common-Base Open-Circuit Output Capacitance | $V_{C B}=10 \mathrm{~V}, \mathrm{IE}=0$. | $\mathrm{f}=1 \mathrm{MHz}$ |  | 12 |  | 10 | pF |
| $C_{\text {ibo }}$ | Common-Base Open-Circuit Input Capacitance | $V_{E B}=0.5 \mathrm{~V}, \mathrm{I}^{\prime}=0$ | $\mathrm{f}=1 \mathrm{MHz}$ |  | 55 |  | 55 | pF |

## TYPES 2N4013, 2N4014 <br> N-P-N SILICON TRANSISTORS

## "switching characteristics at $\mathbf{2 5}{ }^{\circ} \mathrm{C}$ free-air temperature

| PARAMETER | TEST CONDITIONS ${ }^{\dagger}$ | 2N4013 | 2N4014 | UNIT |
| :---: | :---: | :---: | :---: | :---: |
|  |  | MAX | MAX |  |
| $t_{d}$ Delay Time | $\begin{array}{ll} V_{C C}=30 \mathrm{~V}, & \mathrm{IC}_{\mathrm{C}}=500 \mathrm{~mA}, \\ \mathrm{I}_{\mathrm{B}(1)}=50 \mathrm{~mA}, & \mathrm{~V}_{\mathrm{BE}(\text { off })}=-3.8 \mathrm{~V}, \\ \text { See Figure } 1 & \\ \hline \end{array}$ | 10 | 10 | ns |
| $\mathrm{t}_{\mathrm{r}}$ R Rise Time |  | 30 | 30 | ns |
| ton Turn-On Time |  | 35 | 36 | ns |
| $\mathbf{t}_{\mathbf{3}} \quad$ Storage Time | $\begin{array}{ll} \hline V_{C C}=30 \mathrm{~V}, & I_{C}=500 \mathrm{~mA}, \\ I_{B(1)}=50 \mathrm{~mA}, & I_{B(2)}=-60 \mathrm{~mA}, \\ \text { See Figure } 1 \end{array}$ | 80 | 50 | ns |
| ti Fall Time |  | 25 | 30 | ni |
| toff Turn-Off Time |  | 60 | 60 | $n 8$ |

[^86]
## *PARAMETER MEASUREMENT INFORMATION



FIOURE 1-500-mA SWITCHINO TIMES

NOTES: . The input waveforme are supplied by a generator with the following characteristics: $z_{\text {out }}=50 \Omega, t_{r} \leqslant 1$ ns, $t_{f} \leqslant 1$ ns, $t_{w} \approx 1 \mu s$, duty evcle $\leqslant \mathbf{2 \%}$.
 -JE DEC reglstered diate

## MEDIUM POWER P-N.P TRANSISTORS FOR COMPUTER MEMORY APPLICATIONS

- Increased Dissipation at $\mathbf{2 5}{ }^{\circ} \mathrm{C}$ Case Temperature . . . 10 W Max (2N4030 thru 2N4033)
- High V(BR)CEO . . . 80 V Min (2N4027, 2N4029, 2N4031, 2N4033)


## mechanical data


absolute maximum ratings at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

|  | $\begin{array}{\|ll\|} \hline \text { 2N4026 } & \text { 2N4027 } \\ \text { 2N4028 } & \text { 2N4029 } \\ \hline \end{array}$ | 2N4030 $2 N 4031$ 2N4032 2N4033 | UNIT |
| :---: | :---: | :---: | :---: |
| Collector-Base Voltage | -60* -80** | -60* - $80{ }^{*}$ | V |
| Collector-Emitter Voltage (Soe Note 1) | -60**-80* | $-60^{*} \quad-80^{*}$ | V |
| Emitter-Base Voltage | -5* | -5* | V |
| Continuous Collector Current | $-1^{*}$ | $-1^{*}$ | A |
| Continuous Device Dissipation at (or below) $25^{\circ} \mathrm{C}$ Free-Air Temperature (See Note 2) | 0.5* | 0.8* | W |
| Continuous Device Dissipation at (or below) $25^{\circ} \mathrm{C}$ Case Temperature (See Note 3) | 2* | $\begin{gathered} 10^{\dagger} \\ 4^{\prime \prime} \\ \hline \end{gathered}$ | W |
| Storage Temperature Range | -65 to 200* | -65 to 200* | ${ }^{\circ} \mathrm{C}$ |
| Lead Temperature 1/16 Inch from Case for 60 Seconds | 300* | $300 *$ | ${ }^{\circ} \mathrm{C}$ |

NOTES: 1. These values apply between 0 and 10 mA collector current when the base-emitter diode is open-circuited.
2. Derste linmariy to $200^{\circ} \mathrm{C}$ free-air temparature at the rates of $2.86 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$ for 2 N 4026 through 2 N 4029 and $4.56 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$ for 2N4030 through 2N4033.
3. Darate linearly to $200^{\circ} \mathrm{C}$ case temperature of the following rates: $11.4 \mathrm{~mW} / \mathrm{C}$ for the 2 -watt rat $/ \mathrm{ng}, \mathbf{5 7 , 1} \mathrm{mW} /{ }^{\circ} \mathrm{C}$ for the 10 -watt rating, and $22.8 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$ for the 4 -watt rating.
The JEDEC registered outline for these devices is TO-E. TO-39 falis within TO-5 with the exception of lead length.
-JEDEC regiatered data. This data shest contalns all applicable registered data in effect at the time of publication.
${ }^{\dagger}$ This value is guaranteed by Texse instruments in addition to the JEDEC registered value which is also shown.

## TYPES 2N4026 THRU 2N4033 <br> P-N-P SILICON TRANSISTORS

*electrical characteristics at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

| PARAMETER |  | TEST CONDITIONS |  | $\begin{aligned} & \text { 2N4026 } \\ & \text { 2N4030 } \end{aligned}$ |  | $\begin{aligned} & \text { 2N4027 } \\ & \text { 2N4031 } \end{aligned}$ |  | $\begin{aligned} & \text { 2N4028 } \\ & \text { 2N4032 } \end{aligned}$ |  | $\begin{aligned} & \text { 2N4029 } \\ & \text { 2N4033 } \end{aligned}$ |  | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | MIN | MAX | MIN | MAX | MIN | MAX | MIN | MAX |  |
| $V_{(B R) C B O}$ | Collector-Base <br> Breakdown Voltage |  |  | ${ }^{\prime} \mathrm{C}=-10 \mu \mathrm{~A}$, | $\mathrm{I}_{\mathrm{E}}=0$ | -60 |  | -80 |  | -60 |  | -80 |  | V |
| $V_{\text {(BR)CEO }}$ | Collector-Emitter Breakdown Voltage | $I_{C}=-10 m A \text {, }$ <br> See Note 4 | $I_{B}=0,$ | -60 |  | -80 |  | -60 |  | -80 |  | V |
| $V$ (BR)EBO | Emitter-Base <br> Breakdown Voltage | $\mathrm{I}_{\mathrm{E}}=-10 \mu \mathrm{~A}$, | $\mathrm{I}_{\mathrm{C}}=0$ | -5 |  | -5 |  | -5 |  | -5 |  | V |
| ICBO | Collector Cutoff Current | $\mathrm{V}_{\mathrm{CB}}=-50 \mathrm{~V}$, | $t_{E}=0$ |  | -50 |  |  |  | -50 |  |  | nA |
|  |  | $V_{C B}=-60 \mathrm{~V}$, | $\mathrm{I}^{2}=0$ |  |  |  | -50 |  |  |  | -50 |  |
|  |  | $\begin{aligned} & V_{C B}=-50 \mathrm{~V}, \\ & T_{A}=150^{\circ} \mathrm{C} \end{aligned}$ | $\mathrm{I} E=0$ |  | -50 |  |  |  | -50 |  |  | $\mu \mathrm{A}$ |
|  |  | $\begin{aligned} & V_{C B}=-60 \mathrm{~V}, \\ & T_{A}=150^{\circ} \mathrm{C} \end{aligned}$ | $\mathrm{I}_{\mathrm{E}}=0,$ |  |  |  | -50 |  |  |  | -50 |  |
| IEBO | Emitter Cutoff Current | $V_{E B}=-5 \mathrm{~V}$, | $\mathrm{IC}^{\prime}=0$ |  | -10 |  | -10 |  | -10 |  | -10 | $\mu \mathrm{A}$ |
| hfe | Static Forward Current Transfer Ratio | $\mathrm{V}_{\text {CE }}=-5 \mathrm{~V}$, | $1 \mathrm{C}=-100 \mu \mathrm{~A}$ | 30 |  | 30 |  | 75 |  | 75 |  |  |
|  |  | $\begin{aligned} & V_{C E}=-5 \mathrm{~V} \\ & \mathrm{I}_{\mathrm{C}}=-100 \mathrm{~mA} \end{aligned}$ | See Note 4 | 40 | 120 | 40 | 120 | 100 | 300 | 100 | 300 |  |
|  |  | $\begin{aligned} & V_{C E}=-5 \mathrm{~V} \\ & \mathrm{I}_{\mathrm{C}}=-100 \mathrm{~mA} . \\ & T_{A}=-55^{\circ} \mathrm{C} \end{aligned}$ |  | 45 |  | 15 |  | 40 |  | 40 |  |  |
|  |  | $\begin{aligned} & V_{C E}=-5 \mathrm{~V}, \\ & I_{C}=-500 \mathrm{~mA} \end{aligned}$ |  | 25 |  | 25 |  | 70 |  | 70 |  |  |
|  |  | $\begin{aligned} & \mathrm{V}_{\mathrm{CE}}=-5 \mathrm{~V} . \\ & \mathrm{I}_{\mathrm{C}}=-1 \mathrm{~A} \end{aligned}$ |  | 15 |  | 10 |  | 40 |  | 25 |  |  |
| $V_{B E}$ | Base-Emitter Voltage | $\begin{aligned} & I_{B}=-15 \mathrm{~mA}, \\ & I_{C}=-150 \mathrm{~mA} \end{aligned}$ | See Note 4 |  | -0.9 |  | -0.9 |  | -0.9 |  | -0.9 | V |
|  |  | $\begin{aligned} & V_{C E}=-0.5 \mathrm{~V}, \\ & I_{C}=-500 \mathrm{~mA} \end{aligned}$ |  |  | -1.1 |  | -1.1 |  | -1.1 |  | -1.1 |  |
|  |  | $\begin{aligned} & V_{C E}=-1 \mathrm{~V}, \\ & \mathrm{I}_{\mathrm{C}}=-1 \mathrm{~A} \end{aligned}$ |  |  | -1.2 |  |  |  | -1.2 |  |  |  |
| VCE(sat) | Collector-Emitter Saturation Voltage | $\begin{aligned} & I_{B}=-15 \mathrm{~mA}, \\ & I_{C}=-150 \mathrm{~mA} \end{aligned}$ | See Note 4 |  | -0.15 |  | -0.15 |  | -0.15 |  | -0.15 | V |
|  |  | $\begin{aligned} & I_{B}=-50 \mathrm{~mA}, \\ & I_{C}=-500 \mathrm{~mA} \end{aligned}$ |  |  | -0.5 |  | -0.5 |  | -0.5 |  | -0.5 |  |
|  |  | $\begin{aligned} & I_{B}=-100 \mathrm{~mA} \\ & I_{C}=-1 A \end{aligned}$ |  |  | -1 |  |  |  | -1 |  |  |  |
| $\boldsymbol{H f f e}$ | Smail-Signal <br> Common-Emitter <br> Forward Current <br> Transfer Ratio | $\begin{aligned} & V_{C E}=-10 \mathrm{~V}, \quad I_{C}=-50 \mathrm{~mA} \\ & f=100 \mathrm{MHz} \end{aligned}$ |  | 14 |  | 14 |  | 1.55 |  | 1.55 |  | 5 |
| $\mathrm{C}_{\mathrm{cb}}$ | Collector-Base Capacitance | $\begin{aligned} & V_{C B}=-10 \mathrm{~V}, \\ & f=1 \mathrm{MHz}, \end{aligned}$ | $I_{E}=0,$ <br> See Note 5 |  | 20 |  | 20 |  | 20 |  | 20 | pF |
| $C_{\text {ibo }}$ | Common-Base <br> Open-Circuit <br> Input Capacitance | $\begin{aligned} & V_{E B}=-0.5 \mathrm{~V} \\ & \mathrm{f}=1 \mathrm{MHz} \end{aligned}$ | $I_{C}=0$ |  | 110 |  | 110 |  | 110 |  | 110 | pF |

NOTES: 4. These parameters must be measured using pulse techniques. $t_{w}=300 \mu \mathrm{~s}$, duty cycle $\leqslant 1 \%$.
5. $\mathrm{C}_{\mathrm{cb}}$ measurement employs a three-terminal capacitance bridge incorporating a guard circuit. The emittar is connected to the guard terminal of the bridge.

[^87]switching characteristics at $25^{\circ} \mathrm{C}$ free-air temperature

| PARAMETER |  | TEST CONDITIONS ${ }^{\dagger}$ |  | MAX | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: |
| $t_{\text {on }}$ | Turn-On Time | $\mathrm{V}_{\mathrm{CC}}=-30 \mathrm{~V}$, | ${ }^{1} \mathrm{C}=-500 \mathrm{~mA}$, | 100 | ns |
| $t_{5}$ | Storage Time | ${ }^{\prime} \mathrm{V}_{(1)}=-50 \mathrm{~mA}$, | $\mathrm{l}_{\mathrm{B}(2)}=50 \mathrm{~mA}$, | 350 | ns |
| ${ }_{\text {t }}$ | Fall Time | $\mathrm{V}_{\mathrm{BE} \text { (off) }}=3.8 \mathrm{~V}$, | See Figure 1 | 50 | ns |

${ }^{\dagger}$ Voltage and current values shown are nominal; exact values vary slightly with transistor parameters.

- JEDEC registered data


## PARAMETER MEASUREMENT INFORMATION



NOTES: a. The input waveform is supplied by a generator with the following characteristics: $Z_{\text {out }}=50 \Omega, t_{r} \leqslant 20 \mathrm{~ns}, \mathrm{t}_{\mathrm{f}} \leqslant 20 \mathrm{~ns}, \mathrm{t}_{\mathrm{w}} \approx 10 \mu \mathrm{~m}$, duty cycle $\leqslant 2 \%$.
b. Waveforms are monitored on an oscilloscope with the following characteristics: $t_{r} \approx 10 \mathrm{~ns}, \mathrm{R}_{\mathrm{in}} \geqslant 100 \mathrm{k} \Omega$.

FIGURE 1-500-mA SWITCHING TIMES
THERMAL INFORMATION


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texas instruments reserves the right to make changes at any fime in order to improve design and to supply the best product possible.

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# TYPES A5T4026 THRU A5T4029, A8T4026 THRU A8T4029 P-N-P SILICON TRANSISTORS 

BULLETIN NO. DL-S 7312002, MARCH 1973

## SILECT ${ }^{\dagger}$ TRANSISTORS $\ddagger$ <br> FOR GENERAL PURPOSE APPLICATIONS <br> - High V(BR)CEO . . . 80 V Min (A5T4027, A5T4029, A8T4027, A8T4029) <br> - High Current Capability . . . 1 A <br> - Rugged One-Piece Construction with In-Line Leads or Standard TO-18 100-mil Pin-Circule Configuration

## mechanical data

These transistors are encapsulated in a plastic compound specifically designed for this purpose, using a highly mechanized process developed by Texas Instruments. This case will withstand soldering temperatures without deformation. These devices exhibit stable characteristics under high-humidity conditions and are capable of meeting MIL-STD-202C, Method 106B. The transistors are insensitive to light.

| A5T4026 THRU A5T4029 |  |
| :---: | :---: |
| NOTES: A. Lead diameter is not controlled in this area. <br> B. Leads having maximum diameter ( 0.019 ) shall be within 0.007 of their true positions measured in the gaging plane 0.054 balow the seating plane of the device relative to a maximum-diameter package. <br> C. All dimensions are in inches. |  |
| ABT4026 THRU A8T4028 <br> ALL JEDEC TO-92 DIMENSIONS AND NOTES ARE APPLICABLE <br> NOTES: A. Lead diameter is not controlled in this area. <br> B. All dimensions are in inches. |  |

absolute maximum ratings at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)
$\left.\begin{array}{lllllllll}\text { A5T4026 } & \\ \text { A5T4027 } \\ \text { A5T4028 } \\ \text { A5T4029 }\end{array}\right]$

NOTES: 1. These values apply between 0 and 10 mA collector current when the base-emitter diode is open-circuited.
2. Derate lineariv to $150^{\circ} \mathrm{C}$ free-air temperature at the rate of $5 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$.
3. Derate linearly to $150^{\circ} \mathrm{C}$ lead temperature at the rate of $10 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$. Lead temperature is measured on the collector lead $1 / 16$ inch from the case.
${ }^{\dagger}$ Trademark of Texas Instruments
$\ddagger$ U.S. Patent No. $\mathbf{3 , 4 3 9 , 2 3 8}$

## TYPES A5T4026 THRU A5T4029, A8T4026 THRU A8T4029 P-N-P SILICON TRANSISTORS

## dectrical characteristics at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)



NOTES: 4. These parameters must be measured using pulse techniques. $\mathrm{t}_{\mathrm{w}}=300 \mu \mathrm{~s}$, duty cycle $<2 \%$.
5. $\mathbf{C}_{\text {cb }}$ measurement employs a three-terminal capacitance bridge incorporating a guard circuit. The emitter is connected to the guard terminal of the bridge.

## TYPES A5T4026 THRU A5T4029, A8T4026 THRU A8T4029 P-N-P SILICON TRANSISTORS

switching characteristics at $25^{\circ} \mathrm{C}$ free-air temperature

| PARAMETER |  | TEST CONDITIONS ${ }^{\dagger}$ |  | MAX | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: |
| ton | Turn-On Time | $\mathrm{V}_{\mathrm{CC}}=-30 \mathrm{~V}$. | $\mathrm{I}_{\mathrm{C}}=-500 \mathrm{~mA}$, | 100 | ns |
| $\mathrm{t}_{\text {s }}$ | Storage Time | $\mathrm{I}_{\mathrm{B}(1)}=-50 \mathrm{~mA}$, | $\mathrm{I}_{\mathrm{B}(2)}=50 \mathrm{~mA}$, | 350 | ns |
| ${ }_{4}$ | Fall Time | $\mathrm{V}_{\text {BE (off) }}=3.8 \mathrm{~V}$, | See Figure 1 | 50 | ns |

${ }^{\dagger}$ Voltage and current values shown are nominal; exact values vary slightly with transistor parameters.


NOTES: a. The input waveform is supplied by a generator with the following characteristics: $Z_{o u t}=50 \Omega, t_{r} \leqslant 20 \mathrm{~ns}, \mathrm{t}_{\mathrm{f}} \leqslant 20 \mathrm{~ns}, \mathrm{t}_{\mathbf{w}} \approx 10 \mu \mathrm{~m}$, duty cycle $\leqslant 2 \%$.
b. Waveforms are monitored on an oscilloscope with the following characteristics: $\mathrm{t}_{\mathrm{r}} \approx 10 \mathrm{~ns}, \mathrm{R}_{\mathrm{in}} \geqslant 100 \mathrm{k} \Omega$.

FIGURE 1-500-mA SWITCHING TIMES
THERMAL INFORMATION

FREE-AIR TEMPERATURE DISSIPATION DERATING CURVE


FIGURE 2

LEAD TEMPERATURE DISSIPATION DERATING CURVE


## SILECT ${ }^{\dagger}$ TRANSISTORS $\ddagger$

## - Ideal for Low-Level Amplifier Applications

- Rugged One-Piece Construction with In-Line Leads or Standard TO-18 100-mil Pin-Circle Configuration
- Recommended for Complementary Use with 2N3707 thru 2N3711, A5T3707 thru A5T3711, or A8T3707 thru A8T3711


## mechanical data

These transistors are encapsulated in a plastic compound specifically designed for this purpose, using a highly mechanized process developed by Texas Instruments. The case will withstand soldering temperatures without deformation. These devices exhibit stable characteristics under high-humidity conditions and are capable of meeting MIL-STD-202C, Method 106B. The transistors are insensitive to light.

2N4058 THRU 2N4062, A8T4058 THRU A8T4062


NOTES: A. Lead diamater is not controlled in this area.
B. All dimensions are in inches.

| 2N4058 THRU 2N4062, A8T4058 THRU A8T4062 <br> *ALL JEDEC TO-92 DIMENSIONS AND NOTES ARE APPLICABLE <br> NOTES: A. Lead diamater is not controlled in this area. <br> B. All dimansions are in inches. | 2N4058 thru 2 N 4062 <br> ECB | A8T4058 thru A8T4062 <br> EBC |
| :---: | :---: | :---: |
| A5T4058 THRU A5T4062 <br> NOTES: A. Lead diameter is not controlled in this area. <br>  true positions measured in the gaging plane 0.054 below the seating plane of the deviee relative to a maximum-diameter package. <br> C. All dimensions are in inches. |  |  |

## absolute maximum ratings at $\mathbf{2 5}{ }^{\circ} \mathbf{C}$ free-air temperature (unless otherwise noted)



NOTES: 1. This value applies when the base-emitter diode is open-circuited.
2. Derate the $625-\mathrm{mW}$ rating linearly to $150^{\circ} \mathrm{C}$ free-air temperature at the rate of $5 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$. Derate the $360-\mathrm{mW}$ (JEDEC registered) rating Inderly to $150^{\circ} \mathrm{C}$ free-air temparature at the rate of $2.88 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$.

- The asterisk identifies JEDEC registered data for the 2 N 4058 through 2 N 4062 only. This data sheet contains all applicable registerad data in effect at the time of publication.
${ }^{\dagger}$ Trademark of Texas instruments
$\ddagger$ U.S. Patent No. 3,439,238
§ Texas Instruments guarantees this value in addition to the JEDEC registered value which is also shown.
USES CHIP P18


## TYPES 2N4058 THRU 2N4062, A5T4058 THRU A5T4062, A8T4058 THRU A8T4062 P-N-P SILICON TRANSISTORS

*electrical characteristics at $25^{\circ} \mathrm{C}$ free-air temperature

| PARAMETER |  | TEST CONDITIONS | 2N4088 <br> A5T4068 <br> A8T4058 | 2N4059 <br> AET4069 <br> ABT4089 | $\begin{aligned} & \text { 2N4080 } \\ & \text { A6T4080 } \\ & \text { A8T4060 } \end{aligned}$ | 2N40:1 A5T4081 A8T4061 | 2N4062 ABT4082 A8T4062 | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | MIN MAX | MIN MAX | MIN MAX | MIN MAX | MIN MAX |  |
| $V$ (BR)CEO | Collector-Emitter Breakdown Voltage |  | $\begin{aligned} & I_{i} C=-1 \mathrm{~mA}, \quad I_{B}=0, \\ & \text { See Note } 3 \end{aligned}$ | -30 | -30 | -30 | -30 | -30 | V |
| ICBO | Collector Cutoff Current | $V_{C B}=-20 \mathrm{~V}, \mathrm{IE}=0$ | -100 | -100 | -100 | -100 | -100 | nA |
| IEBO | Emitter Cutoff Current | $V_{E B}=-6 \mathrm{~V}, \mathrm{IC}=0$ | -100 | -100 | -100 | -100 | -100 | nA |
| hFE | Static Forward Current Transfer Ratio | $V_{C E}=-6 V_{0}, I_{C}=-100 \mu A$ | 100400 |  |  |  |  |  |
|  |  | $\mathrm{V}_{C E}=-5 \mathrm{~V}, 1 \mathrm{l}=-1 \mathrm{~mA}$ |  | $45 \quad 660$ | $45 \quad 185$ | $80 \quad 330$ | $180 \quad 660$ |  |
| VeE | Base-Emitter Voltage | $\mathrm{V}_{\text {CE }}=-5 \mathrm{~V}, \mathrm{I}_{\mathrm{C}}=-1 \mathrm{~mA}$ | -0.5 -1 | -0.6 -1 | -0.5 -1 | -0.5 -1 | $\begin{array}{\|cc\|}-0.5 & -1\end{array}$ | V |
| VCE(tat) | Collector-Emitter Saturation Voltage | $\mathrm{I}_{\mathrm{B}}=-0.5 \mathrm{~mA}, \mathrm{I}^{\prime}=-10 \mathrm{~mA}$ | -0.7 | -0.7 | -0.7 | -0.7 | -0.7 | V |
| $\mathrm{hfo}^{\text {fe }}$ | Small-Signal <br> Common-Emitter <br> Forward Current <br> Transfer Ratio | $\begin{aligned} & V_{C E}=-5 V, \quad I_{C}=-100 \mu \mathrm{~A}, \\ & f=1 \mathrm{kHz} \end{aligned}$ | 100550 |  |  |  |  |  |
|  |  | $\begin{aligned} & V_{C E}=-5 \mathrm{~V}, \quad \mathrm{I}_{\mathrm{C}}=-1 \mathrm{~mA}, \\ & f=1 \mathrm{kHz} \end{aligned}$ |  | $45 \quad 800$ | $45 \quad 250$ | $90 \quad 450$ | 180800 |  |

"operating characteristics at $\mathbf{2 5}{ }^{\circ} \mathrm{C}$ free-air temperature

| PARAMETER |  | TEST CONDITIONS |  | 2N4058,A5T4058, A8T4058 |  |  | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | MIN | TYP | MAX |  |
| $\bar{F}$ | Average Noise Figure |  |  | $\begin{aligned} & V_{C E}=-5 \mathrm{~V}, \\ & \text { Noise Bandwidth }=15.7 \mathrm{kHz}, \end{aligned}$ | $\mathrm{R}_{\mathrm{G}}=5 \mathrm{k} \Omega$ <br> See Note 4 |  | 1.7 | 5 | dB |

NOTES: 3. This parameter must be measured. using pulse techniques: $\mathbf{t}_{w}=\mathbf{3 0 0} \mu \mathrm{s}$, duty eyele $<\mathbf{2 \%}$.
4. Average Noise Figure is measured in an amplifier with response down 3 dB at 10 Hz and 10 kHz and a high.frequency rolloff of $6 \mathrm{~dB} /$ octave.

- The asterisk Identifies JEDEC registered data for 2N4058 through 2N4062 only.

THERMAL INFORMATION DISSIPATION DERATING CURVE


# SYMMETRICAL N-CHANNEL FIELD-EFFECT TRANSISTORS FOR HIGH-SPEED COMMUTATOR AND CHOPPER APPLICATIONS 

\author{

- Low ID(off) . . . 0.25 nA Max <br> - Low rds(on) Ciss Product
}
"mechanical data

*absolute maximum ratings at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)
Drain-Gate Voltage ..... 40 V ..... 40 V
Drain-Source Voltage
Drain-Source Voltage
Reverse Gate-Source Voltage ..... $-40 \mathrm{~V}$ ..... 10 mA
Continuous Forward Gate Current
Continuous Forward Gate Current
Continuous Device Dissipation at (or below) $\mathbf{2 5}{ }^{\circ} \mathrm{C}$ Case Temperature (See Note 1) ..... 1.8 W
Storage Temperature Range ..... $200^{\circ} \mathrm{C}$
Lead Temperature 1/16 Inch from Case for 10 Seconds ..... $300^{\circ} \mathrm{C}$

NOTE 1: Derate linearly to $200^{\circ} \mathrm{C}$ case temperature at the rate of $10.3 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$.
*JEDEC registered data. This date sheet conteins all applicabie registered date in effect at the time of publication.
*electrical characteristics at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

| PARAMETER |  | TEST CONDITIONS | 2N4091 | 2N4092 | 2N4093 | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| $\mathrm{V}_{\text {[BP] }}$ SSs |  |  | MIN MAX | MIN MAX | MIN MAX |  |
| (BR)GSS | Gate-Source Breakdown Voltage | $\mathrm{I}_{\mathrm{G}}=-1 \mu \mathrm{~A}, \mathrm{~V}_{\text {DS }}=0$ | -40 | -40 | -40 | $V$ |
| logo | Drain Reverse Current | $V_{D G}=20 \mathrm{~V}, \mathrm{I}_{\mathrm{s}}=0$ | 0.2 | 0.2 | 0.2 | nA |
|  |  | $V_{D G}=20 \mathrm{~V}, \mathrm{I}_{\mathrm{S}}=0, \quad \mathrm{I}_{\mathrm{A}}=150^{\circ} \mathrm{C}$ | 0.4 | 0.4 | 0.4 | $\mu \mathrm{A}$ |
| $\mathrm{I}_{560}$ | Source Reverse Current | $V_{S G}=20 \mathrm{~V}, \mathrm{I}_{\mathrm{D}}=0$ | 0.2 | 0.2 | 0.2 | $\ldots \mathrm{A}$ |
| $\mathrm{I}_{\text {Dofifl }}$ | Drain Cutoff Current | $V_{D S}=20 \mathrm{~V}, \quad V_{G S}=-12 \mathrm{~V}$ | 0.2 |  |  | nA |
|  |  | $V_{D S}=20 \mathrm{~V}, \quad V_{G S}=-8 \mathrm{~V}$ |  | 0.2 |  |  |
|  |  | $V_{D S}=20 \mathrm{~V}, V_{G S}=-6 \mathrm{~V}$ |  |  | 0.2 |  |
|  |  | $V_{D S}=20 \mathrm{~V}, \quad V_{G S}=-12 \mathrm{~V}, \mathrm{~T}_{\mathrm{A}}=150^{\circ} \mathrm{C}$ | 0.4 |  |  | $\mu \mathrm{A}$ |
|  |  | $V_{D S}=20 \mathrm{~V}, \quad V_{G S}=-8 \mathrm{~V}, \quad \mathrm{~T}_{\mathrm{A}}=150^{\circ} \mathrm{C}$ |  | 0.4 |  |  |
|  |  | $V_{D S}=20 \mathrm{~V}, \quad V_{G S}=-6 \mathrm{~V}, \mathrm{~T}_{A}=150^{\circ} \mathrm{C}$ |  |  | 0.4 |  |
| $\mathrm{V}_{\text {GS }} \mathrm{l}_{\text {(off }}$ | Gate-Source Cutoff Voltage | $V_{\text {DS }}=20 \mathrm{~V}, \mathrm{I}_{\mathrm{D}}=1 \mathrm{nA}$ | -5 $\quad-10$ | -2 | -1 $\quad-5$ | $V$ |
| ldss | Zero-Gate-Voltage Drain Current | $V_{\text {DS }}=20 \mathrm{~V}, \quad V_{G S}=0, \quad$ See Note 2 | 30 | 15 | 8 | mA |
| $V_{\text {DS }}^{\text {(on) }}$ | Drain-Source On-State Voltage | $V_{G S}=0, \quad I_{D}=6.6 \mathrm{~mA}$ | 0.2 |  |  | $v$ |
|  |  | $V_{\text {VS }}=0, \quad \mathrm{I}_{\mathrm{D}}=4 \mathrm{~mA}$ |  | 0.2 |  |  |
|  |  | $V_{G S}=0, \quad I_{D}=2.5 \mathrm{~mA}$ |  |  | 0.2 |  |
| rosion) | On-State Resistance | $V_{G S}=0, \quad I_{0}=1 \mathrm{~mA}$ | 30 | 50 | 80 | $\Omega$ |
| $\mathrm{r}_{\text {dision }}$ | Small-Signal Drain-Source On-State Resistance | $V_{G S}=0, \quad \mathrm{I}_{0}=0, \quad f=1 \mathrm{kHz}$ | 30 | 50 | 80 | $\Omega$ |
| $\mathrm{Ciss}^{\text {s }}$ | Common-Source Short-Circuit Input Capacitance | $V_{D S}=20 \mathrm{~V}, \quad V_{G S}=0, \quad \begin{aligned} & f=1 \mathrm{MHz}, \\ & \text { See Note } 3\end{aligned}$ | 16 | 16 | 16 | pF |
| $C_{\text {sss }}$ | Common-Source Short-Cifcuif Reverse Transfer Capacitance | $V_{\text {DS }}=0, \quad V_{G S}=-20 \mathrm{~V}, f=1 \mathrm{MHz}$ | 5 | 5 | 5 | pF |

*switching characteristics at $25^{\circ} \mathrm{C}$ free-air temperature

| PARAMETER |  | TEST CONDITIONS |  | 2N4091 |  | 2N4092 |  | 2N4093 |  | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  | TYP |  | TYP | MAX | TYP | MAX |  |
| $t_{\text {d }}(\mathrm{m})$ | Turn-On Delay Time |  |  | 15 |  | 15 |  | 20 |  | ns |
| $t_{r}$ | Rise Time |  |  |  | 10 |  | 20 |  | 40 | ns |
| toff | Turn-Off Time |  |  |  | 40 |  | 60 |  | 80 | ns |
| $t_{r}$ | Rise Time |  | $t=\int 12 \mathrm{~mA}(2 \mathrm{~N} 409 \mathrm{l})$ | 2 |  | 3 |  | 4 |  | ns |
| $t_{\text {on }}$ | Turn-On Time |  | $\mathrm{l}_{\mathrm{D} / \text { ont }} \mathrm{t}^{\mathrm{l}}=\left\{\begin{array}{l}12 \mathrm{~mA}(2 \mathrm{~N} 4092) \\ 3 \mathrm{~mA}(2 \mathrm{~N} 4093)\end{array}\right.$ | 5.5 |  | 6.5 |  | 8 |  | ns |
| $t_{f}$ | Fall Time |  | $v_{\text {coin }}=\left\{\begin{array}{l}-12 \mathrm{~V}(2 \mathrm{~N} 4099) \\ -7 \vee(2 N 4092)\end{array}\right.$ | 7 |  | 13 |  | 27 |  | ns |
| $\mathrm{t}_{\text {off }}$ | Turn-Off Time | See Figure 2, | $V_{G S \text { loff }}=\left\{\begin{array}{l}\text { - } \\ -7 V(2 N 4092) \\ -5 V(2 N 4093)\end{array}\right.$ | 10 |  | 18 |  | 31 |  | ns |

NOTES: 2. This parameter must be measured using pulse rechniques. $\mathrm{I}_{\mathrm{w}}=300 \mu \mathrm{~s}$, duty cycle $\leq \mathbf{3} \%$.
3. This parameter mus! be measured with bias voltages applied for less thon $\mathbf{S}$ seconds to avoid overheating.
†These ore nominal values; exact values vary slightly with transistor parameters.
*JEDEC registered data (typical doto excluded).

# TYPES 2N4091 THRU 2N4093 N-CHANNEL SILICON JUNCTION FIELD-EFFECT TRANSISTORS 

PARAMETER MEASUREMENT INFORMATION
SKL MODEL
503A

TEST CIRCUIT

| TYPE | $R_{\mathrm{L}}$ | $\mathbf{V}_{\mathbf{G S}}$ (off) |
| :---: | :---: | :---: |
| 2 N 4091 | $422 \Omega$ | -12 V |
| 2N4092 | $698 \Omega$ | -8 V |
| 2 N 4093 | $1.13 \mathrm{k} \Omega$ | -6 V |


(See Notes a and b)
(See Notes a and b)
VOLTAGE WAVEFORMS

NOTES: a. The input waveforms are supplied by a generator with the following characteristics: $Z_{\text {out }}=50 \Omega$, duty cycle $\approx 2 \%$.
b. Waveforms are monitored on an oscilloscope with the following characteristics: $t_{r} \leqslant 0.4 \mathrm{~ns}, \mathrm{R}_{\text {in }}=10 \mathrm{M} \Omega, \mathrm{C}_{\text {in }}=1.5 \mathrm{pF}$. FIGURE 1


NOTE a. An equivalent generator and oscilloscope may be used. The oscilloscope must have a $50-\Omega$ input impedance. FIGURE 2

TEXAS INSTRUMENTS
INCORPORATED
POST OFFICE BOX 5012 . DALLAS. TEXAS 75222

## DESIGNED FOR USE IN LOW-LEVEL, LOW-NOISE AMPLIFERS

- Guaranteed Low-Noise Characteristics at $10 \mathrm{~Hz}, 100 \mathrm{~Hz}, 1 \mathrm{kHz}$ and 10 kHz
- Very High Guarantoed hfE at $I_{C}=10 \mu \mathrm{~A}: 400$ Minimum
- High Rated $\mathrm{V}_{\text {EBo }}$ : 10 V
*mechanical data

*absolute maximum ratings af $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)
Collector-Base Voltage ..... 60 V
Collector-Emitter Voltage (See Note 1) ..... 60 V
Emitter-Base Voltage ..... 10 V
Continuous Collector Current
50 mA
50 mA
Continuous Device Dissipation at (or below) $25^{\circ} \mathrm{C}$ Free-Air Temperature (See Note 2) ..... 0.3 W
Continuous Device Dissipation at (or below) $25^{\circ} \mathrm{C}$ Case Temperature (See Note 3)
1.2 W
1.2 W
Storage Temperature Range ..... $200^{\circ} \mathrm{C}$
Lead Temperature $1 / 6$ Inch from Case for 10 Seconds ..... $300^{\circ} \mathrm{C}$
motes: 1. This value applies between 0 and 10 mA when the baso-emitter diede is apen-circuiled.

2. Derate lineorly to $175^{\circ} \mathrm{C}$ free-air temparature of the rate of $2 \mathrm{~mm} /{ }^{\circ} \mathrm{C}$.
3. Derate linearly to $175^{\circ} \mathrm{C}$ case iemperature at the rate of $8 \mathrm{~mm} /{ }^{\circ} \mathrm{C}$.
*JEDEC registerad dafa
*electrical characteristics et $25^{\circ} \mathrm{C}$ free-air temperafure (unless otherwise noted)

| PARAMETER |  | TEST CONDITIONS |  | MIN | max | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| $V_{\text {Impla }}$ | Collector-Bose Breakdown Voltage | $\mathrm{l}_{c}=10 \mu \mathrm{l}, \mathrm{l}_{E}=0$ |  | 60 |  | V |
| $V_{\text {Impeso }}$ | Coliector-Embtter Breakdown Voltage | $\mathrm{I}_{\mathrm{c}}=10 \mathrm{~mA}, \mathrm{I}_{\mathrm{L}}=0$, | See Mote 4 | 60 |  | $V$ |
|  | Emitter-Base Breakdown Voltage | $l_{E}=10 \mu \mathrm{~A}, \quad \mathrm{I}_{\mathrm{C}}=0$ |  | 10 |  | V |
| laso | Collector Cutoff Curment | $V_{C E}=45 V_{1} I_{E}=0$ |  |  | 10 | nA |
|  |  | $V_{C B}=45 \mathrm{~V}, \mathrm{I}_{\mathrm{E}}=0$, | $\mathrm{T}_{\mathrm{A}}=150^{\circ} \mathrm{C}$ |  | 10 | $\mu \mathrm{h}$ |
| lemo | Emither Cutofi Current | $V_{\text {Et }}=5 \mathrm{~V}, \mathrm{I}_{\mathrm{c}}=0$ |  |  | 10 | nis |
| $h_{r e}$ | Static Forword Current Transior Ratio | $V_{C E}=5 V_{1}, I_{C}=1 \mu$ |  | 150 |  |  |
|  |  | $V_{C E}=5 V_{1} \quad l_{C}=10 \mu \mathrm{~h}$ |  | 400 | 800 |  |
|  |  | $V_{C E}=5 V_{1} \quad I_{C}=100 \mu \mathrm{~A}$ |  | 450 |  |  |
|  |  | $\mathrm{V}_{\mathrm{CE}}=5 \mathrm{~V}, \quad \mathrm{IC}_{\mathrm{C}}=1 \mathrm{~mA}$ |  | 500 |  |  |
| $V_{\text {IE }}$ | Base-Emitter Voltage | $V_{\text {CE }}=5 \mathrm{~V}, \quad \mathrm{l}_{C}=100 \mu \mathrm{~A}$ |  |  | 0.7 | $V$ |
| $\mathbf{V}_{\text {ctax }}$ | Colledor-Emitter Soluration Voltage | $\mathrm{I}_{\mathrm{s}}=0.1 \mathrm{~mA}, \mathrm{I}_{\mathrm{C}}=1 \mathrm{~mA}$ |  |  | 0.3 | $v$ |
| hie | Small-Signal Common-Enifter Input Impedance | $\begin{array}{ll}\mathbf{V}_{\mathbf{C E}}=5 \mathrm{~V}, \\ \\ & \mathbf{I C}_{\mathbf{C}=1 \mathrm{~mA},} \\ & f=1 \mathrm{kHz}\end{array}$ |  | 12 | 42 | $k \Omega$ |
| $h_{\text {to }}$ | Small-Signal Commen-Emifter Forward Current Transfer Ratio |  |  | 500 | 1400 |  |
| $h_{\text {re }}$ | Small-Signal Common-Emittor Revarse Voltage Tronsfer Ratio |  |  |  | $8 \times 10^{-4}$ |  |
| $h_{\text {co }}$ | Small-Signal Common-Emittor Output Admittance |  |  | 8 | 60 | $\mu \mathrm{mmo}$ |
| \| $h_{0}$ \| | Small-Signal Common-Emittor Forward Current Irunster Ratio | $V_{\text {CE }}=5 \mathrm{~V}, \mathrm{IC}^{\prime}=0.5 \mathrm{~mA}, \mathrm{f}=30 \mathrm{mHz}$ |  | 3 | 18 |  |
| Cobe | Common-Base Open-Circuit Output Copocitance | $V_{C E}=5 V_{1} \quad l_{E}=0$, | $f=1$ MHz |  | 4.5 | pF |
| $\mathrm{Cb}_{\mathrm{bo}}$ | Common-Base Open-Circuit Input Capocitance | $V_{\text {Ei }}=0.5 \mathrm{~V}, \mathrm{I}_{\mathrm{C}}=0$, | $f=1$ mitz |  | 6 | pF |

*operating characteristics af $25^{\circ} \mathrm{C}$ free-air temperature

| PARAMETER | TEST CONDITIONS | MIN | MAX | UNIT |
| :---: | :---: | :---: | :---: | :---: |
| NF Spot Noise Figure | $\begin{aligned} & V_{C E}=5 V, \quad I_{C}=30 \mu \mathrm{~A}, \quad R_{0}=10 \mathrm{k} \Omega, \\ & f=10 \mathrm{~Hz} \end{aligned}$ |  | 15 | $d$ |
|  | $\begin{aligned} & \begin{array}{l} Y_{\mathrm{cE}}=5 \mathrm{Y}, \quad \mathrm{lc}_{\mathrm{c}}=30 \mu \mathrm{~A}, \\ \mathrm{f}=100 \mathrm{~Hz} \end{array} \\ & \hline \end{aligned}$ |  | 4 | ${ }_{8}$ |
|  | $\begin{aligned} & Y_{C E}=5 \mathrm{Y}, \quad \mathrm{l}_{\mathrm{C}}=5 \mu \mathrm{~A}, \quad \mathrm{R}_{6}=50 \mathrm{k} \Omega, \\ & f=1 \mathrm{kHz} \end{aligned}$ |  | 1 | ${ }^{3}$ |
|  | $\begin{aligned} & V_{C E}=5 \mathrm{~V}, \quad I_{C}=5 \mu \mathrm{~A}, \quad R_{\phi}=50 \mathrm{k} \Omega, \\ & f=10 \mathrm{kHz} \end{aligned}$ |  | 1 | d |

MOTE 4: Tils parenotor must be moesurad wing mise tociniques: $t_{p}=300 \mu s$, waty cycle $\leq \mathbf{2 \%}$.

* EEDEC ragisternd data


# SILECT ${ }^{\dagger}$ TRANSISTORS ${ }^{\ddagger}$ <br> DESIGNED FOR GENERAL PURPOSE SATURATED SWITCHING AND AMPLIFIER APPLICATIONS 

## - For Complementary Use with P-N-P Types 2N4125, 2N4126, A5T4125, and A5T4126

- Rugged One-Piece Construction with In-Line Leads or Standard TO-18 100-mil Pin-Circle Configuration
mechanical data
These transistors are encapsulated in a plastic compound specifically designed for this purpose, using a highly mechanized process developed by Texas Instruments. This case will withstand soldering temperatures without deformation. These devices exhibit stable characteristics under high-humidity conditions and are capable of meeting MIL-STD-202C, Method 106B. The transistors are insensitive to light.

| 2N4123, 2N4124 <br> *ALL JEDEC TO-92 DIMENSIONS AND NOTES ARE APPLICABLE <br> NOTES: A. Lead diameter is not controlled in this area. <br> B. All dimensions are in inches. | $\underset{\text { EBC }}{ }$ |
| :---: | :---: |
| A5T4123, A5T4124 <br> NOTES: A. Lead diameter is not controlled in this area. <br> B. Leads having maximum diameter ( 0.019 ) shall be within 0.007 of their true positions measured in the gaging plane 0.054 below the seating plane of the device relative to a maximum-diameter package. <br> C. All dimensions are in inches. |  |

absolute maximum ratings at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)


NOTES: 1. These values apply between $10 \mu \mathrm{~A}$ and 200 mA collector current when the base-emitter diode is open-circuited.
2. Derate the $625-\mathrm{mW}$ rating linearly to $150^{\circ} \mathrm{C}$ free-air temperature at the rate of $5 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$. Derate the $310-\mathrm{mW}$ (JEDEC registered) rating linearly to $135^{\circ} \mathrm{C}$ free-air temperature at the rate of $2.81 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$.
*The asterisk identifies JEDEC registered data for the 2 N4123 and 2 N4124 only. This data sheet contains all applicable registered data in effect at the time of publication.
${ }^{\dagger}$ Trademark of Texas Instruments
\#U.S. Patent No. 3,439,238
§Texas Instruments guarantees these values in addition to the JEDEC registered values which are also shown.

## TYPES 2N4123, 2N4124, A5T4123, A5T4124 N-P-N SILICON TRANSISTORS

*electrical characteristics at $\mathbf{2 5}{ }^{\circ} \mathbf{C}$ free-air temperature

| PARAMETER |  | TEST CONDITIONS |  | $\begin{gathered} \text { 2N4123 } \\ \text { A5T4123 } \end{gathered}$ |  | 2N4124 <br> A5T4124 |  | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | MIN | MAX | MIN | MAX |  |
| $V_{\text {(BR) }}$ CBO | Collector-Base Breakdown Voltage |  |  | $I_{C}=10 \mu A, \quad I_{E}=0$ |  | 40 |  | 30 |  | V |
| $V_{\text {(BR) }}$ CEO | Collector-Emitter Breakdown Voltage | $I_{C}=1 \mathrm{~mA}, \quad \mathrm{I}_{\mathrm{B}}=0$, | See Note 3 | 30 |  | 25 |  | $V$ |
| $V_{\text {(BR) }}$ EBO | Emitter-Base Breakdown Voltage | $I_{E}=10 \mu A, \quad I C=0$ |  | 5 |  | 5 |  | V |
| ${ }^{\text {I CBO }}$ | Collactor Cutoff Current | $V_{C B}=20 \mathrm{~V}, \mathrm{IE}=0$ |  |  | 50 |  | 50 | nA |
| IEbo | Emitter Cutoff Current | $V_{E B}=3 \mathrm{~V}, \mathrm{I}^{\prime}=0$ |  |  | 50 |  | 50 | nA |
| hFE | Static Forward Current Transfer Ratio | $V_{C E}=1 \mathrm{~V}, \quad I^{\prime}=2 \mathrm{~mA}$ | See Note 3 | 50 | 150 | 120 | 360 |  |
|  |  | $V_{C E}=1 \mathrm{~V}, I^{\prime} \mathrm{C}=50 \mathrm{~mA}$ |  | 25 |  | 60 |  |  |
| $V_{\text {BE }}$ | Base-Emitter Voltage | $\mathrm{I}_{\mathrm{B}}=5 \mathrm{~mA}, \quad 1 \mathrm{C}=50 \mathrm{~mA}$, | See Note 3 |  | 0.95 |  | 0.95 | V |
| $V_{C E}$ (sat) | Collector-Emitter Saturation Voltege | $I_{B}=5 \mathrm{~mA}, \quad I_{C}=50 \mathrm{~mA}$, | See Note 3 |  | 0.3 |  | 0.3 | V |
| $h_{\text {fe }}$ | Small-Signal Common-Emitter Forward Current Transfer Ratio | $V_{C E}=10 \mathrm{~V}, \mathrm{I}^{\prime}=2 \mathrm{~mA}$, | $\mathrm{f}=1 \mathrm{kHz}$ | 50 | 200 | 120 | 480 |  |
| $\mathrm{l}_{\text {fe }} \mathrm{l}$ | Small-Signal Common-Emitter <br> Forward Current Transfer Ratio | $V_{C E}=20 \mathrm{~V}, I_{C}=10 \mathrm{~mA}$, | $f=100 \mathrm{MHz}$ | 2.5 |  | 3 |  |  |
| ${ }^{\text {f }}$ | Transition Frequency | $V_{\text {CE }}=20 \mathrm{~V}$, $\mathrm{IC}=10 \mathrm{~mA}$, | See Note 4 | 250 |  | 300 |  | MHz |
| Cobo | Common-B ase Open-Circuit Output Capacitance | $V_{C B}=5 \mathrm{~V}, \quad I_{E}=0$, | $f=100 \mathrm{kHz}$ |  | 4 |  | 4 | pF |
| Cibo | Common-B ase Open-Circuit Input Capacitance | $V_{E B}=0.5 \mathrm{~V}, \mathrm{I}^{\prime}=0$, | $f=100 \mathrm{kHz}$ |  | 8 |  | 8 | pF |

NOTES: 3. These parameters must be measured using pulse techniques. $t_{w}=\mathbf{3 0 0} \mu \mathrm{s}$, duty cycle $<\mathbf{2 \%}$.
4. To obtain $f_{T}$, the $h_{f e}$ l response is extrapolated at the rate of -6 dB per octave from $\mathrm{f}=100 \mathrm{MHz}$ to the frequency at which $h_{f 9} \mid=$ ?
*operating characteristics at $\mathbf{2 5}{ }^{\circ} \mathrm{C}$ free-air temperature

| PARAMETER |  | TEST CONDITIONS | $\begin{gathered} \text { 2N4123 } \\ \text { A5T4123 } \\ \hline \end{gathered}$ |  | $\begin{gathered} \hline \text { 2N4124 } \\ \text { A5T4124 } \end{gathered}$ |  | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | MIN | MAX | MIN | MAX |  |
| $\overline{\mathbf{N F}}$ | Averege Noise Figure |  | $\begin{array}{ll} V_{C E}=5 \mathrm{~V}, & I_{C}=100 \mu \mathrm{~A}, \\ R_{G}=1 \mathrm{k} \Omega, & \text { Noise Bandwidth }=15.7 \mathrm{kHz}, \\ \text { See Note } 5 \end{array}$ |  | 6 |  | 5 | dB |

NOTE 5: Average noise figure is messured in on amplifier with response down 3 dB at 10 Hz and 10 kHz and a high-frequency rolloff of $6 \mathrm{~dB} / \mathrm{octave}$.
*The asterisk identifies JEDEC registered data for the 2N4123 and 2N4124 only.
switching characteristics at $\mathbf{2 5}{ }^{\mathbf{}} \mathbf{C}$ free-air temperature

|  | PARAMETER | TEST CONDITIONS ${ }^{\text { }}$ | TYP | UNIT |
| :---: | :---: | :---: | :---: | :---: |
| $t_{d}$ | Delay Time |  | 14 | ns |
| $t_{r}$ | Rise Time | $R_{L}=275 \Omega$, See Figure 1 | 8 | ns |
| $t_{3}$ | Storage Time | $\mathrm{I}^{\prime}=10 \mathrm{~mA}, \mathrm{I}_{\mathrm{B}(1)}=1 \mathrm{~mA}, \mathrm{I}_{\mathrm{B}(2)}=-1 \mathrm{~mA}$, | 22 | ns |
| ${ }_{4}$ | Fall Time' | $R_{L}=275 \Omega$, See Figure 2 | 10 | ns |

$\dagger$ Voltage and current values shown are nominal; exact values vary silghtly with transistor paremeters. Nominal base current for delay and rise times is calculated using the minimum value of $V_{\mathbf{g E}}$. Nominal base currents for storage and fall times are calculated using the maximum value of $V_{\mathrm{BE}}$.

## PARAMETER MEASUREMENT INFORMATION


figure 1-delay and rise times


TEST CARCUIT


VOLTAGE WAVEFORMS

FIGURE 2-STORAGE AND FALL TIMES

NOTES: 2. The input woveforme are supplled by a penerator with the following charactaristics: $\mathbf{z}_{\text {out }}=\mathbf{8 0} \Omega$, duty eycle $=\mathbf{2 \%}$.
b. Waveforms are monitored on an oncilioscope with the following characteristics: $\mathrm{t}_{\mathrm{r}}<1 \mathrm{~ms}, \mathrm{R}_{\mathrm{In}}=10 \mathrm{M} \Omega, \mathrm{C}_{\mathrm{in}}<4 \mathrm{pF}$.

## SILECT TRANSISTORS $\ddagger$ <br> FOR GENERAL PURPOSE SATURATED-SWITCHING AND AMPLIFIER APPLICATIONS

- For Complementary Use with N.P.N Types 2N4123, 2N4124, A5T4123, and A5T4124
- Rugged One-Piece Construction with In-Line Leads or Standard TO-18 100-mil Pin-Circle Configuration


## mechanical data

These transistors are encapsulated in a plastic compound specifically designed for this purpose, using a highly mechanized process developed by Texas Instruments. The case will withstand soldering temperatures without deformation. These devices exhibit stable characteristics under high-humidity conditions and are capable of meeting MIL-STD-202C, Method 106B. The transistors are insensitive to light.

absolute maximum ratings at $25^{\circ} \mathrm{C}$ free-air temparature (unless otherwise noted)

|  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  |  |
|  |  |  |  |  |  |
|  |  |  |  |  |  |
|  |  |  |  |  |  |

## Storage Temperature Range

Lead Temperature $\mathbf{1 / 1 6}$ Inch from Case for 60 Seconds


NOTES: 1. Thase values apply batween $10 \mu \mathrm{~A}$ and 200 mA collector currant when the base-emitter diode is open-clrcuited
2. Derste the $625-\mathrm{mW}$ rating Hnearly to $150^{\circ} \mathrm{C}$ free-air temperature at the rate of $\mathrm{EmW} /^{\circ} \mathrm{C}$. Derate the $310-\mathrm{mW}$ (JEDEC registered) rating linesply to $138^{\circ} \mathrm{C}$ free-air temperature at the rate of $2.81 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$.
*The asteriak identifies JEDEC registered data for the 2 N 4128 and 2 N 4126 only. This data aheat contalns all applleable registered data in offect at the time of publication.
$\dagger$ Trademark of Texae Instrumenta.
$\ddagger$ U.S. Patent No. 3,439,238.
USES CHIP P15
8 Toxas instrumenta guarantees these values in addition to the JEDEC regletered values which are also shown.

## TYPES 2N4125, 2N4126, A5T4125, A5T4126 P-N-P SILICON TRANSISTORS

## *electrical characteristics at $25^{\circ} \mathrm{C}$ free-air temperature



NOTES: 3. These parameters must be measured using pulse techniques. $t_{w}=300 \mu$, dury cycle $<\mathbf{2 \%}$.
4. To obtain $f_{T}$, the $h_{h_{f}} \mid$ response is extrpolated at the rate of -6 dB per octave from $f$ $h_{f_{e}}=1$.
*operating characteristics at $25^{\circ} \mathrm{C}$ free-air temperature

| PARAMETER |  | TEST CONDITIONS | $\begin{gathered} \text { 2N4125 } \\ \text { A5T4125 } \end{gathered}$ |  | 2N4126 A5T4126 |  | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | MIN | MAX | Min | MAX |  |
| $\overline{N F}$ | Average Noise Figure |  | $\begin{array}{ll} V_{C E}=-5 \mathrm{~V}, & \mathrm{I}_{\mathrm{C}}=-100 \mu \mathrm{~A}, \\ R_{\mathrm{G}}=1 \mathrm{k} \Omega, & \text { Noise B andwidth }=15.7 \mathrm{kHz}, \end{array}$ <br> See Note 5 |  | 5 |  | 4 | dB |

NOTE 5: Average Noise Figure is measured in an amplifier with response down 3 dB at 10 Hz and 10 kHz and a high-frequency rolloff of 6

- The asterisk identifies JEDEC registerad date for the 2N4125 and 2N4126 only.
switching characteristics at $25^{\circ} \mathrm{C}$ free-air temperature

| PARAMETER | TEST CONDITIONS ${ }^{\text {f }}$ | TYP | UNIT |
| :---: | :---: | :---: | :---: |
| $\mathrm{t}_{\mathrm{d}}$ Delay Time | $\begin{array}{ll} \mathrm{I}_{\mathrm{C}}=-10 \mathrm{~mA}, & \mathrm{I}_{\mathrm{B}(1)}=-1 \mathrm{~mA}, \mathrm{~V}_{\mathrm{BE}}(\text { off })=0.5 \mathrm{~V}, \\ R_{\mathrm{L}}=275 \Omega, & \text { See Figure } 1 \end{array}$ | 13 | ns |
| $\mathrm{t}_{\mathrm{r}} \quad$ Rise Time |  | 13 | ns |
| $t_{\text {s }} \quad$ Storage Time | $\begin{array}{ll} \mathrm{I}_{\mathrm{C}}=-10 \mathrm{~mA}, & \mathrm{I}_{\mathrm{B}(1)}=-1 \mathrm{~mA}, \mathrm{I}_{\mathrm{B}(2)}=1 \mathrm{~mA}, \\ \mathrm{R}_{\mathrm{L}}=275 \Omega, & \text { See Figure } 2 \end{array}$ | 60 | ns |
| $\mathrm{t}_{\mathrm{f}} \quad$ Fall Time |  | 22 | ns |

[^88]
## PARAMETER MEASUREMENT INFORMATION



TEST CIRCUIT


VOLTAGE WAVEFORMS

FIGURE 1-DELAY AND RISE TIMES



VOLTAGE WAVEFORMS

FIGURE 2-STORAGE AND FALL TIMES

NOTES: a. The input waveforms are supplied by a generator with the following characteristics: $\mathbf{Z}_{\text {out }}=\mathbf{5 0} \Omega 2$, duty cycle $=\mathbf{2 \%}$.
b. Waveforms are monitored on an oscilloscope with the following characteristics: $t_{r} \leqslant 1 \mathrm{~ns}, \mathrm{R}_{\mathrm{in}}=10 \mathrm{MS}, \mathrm{C}_{\mathrm{in}} \leqslant 4 \mathrm{pF}$.

## FOR LOW-LEVEL, HIGH-SPEED CHOPPER APPLICATIONS IN INVERTED CONNECTION

- Low Offset Voltage... 0.4 mV Max (2N2432A)
- Low Ita... 2 nA Max
- High Reted Vico for Inverted Connection


## ALSO USEFUL FOR LOW-LEVEL AMPLIFER APPLICATIONS <br> - $h_{\text {fe }} \ldots 30$ Min at $10 \mu A$

*mechanical defa

tII guranoted minimum. The JEDEC registored minimum lead diameter for the T0-46 is 0.012 .
*absolute maximum ratings at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)


WOTES: 1. This value applles betwoen 0 and 10 mA collecter current when the amilier-bose diode is open-cirecuited.
2. This valve applias between 0 and $100 \mu \mathrm{~h}$ amitter current when the coilector-bese diode is epen-circuited.
3. Derate linsarly to $175^{\circ} \mathrm{C}$ free-air tamperature at the rate of $2 \mathrm{~mW} / \mathrm{dey}$.
4. Derate lineerly to $175^{\circ} \mathrm{C}$ case temperature al the rate of $4 \mathrm{~mW} / \mathrm{deg}$.
*Indicates JEDEC reglistored data.
*electrical characteristics at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

| PARAMETER |  | TEST CONDITIONS |  | $\begin{array}{\|l\|} \hline \text { 2N2432 } \\ \text { 2N4138 } \\ \hline \text { M1N MAX } \\ \hline \end{array}$ | $\begin{array}{\|l\|} \hline \text { 2N2432A } \\ \hline \text { MINMAX } \\ \hline \end{array}$ | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| $V_{\text {(Br) }}$ | Collector-Base Breakdown Voltage | $\mathrm{I}_{\mathrm{C}}=100 \mu{\mathrm{~A}, \mathrm{I}_{\mathrm{E}}=0}$ |  | 30 | 45 | V |
|  | Collector-Emitter Breakdown Voltage | $\mathrm{I}_{\mathrm{c}}=10 \mathrm{~mA}, \mathrm{I}_{\mathrm{B}}=0$, | See Note 5 | 30 | 45 | V |
| $V_{\text {(R)RIECO }}$ | Emitter-Collector Breakdown Yoltage | $\mathrm{I}_{\mathrm{E}}=100 \mu \mathrm{~A}, \mathrm{I}_{\mathrm{E}}=0$ |  | 15 | 18 | $V$ |
| Icmo | Collector Cutoff Current | $\mathrm{V}_{\mathrm{CB}}=25 \mathrm{~V}, \mathrm{I}_{\mathrm{E}}=0$ |  | 10 |  | nA |
|  |  | $V_{C E}=40 \mathrm{~V}, \mathrm{I}_{\mathrm{E}}=0$ |  |  | 10 | nA |
| Ices | Collector Cutoff Current | $V_{C E}=25 \mathrm{~V}, V_{\text {VE }}=0$ |  | 10 |  | nA |
|  |  | $V_{\text {CE }}=25 \mathrm{~V}, \mathrm{~V}_{\text {EE }}=0$, | $\mathrm{T}_{\mathrm{A}}=125^{\circ} \mathrm{C}$ | 250 |  | nA |
|  |  | $V_{\text {CE }}=40 \mathrm{~V}, \mathrm{~V}_{\text {BE }}=0$ |  |  | 10 | nA |
|  |  | $\mathrm{V}_{\mathrm{CE}}=40 \mathrm{~V}, \mathrm{~V}_{\mathrm{EE}}=0$, | $\mathrm{T}_{\mathbf{A}}=125^{\circ} \mathrm{C}$ |  | 250 | nA |
| $\mathrm{I}_{\text {EMO }}$ | Emitter Cutoff Currenf | $V_{E B}=15 \mathrm{~V}, \mathrm{I}_{\mathrm{C}}=0$ |  | 2 | 2 | nA |
| IEcS | Emitter Cutoff Current | $V_{E C}=15 \mathrm{~V}, V_{B C}=0$ |  | 2 | 2 | nA |
|  |  | $V_{\text {EC }}=15 \mathrm{~V}, V_{\text {BC }}=0$, | $\mathrm{T}_{\mathrm{A}}=125^{\circ} \mathrm{C}$ | 200 | 200 | nA |
| $h_{\text {fre }}$ | Static Forward Current Iransfer Ratio | $\mathrm{V}_{\text {CE }}=5 \mathrm{~V}, \quad \mathrm{I}_{\mathrm{C}}=10 \mu \mathrm{~A}$ |  | 30 | 30 |  |
|  |  | $\mathrm{V}_{\mathrm{CE}}=5 \mathrm{~V}, \quad \mathrm{I}_{\mathrm{C}}=1 \mathrm{~mA}$ |  | 50 | 50 |  |
| $h_{\text {felinim }}$ | Static Forward Current Tromsfer Ratio (Inverted Connection) | $\mathrm{V}_{\mathrm{EC}}=5 \mathrm{~V}, \quad \mathrm{I}_{\mathrm{E}}=0.2 \mathrm{~mA}$ |  | 2 | 3 |  |
| $V_{\text {cetart }}$ | Collector-Emitter Saturation Voltage | $\mathrm{I}_{\mathrm{B}}=0.5 \mathrm{~mA}, \mathrm{I}_{\mathrm{C}}=10 \mathrm{~mA}$ |  | 0.15 | 0.15 | $v$ |
| $V_{\text {ECloti) }}$ | Oftset Voltage (Inverted Connection) | $\mathrm{I}_{\mathrm{B}}=200 \mu \mathrm{~A}, \mathrm{I}_{\mathrm{E}}=0$, | See figure I | 0.5 | 0.4 | m V |
|  |  | $\mathrm{I}_{\mathrm{E}}=1 \mathrm{~mA}, \quad \mathrm{l}_{\mathrm{E}}=0$, | See Figure 1 | 1 | 0.7 | mV |
| ${ }^{5} \mathrm{c}$ (en) | Small-Signal Emitter-Collector On-Stote Resistance | $\begin{array}{ll} \mathrm{I}_{\mathrm{B}}=1 \mathrm{~mA}, & \begin{array}{l} \mathrm{I}_{\mathrm{E}}=0 \\ \mathrm{f}=1 \mathrm{kHz}, \end{array} \end{array}$ | $T_{0}=100 \mu \mathrm{~A},$ <br> See figure 2 | 20 | 15 | $\Omega$ |
| \| $h_{\text {fol }}$ \| | Small-Signal Common-Emitter Forward Current Trunsfer Ratio | $\mathrm{V}_{\text {CE }}=5 \mathrm{~V}, \quad \mathrm{I}_{\mathrm{C}}=1 \mathrm{~mA}$, | $f=20 \mathrm{mHz}$ | 1 | 1 |  |
| $\mathrm{Cbob}^{\text {c }}$ | Common-Base Open-Circuit Output Capacitance | $V_{C E}=0, \quad l_{E}=0$, | $f=140 \mathrm{kHz}$ | 12 | 12 | pF |
| $C_{c b}$ | Collector-Base Caporitance | $V_{C E}=0, \quad i_{E}=0$, | $f=1 \mathrm{mHz}$ <br> See Note 6 | 12 | 12 | pF |
| $\mathrm{c}_{\mathrm{ibo}}$ | Common-Bose Open-Circuit Input Capocitonce | $V_{E E}=0, \quad I_{C}=0$, | $\mathrm{f}=140 \mathrm{kHz}$ | 12 | 12 | pF |
| Cbb | Emitter-Base Capacitance | $V_{E B}=0, \quad I_{C}=0$, | $f=1 \text { MHz, }$ <br> See Note 6 | 12 | 12 | pF |

WOTES: 5. This paramoter must be measured using pulse techniques. ${ }^{t} p=300 \mu 5$, duty cycle $\leq 2 \%$.
6. $C_{c b}$ and $C_{a b}$ are measured using thres-terminal measurement techniques with the third electrode (emitter or collector respectively) guarded.

## PARAMETER MEASUREMENT INFORMATION



FIGURE 1
measurement circuit for offset voltage


FIGURE 2
MEASUREMENT CIRCUIT FOR EMITTER-
COLLECTOR ON-STATE RESISTANCE

MOTE a: The volimeler must have high enough impedance that halving the value of the volimeler impedance does not change the measured value. -Indicates JEDEC registered defa.

## N-CHANNEL FIELD-EFFECT TRANSISTORS

- Designed for General Purpose Amplifier and Switching Applications
- Low IGSS . . . 100 pA Max
- Low Input Capacitance . . . 6 pF Max
- High ${ }^{\text {ffs }}$ $/ / \mathbf{C}_{\text {iss }}$ Ratio
*mechanical data

*absolute maximum ratings at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)
Drain-Gate Voltage ..... 30 V
Drain-Source Voltage ..... 30 V
Reverse Gate-Source Voltage ..... $-30 \mathrm{~V}$
Continuous Forward Gate Current ..... 10 mA
Continuous Drain Current ..... 15 mA
Continuous Device Dissipation at (or below) $25^{\circ} \mathrm{C}$ Free-Air Temperature (See Note 1 ) ..... 300 mW
Storage Temperature Range ..... $-65^{\circ} \mathrm{C}$ to $200^{\circ} \mathrm{C}$
Lead Temperature $1 / 16$ Inch from Case for 10 Seconds ..... $300^{\circ} \mathrm{C}$

NOTE 1: Derate linearly to $175^{\circ} \mathrm{C}$ free-air temperature at the rate of $2 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$.
*JEDEC registered data. This data sheet contains all applicable registered data in effect at the time of publication.
electrical characteristics at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

| PARAMETER |  | TEST CONDITIONS ${ }^{\dagger}$ | $\begin{aligned} & \text { 2N4220 } \\ & \text { 2N4220A } \end{aligned}$ | $\begin{gathered} \text { 2N4221 } \\ \text { 2N4221A } \end{gathered}$ | $\begin{gathered} \text { 2N4222 } \\ \text { 2N4222A } \end{gathered}$ | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | MIN MAX | MIN MAX | MIN MAX |  |
| $V_{\text {(BR)GSS }}$ | Gate-Source Breakdown Voltage |  | $\mathrm{I}_{\mathbf{G}}=10 \mu \mathrm{~A}, \quad V_{\text {DS }}=0$ | $-30^{*}$ | $-30^{*}$ | $-3{ }^{*}$ | V |
| IGSS | Gate Reverse Current | $V_{\text {GS }}=-15 \mathrm{~V}, \mathrm{~V}_{\text {DS }}=0$ | -0.1* | -0.1* | -0.1* | nA |
|  |  | $\begin{aligned} & V_{G S}=-15 \mathrm{~V}, V_{D S}=0, \\ & T_{A}=150^{\circ} \mathrm{C} \end{aligned}$ | -0.1* | -0.1* | -0.1* | $\mu \mathrm{A}$ |
| VGS(off) | Gate-Source Cutoff Voitage | $V_{\text {DS }}=15 \mathrm{~V}, \quad I_{D}=0.1 \mathrm{nA}$ | -4* | $-6^{*}$ | $-8^{*}$ | V |
| $V_{\text {GS }}$ | Gate-Source Voltage | $V_{\text {DS }}=15 \mathrm{~V}, \quad \mathrm{I}_{\mathrm{D}}=50 \mu \mathrm{~A}$ | -0.5* $-2.5^{*}$ |  |  | V |
|  |  | $V_{D S}=15 \mathrm{~V}, I_{D}=200 \mu \mathrm{~A}$ |  | $-1^{* *}-5^{*}$ |  |  |
|  |  | $V_{D S}=15 \mathrm{~V}, \mathrm{I}_{\mathrm{D}}=500 \mu \mathrm{~A}$ |  |  | -2* -6* |  |
| IDSS | Zero-Gate-Voltage Drain Current | $\begin{array}{ll} V_{D S}=15 V, & V_{G S}=0, \\ \text { See Note } 2 & \\ \end{array}$ | 0.5* 3* | 2* 6* | 5* 15* | mA |
| $\left\|y_{f s}\right\|$ | Smail-Signal Common-Source <br> Forward Transfer Admittance | $\begin{array}{ll} V_{D S}=15 \mathrm{~V}, & V_{G S}=0 \\ f=1 \mathrm{kHz}, & \text { See Note } 2 \end{array}$ | 1* 4* | 2* 5* | 2.5* 6* | mmho |
| \|Yos $\mid$ | Small-Signal Common-Source Output Admittance |  | 10* | 20* | 40* | $\mu \mathrm{mho}$ |
| $C_{\text {iss }}$ | Common-Source Short-Circuit Input Capacitance | $V_{\text {DS }}=15 \mathrm{~V}, \quad V_{G S}=0$, | 6* | 6* | $6^{*}$ | pF |
| $\mathrm{C}_{\text {rss }}$ | Common-Source Short-Circuit Reverse Transfer Capacitance |  | 2* | 2* | 2* | pF |
| $\left\|y_{\text {fs }}\right\|$ | SmallSignal Common-Source Forwerd Transfer Admittance | $\begin{array}{ll} V_{D S}=15 V, & V_{G S}=0, \\ f=100 \mathrm{MHz} \end{array}$ | 0.75* | $\begin{array}{r} 1.5 \S \\ 0.75^{*} \\ \hline \end{array}$ | $\begin{array}{r} 28 \\ 0.75^{*} \end{array}$ | mmho |

operating characteristics at $25^{\circ} \mathrm{C}$ free-air temperature

| PARAMETER |  | TEST CONDITIONs ${ }^{\dagger}$ | $\begin{aligned} & \text { 2N4220A } \\ & \text { 2N4221A } \\ & \text { 2N4222A } \end{aligned}$ |  | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | MIN | MAX |  |
| NF | Common-Source Spot Noise Figure |  | $V_{D S}=15 \mathrm{~V}, \mathrm{~V}_{G S}=0, f=100 \mathrm{~Hz}, \mathrm{R}_{\mathrm{G}}=1 \mathrm{M} \Omega$ |  | 2.5* | dB |

NOTE 2: These parameters must be measured using pulse techniques. $t_{\mathbf{w}}=100 \mathrm{~ms}$, duty cycle $\leqslant 10 \%$.
${ }^{\dagger}$ The fourth lead (case) is connected to the source for all measurements.

- JEDEC registered data
§Texas instruments guarantees these values in addition to the JEDEC registered values which are also shown.


## FOR VHF AMPLIFIER AND MIXER APPLICATIONS

- Low $\mathrm{C}_{\text {rss }}$. . . 2 pF Max
- High $\mid y_{f s} / C_{\text {iss }}$ Ratio (High-Frequency Figure-of-Merit)
- Cross Modulation Minimized by Square-Law Transfer Characteristic
- Low Noise Figure . . . 5 dB Max at 200 MHz
*mechanical data

*absolute maximum ratings at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)


NOTE 1: Derate linearly to $175^{\circ} \mathrm{C}$ free-alf temperazure at the rate of $2 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$.
"JEDEC registered data. This data shear contains all applicable regletered data in effect at the time of publication.

# TYPES 2N4223, 2 N4224 N-CHANNEL SILICON JUNCTION FIELD-EFFECT TRANSISTORS 

*electrical characteristics at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

| PARAMETER |  | TEST CONDITIONE ${ }^{\dagger}$ |  |  | 2N4223 |  | 2 N 4224 |  | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | MIN | MAX | MIN | MAX |  |
| $V_{\text {(BR) }}$ GSS | Gate-Source Breakdown Voltage |  |  |  | $1 G^{-10}-10$ A | $V_{0 S}=0$ |  | -30 |  | -30 |  | V |
| IGSS | Gate Reverse Current | $V_{G S}=-20 \mathrm{~V}$ | $V_{D S}=0$ |  |  | -0.25 |  | -0.5 | nA |
|  |  | $V_{\text {GS }}=-20 \mathrm{~V}$ | $V_{D S}=0$, | $T_{A}=100^{\circ} \mathrm{C}$ |  | -0.25 |  | -0.5 | $\mu \mathrm{A}$ |
| VGS(off) | Gate-Source Cutoff Voltage | $V_{D S}=15 \mathrm{~V}$, | $10=0.25$ |  | -1.2 | -8 |  |  | V |
|  |  | $V_{D S}=16 \mathrm{~V}$, | $1 \mathrm{D}=0.5 \mathrm{nA}$ |  |  |  | -1.2 | -8 |  |
| VGS | Gatt-Source Voltege | $V_{D S}=15 \mathrm{~V}$, | $1 \mathrm{D}=0.3 \mathrm{~m}$ |  | -1 | -7 |  |  | $V$ |
|  |  | $V_{D S}=15 \mathrm{~V}$ | $I_{D}=0.2 \mathrm{~m}$ |  |  |  | -1 | -7.6 |  |
| IDSS | Zero-Gate-Voltage Drain Current | $V_{D S}=15 \mathrm{~V}$, | $V_{\text {GS }}=0$, | See Note 2 | 3 | 18 | 2 | 20 | mA |
| \|Vfs ${ }^{\text {c }}$ | Small-Signal Common-Source Forward Transfer Admittance | $\begin{aligned} & V_{D S}=16 \mathrm{~V} \\ & \text { See Note } 2 \end{aligned}$ | $V_{G S}=0,$ | $f=1 \mathrm{kHz},$ | 3 | 7 | 2 | 7.6 | mmho |
| $C_{\text {iss }}$ | Common-Source Short-Circuit Input Capacitance | $V_{D S}=15 \mathrm{~V}$, | $V_{G S}=0$, | $f=1 \mathrm{MHz}$ | 6 |  | 6 |  | DF |
| $C_{\text {rss }}$ | Common-Source Short-Circuit Reverse Transfer Capacitance |  |  |  |  | 2 |  | 2 | pF |
| Gis | Small-Signal Common-Source Input Conductance | $V_{D S}=15 \mathrm{~V},$ <br> See Note 2 | $V_{G S}=0$, | $f=200 \mathrm{MHz}$, |  | 800 |  | 800 | $\mu \mathrm{mho}$ |
| \|Vfs $\mid$ | Small-Signal Common-Source Forwerd Transfer Admittance |  |  |  | 2.7 |  | 1.7 |  | mmho |
| 908 | Small-Signal Common-Source Output Conductance |  |  |  |  | 200 |  | 200 | $\mu \mathrm{mho}$ |

*operating characteristics at $25^{\circ} \mathrm{C}$ free-air temperature

| PARAMETER |  | TEST CONDITIONS ${ }^{\dagger}$ |  |  | 2N4223 |  | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | MIN | MAX |  |
| $F$ | Common-Source Spot Noise Figure |  |  |  | $\begin{aligned} & V_{D S}=15 \mathrm{~V}, \\ & R_{G^{\prime}}=1 \mathrm{k} \Omega \end{aligned}$ | $V_{G S}=0,$ <br> Ses Figure 1 | $f=200 \mathrm{MHz}$ |  | 5 | dB |
| $\mathrm{G}_{\mathrm{ps}}$ | Small-Signal Common-Source Insertion Power Gain | $\begin{aligned} & \text { VDS }=15 \mathrm{~V}, \\ & \text { See Figure } 1 \end{aligned}$ | $V_{G S}=0,$ | $\mathrm{f}=200 \mathrm{MHz},$ | 10 |  | d8 |

NOTE 2: These parameters must be measured using pulse techniques. $t_{w} \leqslant \mathbf{6 3 0} \mathbf{~ m s}$, duty cycle $<\mathbf{1 0 \%}$.
${ }^{\dagger}$ The fourth leed (case) is connected to the source for all measurements.

- JEDEC reglatered data


FIGURE 1-NOISE FIGURE AND POWER GAIN TEST CIRCUIT
NOTE 3: Transformad equivalent source resistance ( $R_{G}^{\prime}$ ) is $1 \mathrm{k} \Omega$ at $\mathbf{2 0 0} \mathbf{M H z}$.

# SILECT ${ }^{\dagger}$ TRANSISTORS $\ddagger$ FOR LOW-LEVEL, LOW-NOISE AMPLIFIER APPLICATIONS 

- hfe Guaranteed at $\mathbf{1 0 0} \mu \mathrm{A}$
- Low Noise Figure . . . 2 dB Max (A5T4250)
- Plug-In Replacements for 2N4248, 2N4249, 2N4250 (TO-106)
mechanical data
These transistors are encapsulated in a plastic compound specifically designed for this purpose, using a highly mechanized process developed by Texas Instruments. The case will withstand soldering temperatures without deformation. These devices exhibit stable characteristics under high-humidity conditions and are capable of meeting MIL-STD-202C, Method 106B. The transistors are insensitive to light.

absolute maximum ratings at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)


NOTES: 1. These values apply when the base-emitter diode is open-clrcuited.
2. Derate Unearly to $150^{\circ} \mathrm{C}$ free-air temperature at the rate of $5 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$.

[^89]USES CHIP P18

## TYPES A5T4248, A5T4249, A5T4250 P-N-P SILICON TRANSISTORS

## electrical characteristics at $25^{\circ} \mathrm{C}$ free-air temperature

| PARAMETER |  | TEST CONDITIONS | A5T4248 |  | A5T4249 |  | A5T4250 |  | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | MIN | MAX | MIN | MAX | MIN | MAX |  |
| $V_{\text {(BR)CEO }}$ | Collector-Emitter Breakdown Voltage |  | $I_{C}=-5 \mathrm{~mA}, \quad I_{B}=0,$ <br> See Note 3 | -40 |  | -60 |  | -40 |  | V |
| $V_{\text {(BR) }}$ CES | Collector-Emitter Breakdown Voltage | ${ }^{1} C=-10 \mu A, \quad V_{B E}=0$ | -40 |  | -60 |  | -40 |  | $\checkmark$ |
| $V_{\text {(BR)EBO }}$ | Emitter-Base Breakdown Voltage | $\mathrm{I}_{\mathrm{E}}=-10 \mu \mathrm{~A}, \quad \mathrm{I}_{\mathrm{C}}=0$ | -5 |  | -5 |  | -5 |  | V |
| ${ }^{\prime} \mathrm{CBO}$ | Collector Cutoff Current | $V_{C B}=-40 \mathrm{~V}, \mathrm{IE}^{\prime}=0$ |  | -10 |  | -10 |  | $-10$ | nA |
| ${ }_{\text {t EBO }}$ | Emitter Cutoff Current | $\mathrm{VEB}=-3 \mathrm{~V}, \mathrm{I}^{\text {c }}=0$ |  | -20 |  | -20 |  | -20 | nA |
| hFE | Static Forward Current Transfer Ratio | $V_{C E}=-5 \mathrm{~V}, \quad \mathrm{I}^{\text {C }}=-100 \mu \mathrm{~A}$ | 50 |  | 100 | 300 | 250 | 700 |  |
|  |  | $V_{C E}=-5 \mathrm{~V}, \quad \mathrm{I}^{\prime}=-1 \mathrm{~mA}$ | 50 |  | 100 |  | 250 |  |  |
|  |  | $V_{C E}=-5 V, \quad I_{C}=-10 \mathrm{~mA},$ <br> See Note 3 | 50 |  | 100 |  | 250 |  |  |
| VBE | Base-Emitter Voltage | $I_{B}=-0.5 \mathrm{~mA}, \quad I_{C}=-10 \mathrm{~mA},$ <br> See Note 3 |  | -0.9 |  | -0.9 |  | -0.9 | V |
| VCE(sat) | Collector-Emitter Saturation Voltage | $I_{B}=-0.5 \mathrm{~mA}, \quad I_{C}=-10 \mathrm{~mA},$ <br> See Note 3 |  | -0.25 |  | -0.25 |  | -0.25 | V |
| $h_{\text {ie }}$ | Small-Signal Common-Emitter Input Impedance | $\begin{aligned} & V_{C E}=-5 \mathrm{~V}, \quad \mathrm{I} \mathrm{C}=-1 \mathrm{~mA}, \\ & \mathrm{f}=1 \mathrm{kHz} \end{aligned}$ |  |  | 2.5 | 17 | 6 | 20 | k $\Omega$ |
| $h_{\text {fe }}$ | Small-Signal Common-Emitter Forward Current Transfer Ratio |  | 50 | 1000 | 100 | 550 | 250 | 800 |  |
| $\mathrm{hre}_{\text {re }}$ | Small-Signal Common-Emitter Reverse Voltage Transfer Ratio |  |  |  |  | $\begin{array}{r} 10 x \\ 10^{-4} \end{array}$ |  | $\begin{array}{r} 10 x \\ 10^{-4} \end{array}$ |  |
| $\mathrm{h}_{\mathbf{o e}}$ | Small-Signal Common-Emitter Output Admittance |  |  |  | 5 | 40 | 5 | 50 | $\mu \mathrm{mho}$ |
| $\mathbf{l h}_{\text {fe }}{ }^{\text {l }}$ | Small-Signal Common-Emitter Forward Current Transfer Ratio | $\begin{aligned} & V_{C E}=-5 \mathrm{~V}, \quad \mathrm{I}_{\mathrm{C}}=-0.5 \mathrm{~mA}, \\ & \mathrm{f}=20 \mathrm{MHz} \end{aligned}$ | 2 |  | 2 |  | 2.5 |  |  |
| Cobo | Common-Base Open-Circuit Output Capacitance | $\begin{aligned} & V_{C B}=-5 \mathrm{~V}, \\ & \mathrm{f}=1 \mathrm{MHz}=0, \end{aligned}$ |  | 6 |  | 6 |  | 6 | pF |
| $\mathrm{C}_{\text {ibo }}$ | Common-Base Open-Circuit Input Capacitance | $\begin{aligned} & V_{E B}=-0.5 \mathrm{~V}, \mathrm{I} C=0, \\ & \mathrm{f}=1 \mathrm{MHz} \end{aligned}$ |  | 16 |  | 16 |  | 16 | pF |

operating characteristics at $25^{\circ} \mathrm{C}$ free-air temperature

| PARAMETER |  | TEST CONDITIONS | A5T4248 |  | A5T4249 |  | A5T4250 |  | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | MIN | MAX | MIN | MAX | MIN | MAX |  |
| F | Spat Noise Figure |  | $\begin{array}{ll} V_{C E}=-5 \mathrm{~V}, & I_{C}=-20 \mu \mathrm{~A} \\ \mathrm{R}_{\mathrm{G}}=10 \mathrm{k} \Omega, & f=1 \mathrm{kHz} \end{array}$ |  |  |  | 3 |  | 2 | dB |
|  | Spot Noise Figure | $\begin{array}{ll} V_{C E}=-5 \mathrm{~V}, & \mathrm{I} C=-250 \mu \mathrm{~A}, \\ \mathrm{R}_{\mathrm{G}}=1 \mathrm{k} \Omega, & f=1 \mathrm{kHz} \end{array}$ |  |  |  | 3 |  | 2 |  |  |
| F | Average Noise Figure | $\begin{aligned} & V_{C E}=-5 \mathrm{~V}, \quad I_{C}=-20 \mu \mathrm{~A}, \\ & R_{\mathrm{G}}=10 \mathrm{k} \Omega, \\ & \text { Noise Bandwidth }=15.7 \mathrm{kHz}, \\ & \text { See Note } 4 \end{aligned}$ |  |  |  | 3 |  | 2 | dB |  |

NOTES: 3. These parameters must be measured using pulse techniques. $\mathrm{t}_{\mathrm{w}}=300 \mu \mathrm{~s}$, duty cycle $\leq 2 \%$.
4. Average Noise Figure is measured in an amplifier with response down 3 dB at 10 Hz and 10 kHz and a high-frequency roll-off of
NOTES: 3. These parameters must be measured using pulse techniques. $\mathrm{t}_{\mathrm{w}}=300 \mu \mathrm{~s}$, duty cycle $\leqslant \mathbf{2 \%}$. 10 kHz and a high-frequency roll-off of
4. Average Noise Figure is measured in an amplifier with response down 3 dB at 10 Hz and 10 kH , $6 \mathrm{~dB} /$ octave.

## HIGH-FREQUENCY TRANSISTORS FOR TUNER AND IF-AMPLIFIER STAGES IN FM AND AM/FM STEREO-MULTIPLEX RECEIVERS

*mechanical data

*absolute maximum ratings at $25^{\circ} \mathrm{C}$ free-air temperature (unless atherwise noted)

$$
\text { Collector-Base Voltage . . . . . . . . . . . . . . . . . . . . . . . . . } 30 \text { V }
$$

Collector-Emitter Voltage (See Note 1) . . . . . . . . . . . . . . . . . . . . 18 V
Emitter-Base Voltage . . . . . . . . . . . . . . . . . . . . . . . . . . 4 V
Continuous Collector Current . . . . . . . . . . . . . . . . . . . . . . 50 mA
Continuous Device Dissipation of (or below) $25^{\circ} \mathrm{C}$ Free-Air Temperature (See Note 2) . . . . 200 mW
Storage Temperature Range . . . . . . . . . . . . . . . . . . . . $-65^{\circ} \mathrm{C}$ to $200^{\circ} \mathrm{C}$
Lead Temperature $1 / 10$ Inch from Case for 10 Seconds . . . . . . . . . . . . . . . $300^{\circ} \mathrm{C}$
*electrical characteristics at $25^{\circ} \mathbf{C}$ free-air semperature (unless otherwise noted)

| PARAMETER | TEST CONDITIONS | 2N4252 |  | 2N4253 |  | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | MIN | MaX | MIN | MAX |  |
| $V_{\text {(Ra) Coo }}$ Collector-Base Breakdown Voltage | $\mathrm{I}_{\mathrm{C}}=10 \mu \mathrm{~A}, \mathrm{I}_{\mathrm{E}}=0$ | 30 |  | 30 |  | $V$ |
| $V_{\text {(ax] ceo }}$ Collector-Emitter Breakdown Voltage | $\mathrm{IC}_{\mathrm{C}}=2 \mathrm{~mA}, \mathrm{I}_{\mathrm{B}}=0, \quad$ See Note 3 | 18 |  | 18 |  | $V$ |
|  | $\mathrm{I}_{\mathrm{E}}=10 \mu \mathrm{~A}, \mathrm{I}_{\mathrm{C}}=0$ | 4 |  | 4 |  | $V$ |
| Coliector Cutoff Current | $V_{C B}=15 V_{1} J_{E}=0$ |  | 50 |  | 50 | ni |
|  | $V_{C B}=15 \mathrm{~V}, \mathrm{I}_{\mathrm{E}}=0, \quad \mathrm{~T}_{\mathrm{A}}=85^{\circ} \mathrm{C}$ |  | 5 |  | 5 | $\mu \mathrm{A}$ |
| here Static Forward Current Transter Ratio | $V_{C E}=10 \mathrm{~V}, I_{C}=2 \mathrm{~mA}$ | 50 |  | 30 | 150 |  |
| \| $h_{t h} \mid$ Small-Signal Common-Emitter <br> Forward Current Transfer Ratio | $V_{\text {CE }}=10 \mathrm{~V}, \mathrm{I}_{\mathrm{C}}=2 \mathrm{~mA}, \quad f=100 \mathrm{mHz}$ | 6 | 14 | 6 | 14 |  |
| Ccb Collector-Base Copacitance | $V_{C t}=10 \mathrm{~V}, \mathrm{l}_{\mathrm{E}}=0, \quad \begin{aligned} & i=1 \\ & \text { See Mole } 4\end{aligned}$ | 0.1 | 0.45 | 0.1 | 0.45 | pf |
| $\mathrm{r}_{\text {cop }}$ Parallel-Equivalent Common-Emitter <br> Short-Circuit Output Resistance | $V_{C E}=10 \mathrm{~V}, \mathrm{I}_{\mathrm{C}}=2 \mathrm{~mA}, f=10 \mathrm{mHz}$ |  |  | 50 |  | k $\boldsymbol{\Omega}$ |
| $\mathrm{I}_{\mathrm{b}} \mathrm{C}_{\mathrm{c}}$ Collector-Base Time Constont | $V_{C I}=10 \mathrm{~V}, \mathrm{I}_{\mathrm{E}}=-2 \mathrm{~mA}, f=79.8 \mathrm{MHz}$ |  | 12 |  | 12 | ps |

MOTES: 1. This value applies when bese-emitter diede is open-circuited.
2. Derale linaarly to $175^{\circ} \mathrm{C}$ free-air temperature at the rats of $1.33 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$.
3. Thase paramaters must be measured using pulse techiniquas. $t_{p}=\mathbf{3 0 0} \mu$, duty cycie $\leq \mathbf{2 \%}$.
4. Cellector-lase Capacitonce is measured using thre-torminal moasurement lechniques with the case and mifitor guarded.
*JEDEC ragisterod data
USES CHIP N16

## DESIGNED FOR VHF AND UHF AMPLIFIER APPLICATIONS

- High fT . . . 2 GHz Min (2N4261)
- Low Capacitances . . 2.5 pF Max $\mathrm{C}_{\mathrm{cb}}$ and $\mathrm{C}_{\mathrm{eb}}$
- Calculated $\mathrm{f}_{\text {max }}{ }^{\dagger} \ldots$. $1.27 \mathrm{GHz} \operatorname{Min}(\mathbf{2 N 4 2 6 1 )}$


## *mechanical data


*absolute maximum ratings at $\mathbf{2 5}{ }^{\circ} \mathbf{C}$ free-air temperature (unless otherwise noted)


NOTES: 1. This value applies between 0 and 30 mA collector current when the base-emitter diode is open-circuited.
2. Derate linearly to $200^{\circ} \mathrm{C}$ free-air temperature at the rate of $1.14 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$.

* JEDEC registered data. This data sheet contains all applicable registered data in effect at the time of publication.
$t_{\text {Maximum }}$ Frequancy of Oscillation may be calculated from the equation: $f_{\text {max }}(\mathrm{MHz})=200 \sqrt{\frac{f_{T}(\mathrm{MHz})}{r_{b} \mathrm{C}_{\mathrm{c}}(\mathrm{ps})}}$


## P-N-P SILICON TRANSISTORS

*electrical characteristics at $\mathbf{2 5} \mathbf{~} \mathbf{C}$ free-air temperature (unless otherwise noted)

| PARAMETER | TEST CONDITIONS | 2N4260 | 2N4261 | UNIT |
| :---: | :---: | :---: | :---: | :---: |
|  |  | MIN MAX | MIN MAX |  |
| $\mathrm{V}_{(B R)}$ CBO Collector-Base Breakdown Voltage | ${ }^{1} C=-10 \mu A, \quad I E=0$ | -15 | -15 | V |
| $V_{\text {(BR)CEO }}$ Collector-Emitter Breakdown Voltage | $I^{\prime} C=-10 \mathrm{~mA}, \quad I_{B}=0, \quad$ See Note 3 | -15 | -15 | $V$ |
| $\mathrm{V}_{\text {(BR)EBO }}$ Emitter-Base Breakdown Voltage | $\mathrm{I}_{\mathrm{E}}=-10 \mu \mathrm{~A}, \quad \mathrm{I}^{\prime} \mathrm{C}=0$ | -4.5 | -4.5 | $V$ |
| Collector Cutoff Current | $\mathrm{V}_{\mathrm{CE}}=-10 \mathrm{~V}, \mathrm{~V}_{\text {BE }}=2 \mathrm{~V}$ | -5 | -5 | nA |
|  | $V_{C E}=-5 \mathrm{~V}, \quad \mathrm{~V}_{\text {BE }}=0.4 \mathrm{~V}$ | $-50$ | -50 | nA |
|  | $V_{C E}=-10 \mathrm{~V}, V_{B E}=2 \mathrm{~V}, \quad \mathrm{~T}_{\mathrm{A}}=150^{\circ} \mathrm{C}$ | -5 | -5 | $\mu \mathrm{A}$ |
| IBEV Base Cutoff Current | $\mathrm{V}_{\mathrm{CE}}=-10 \mathrm{~V}, \mathrm{~V}_{\text {BE }}=2 \mathrm{~V}$ | 5 | 5 | nA |
| Static Forward Current Transfer Ratio | $\mathrm{V}_{C E}=-1 \mathrm{~V}, \quad \mathrm{I}_{\mathrm{C}}=-1 \mathrm{~mA}$ | 25 | 25 |  |
|  | $V_{C E}=-1 \mathrm{~V}, \quad \mathrm{I}_{\mathrm{C}}=-10 \mathrm{~mA}$, See Note 3 | $30 \quad 150$ | $30 \quad 150$ |  |
|  |  | 20 | 20 |  |
| Baso-Emitter Voltage | $\mathrm{V}_{\text {CE }}=-1 \mathrm{~V}, \quad \mathrm{I}^{\prime}=-1 \mathrm{~mA}$ | -0.8 | -0.8 | V |
|  | $\mathrm{V}_{\text {CE }}=-1 \mathrm{~V}, \quad \mathrm{I}_{\mathrm{C}}=-10 \mathrm{~mA}$, See Note 3 | -1 | -1 |  |
| Collector-Emitter Saturation Voltage | $\mathrm{I}_{\mathrm{B}}=-0.1 \mathrm{~mA}, \quad \mathrm{I}_{\mathrm{C}}=-1 \mathrm{~mA}$ | -0.15 | -0.15 | $V$ |
|  | $\mathrm{I}^{1} \mathrm{~B}=-1 \mathrm{~mA}, \quad \mathrm{I}^{2}=-10 \mathrm{~mA}$, See Note 3 | -0.35 | -0.35 |  |
| Small-Signal Common-Emitter Forward Current Transfer Ratio | $V_{C E}=-4 \mathrm{~V}, \quad \mathrm{I}^{\text {C }}=-5 \mathrm{~mA}, \quad f=100 \mathrm{MHz}$ | 12 | 15 |  |
|  | $V_{C E}=-10 \mathrm{~V}, \mathrm{I}^{\prime} \mathrm{C}=-10 \mathrm{~mA}, \quad f=100 \mathrm{MHz}$ | 16 | 20 |  |
| Transition Frequency | $V_{C E}=-4 \mathrm{~V}, \quad \mathrm{I}_{\mathrm{C}}=-5 \mathrm{~mA}$ | 1.2 | 1.5 | GHz |
|  |  | 1.6 | 2 |  |
| Ccbere ${ }_{\text {collector-Base }}$ Capacitance | $\begin{aligned} & V_{C B}=-4 \mathrm{~V}, \quad \mathrm{IE}=0, \\ & \mathrm{f}=100 \mathrm{kHz} \text { to } 1 \mathrm{MHz}, \end{aligned}$ <br> See Note 5 | 2.5 | 2.5 | pF |
| $\mathrm{C}_{\text {eb }} \quad$ Emitter-Base Capacitance | $\begin{aligned} & V_{E B}=-0.5 \mathrm{~V}, \quad \mathrm{I}=0, \\ & \mathrm{f}=100 \mathrm{kHz} \text { to } 1 \mathrm{MHz}, \end{aligned}$ <br> See Note 5 | 2.5 | 2.5 | pF |
| Collector-Base Time Constant | $\mathrm{V}_{\text {CE }}=-4 \mathrm{~V}, \quad \mathrm{IC}^{\text {c }}=-5 \mathrm{~mA}, \quad \mathrm{f}=31.8 \mathrm{MHz}$ | 35 | 60 | ps |
|  | $\mathrm{V}_{\text {CE }}=-10 \mathrm{~V}, \mathrm{I}^{\prime}=-10 \mathrm{~mA}, \quad \mathrm{f}=31.8 \mathrm{MHz}$ | 30 | 50 |  |

NOTES: 3. These parameters must be measured using pulse techniques. $\mathbf{t}_{\mathbf{w}}=\mathbf{3 0 0} \mu \mathrm{s}$, duty cycle $\leq \mathbf{2 \%}$.
4. To obtain ${ }^{f} T$, the $h_{\text {fe }} \mid$ response is extrapolated at the rate of $\mathbf{- 6 ~ d B}$ per octave from $f=100 \mathrm{MHz}$ to the frequency at which $\left|h_{f e}\right|=1$.
5. $\mathrm{C}_{\mathrm{cb}}$ and $\mathrm{C}_{\mathrm{eb}}$ measurements employ a three-terminal capacitance bridge incorporating a guard circuit. The third electrode (emitter or collector, respectively) and the case are connected to the guard terminal of the bridge.

- JEDEC registered data


# SILECT ${ }^{\dagger}$ TRANSISTORS $\ddagger$ DESIGNED FOR VHF AND UHF AMPLIFIER APPLICATIONS 

- High fT . . . 2 GHz Min (A5T4261)
- Low Capacitances . . . 2.5 pF Max $\mathrm{C}_{\mathrm{cb}}$ and $\mathrm{C}_{\mathrm{eb}}$
- Calculated $\mathrm{f}_{\max } \mathrm{E}^{\text {. . . } 1.27 \mathrm{GHz} \text { Min (A5T4261) }}$
mechanical data
These transistors are encapsulated in a plastic compound specifically designed for this purpose, using a highly mechanized process developed by Texas Instruments. The case will withstand soldering temperatures without deformation. These devices exhibit stable characteristics under high-humidity conditions and are capable of meeting MIL-STD-202C, Method 106B. The transistors are insensitive to light.

absolute maximum ratings at $\mathbf{2 5}{ }^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)


NOTES: 1. This value applies between 0 and 30 mA collector current when the base-emitter diode is open-circuited.
2. Derate linearly to $150^{\circ} \mathrm{C}$ free-air temperature at the rate of $4 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$.
${ }^{\dagger}$ Trademark of Texas instruments
$\ddagger$ U.S. Patent No. $3,439,238$
§Maximum Frequancy of Oselliation may be calculated from the equation: $f_{\text {max }}(\mathrm{MHz})=200 \sqrt{\frac{{ }^{f_{T}(\mathrm{MHz}}}{\mathrm{r}_{\mathrm{b}} \cdot \mathrm{C}_{\mathrm{c}}(\mathrm{ps})}}$.

## TYPES A5T4260, A5T4261 P-N-P SILICON TRANSISTORS

electrical characteristics at $\mathbf{2 5}{ }^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

| PARAMETER | TEST CONDITIONS |  |  | A5T4260 |  | A6T4281 |  | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  | MIN | MAX | MIN | MAX |  |
| V(BR)CBO Collector-Base Breakdown Vottage | $I_{C}=-10 \mu A$, | $1 E=0$ |  | -16 |  | -15 |  | $V$ |
| V(BR)CEO Collector-Emitter Breakdown Voltage | $1 c^{=}=-10 m A_{1}$ | $\mathrm{I}_{\mathrm{B}}=0$, | See Note 3 | -16 |  | -16 |  | $V$ |
| $V_{\text {(BR)EBO }}$ Emitter-Base Breakdown Voltage | $\mathrm{I}_{\mathrm{E}}=-10 \mu \mathrm{~A}_{\text {, }}$ | $I_{C}=0$ |  | -4.5 |  | -4.5 |  | V |
| ICEV Collector Cutoff Current | $\mathrm{V}_{\text {ce }}=-10 \mathrm{~V}$ | $V_{B E}=2 \mathrm{~V}$ |  | -5 |  | -5 |  | nA |
|  | $V_{C E}=-5 V_{1} \quad V_{B E}=0.4 \mathrm{~V}$ |  |  | -80 |  | -60 |  |  |
|  | $V_{C E}=-10 \mathrm{~V}$ | $V_{B E}-2 V^{\prime}$ | $\mathrm{T}_{\mathrm{A}}=85^{\circ} \mathrm{C}$ | -200 |  | -200 |  |  |
| IBEV ${ }^{\text {a }}$ Base Cutoff Current | $V_{C E}=-10 V_{8}$ | $V_{B E}=2 \mathrm{~V}$ |  |  | 5 |  | 5 | nA |
| Static Forward Current Trensfer Ratio | $V_{C E}=-1 \mathrm{~V}$, | $I_{C}=-1 \mathrm{~mA}$ |  | 28 |  | 25 |  |  |
|  | $V_{C E}=-1 \mathrm{~V}$, | $1 \mathrm{C}=-10 \mathrm{~mA}$ | See Note 3 | 30 | 150 | 30 | 150 |  |
|  | $V_{C E}=-2 V^{\prime}$ | $1 C=-30 \mathrm{~mA}$ |  | 20 |  | 20 |  |  |
| Base-Emitter Voltage | $V_{C E}=-1 V_{\text {, }}$ | $1 \mathrm{c}=-1 \mathrm{~mA}$ |  |  | -0.8 |  | -0.8 | V |
|  | $V_{C E}=-1 \mathrm{~V}$, | $1 c^{=}=-10 \mathrm{~mA}$, | See Note 3 |  | -1 |  | -1 |  |
| Collector-Emitter Saturation Voltage | $I_{B}=-0.1 \mathrm{~mA}$ | $I_{C}=-1 \mathrm{~mA}$ |  |  | -0.15 |  | -0.15 | $V$ |
|  | $\mathrm{I}_{\mathrm{B}}=-1 \mathrm{~mA}$, | $\mathrm{IC}^{\text {c }}=-10 \mathrm{~mA}$, | See Note 3 |  | -0.35 |  | -0.35 |  |
| Small-Signal Common-Emitter <br> Forward Current Transfer Ratio | $V_{C E}=-4 \mathrm{~V}$, | $I_{C}=-5 \mathrm{~mA}$, | $f=100 \mathrm{MHz}$ | 12 |  | 15 |  |  |
|  | $V_{\text {CE }}=-10 \mathrm{~V}$ | $I_{C}=-10 \mathrm{~mA}$, | $f=100 \mathrm{MHz}$ | 16 |  | 20 |  |  |
| Transition Frequency | $V_{C E}=-4 \mathrm{~V}$. | $I_{C}=-5 \mathrm{~mA}$ | See Note 4 | 1.2 |  | 1.5 |  | GHz |
|  | $V_{C E}=-10 \mathrm{~V}$ | $I_{C}=-10 \mathrm{~mA}$ |  | 1.6 |  | 2 |  |  |
| $\mathrm{C}_{\mathrm{cb}} \quad$ Collector-Base Capacitance | $\begin{aligned} & V_{C B}=-4 \mathrm{~V} \\ & \text { See Note } 5 . \end{aligned}$ | $I E=0$ | $\mathrm{f}=1 \mathrm{MHz},$ |  | 2.5 | 2.5 |  | pF |
| $\mathrm{Ceb}_{\text {b }} \quad$ Emitter-Base Capacitance | $V_{E B}=-0.5 \mathrm{~V}$ <br> See Note 5 | $I_{C}=0$ | $f=1 \mathrm{MHz},$ |  | 2.5 |  | 2.5 | pF |
| ${ }^{6}{ }^{\prime} \mathrm{C}_{\mathbf{c}} \quad$ Collector-Base Time Constant | $\mathrm{V}_{\text {CE }}=-4 \mathrm{~V}$. | $1 \mathrm{C}=-5 \mathrm{~mA}$, | $f=31.8 \mathrm{MHz}$ |  | 35 |  | 60 | ps |
|  | $V_{C E}=-10 \mathrm{~V}$ | $1 \mathrm{C}=-10 \mathrm{~mA}$, | $f=31.8 \mathrm{MHz}$ |  | 30 |  | 50 |  |

NOTES: 3. These parameters must be measured using pulse techniques. $t_{w}=300 \mu s$, duty cycle $\leqslant \mathbf{2 \%}$.
4. To obtain $f_{T}$, the $\boldsymbol{H}_{\mathrm{fe}} \mid$ response is extrapolated at the rate of -6 dB per octave from $\mathrm{f}=100 \mathrm{MHz}$ to the frequency at which $\left|h_{f e}\right|=1$.
5. $\mathrm{C}_{\mathrm{cb}}$ and $\mathrm{C}_{\mathrm{eb}}$ measurements employ three-terminal capacitance bridge incorporating aguard circuit. The third electrode (emitter or collector, reapectively) is connected to the guard terminal of the bridge.

- JE DEC registered data


# TYPES 2N4391 THRU 2N4393 N-CHANNEL SILICON JUNCTION FIELD-EFFECT TRANSISTORS 

# SYMMETRICAL N-CHANNEL FIELD-EFFECT TRANSISTORS FOR HIGH-SPEED COMMUTATOR AND CHOPPER APPLICATIONS 

- Low ID(off) . . . 0.25 nA Max
- Low rds(on) Ciss Product


## *mechanical data


*absolute maximum ratings at $\mathbf{2 5}{ }^{\circ} \mathbf{C}$ free-air temperature (unless otherwise noted)
Drain-Gate Voltage ..... 40 V
Drain-Source Voltage ..... 40 V
Reverse Gate-Source Voltage ..... $-40 \mathrm{~V}$
Continuous Forward Gate Current ..... 50 mA
Continuous Device Dissipation at (or below) $25^{\circ} \mathrm{C}$ Case Temperature (See Note 1) ..... 1.8 W
Storage Temperature Range ..... $-65^{\circ} \mathrm{C}$ to $200^{\circ} \mathrm{C}$
Lead Temperature 1/16 Inch from Case for 60 Seconds ..... $300^{\circ} \mathrm{C}$

NOTE 1: Derate lineerly to $200^{\circ} \mathrm{C}$ case temperrature at the rate of $10.3 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$.
-JEDEC registered data. This date sheet conteins all applicable registered data in effect at the time of publication.

## TYPES 2N4391 THRU 2N4393

N-CHANNEL SILICON JUNCTION FIELD-EFFECT TRANSISTORS
*electrical characteristics at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

| PARAMETER |  | TEST CONDITIONS |  |  | 2N4391 |  | 2N4392 |  | 2N4393 |  | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | MIN | MAX | MIN | MAX | MIN | MAX |  |
| $V_{\text {(ma) }}$ | Gate-Source Breakdown Voltage |  |  |  | $\mathrm{I}_{6}=-1 \mu \mathrm{~A}_{\text {c }}$ | $V_{D S}=0$ |  | -40 |  | -40 |  | -40 |  | $V$ |
| $V_{\text {GSF }}$ | Gate-Source Forward Voltage | $\mathrm{I}_{6}=1 \mathrm{~mA}$, | $V_{\text {DS }}=0$ |  |  | 1 |  | 1 |  | 1 | $V$ |
| Igss | Gate Reverse Current | $V_{6 S}=-20$ | $V_{\text {DS }}=0$ |  |  | -0.1 |  | -0.1 |  | -0.1 | nA |
|  |  | $V_{G S}=-20 \mathrm{~V}$ | $V_{\text {DS }}=0$, | $\mathrm{I}_{\mathrm{A}}=150^{\circ} \mathrm{C}$ |  | -0.2 |  | -0.2 |  | -0.2 | $\mu \mathrm{A}$ |
| IDlofin | Drain Cutoff Current | $V_{\text {OS }}=20 \mathrm{~V}$, | $\mathrm{V}_{\text {GS }}=-12$ |  |  | 0.1 |  |  |  |  | nA |
|  |  | $V_{\text {DS }}=20 \mathrm{~V}$, | $V_{G S}=-7$ |  |  |  |  | 0.1 |  |  |  |
|  |  | $V_{\text {DS }}=20 \mathrm{~V}$, | $V_{G S}=-5$ |  |  |  |  |  |  | 0.1 |  |
|  |  | $V_{\text {DS }}=20 \mathrm{~V}$, | $V_{G S}=-12$ | $\mathrm{T}_{\mathrm{A}}=150^{\circ} \mathrm{C}$ | 0.2 |  |  |  |  |  | $\mu \mathrm{h}$ |
|  |  | $V_{\text {DS }}=20 \mathrm{~V}$, | $V_{G S}=-7$ | $\mathrm{T}_{A}=150^{\circ} \mathrm{C}$ |  |  |  | 0.2 |  |  |  |
|  |  | $V_{D S}=20 \mathrm{~V}$, | $V_{\text {¢S }}=-5$ | $\mathrm{T}_{\mathrm{A}}=150^{\circ} \mathrm{C}$ |  |  |  |  |  | 0.2 |  |
| $V_{\text {esiofn }}$ | Gate-Source Cutoff Voltage | $V_{\text {DS }}=20 \mathrm{~V}$, | $\mathrm{l}_{\mathrm{D}}=1 \mathrm{nA}$ |  | -4 | -10 | -2 | -5 | 0.5 | -3 | V |
| Ioss | Zero-Gate-Voltage Droin Current | $V_{\text {DS }}=20 \mathrm{~V}$, | $V_{G S}=0$, | See Note 2 | 50 | 150 | 25 | 75 | 5 | 30 | mA |
| $V_{\text {bS }}^{\text {(or) }}$ ) | Droin-Source On-Slate Voltage | $V_{G S}=0$, | $\mathrm{I}_{\mathrm{D}}=12 \mathrm{~m}$ |  |  | 0.4 |  |  |  |  | $v$ |
|  |  | $V_{G S}=0$, | $\mathrm{l}_{0}=6 \mathrm{~mA}$ |  |  |  |  | 0.4 |  |  |  |
|  |  | $V_{G S}=0$, | $\mathrm{I}_{\mathrm{D}}=3 \mathrm{~mA}$ |  |  |  |  |  |  | 0.4 |  |
| Iostom) | Static Drain-Source On-State Resistance | $V_{\text {SS }}=0$, | $\mathrm{I}_{\mathrm{D}}=1 \mathrm{~mA}$ |  |  | 30 |  | 60 |  | 100 | $\Omega$ |
| ${ }^{\text {dationt }}$ | Small-Signal Droin-Source On-State Resistance | $V_{G S}=0$, | $\mathrm{I}_{0}=0$, | $f=1 \mathrm{kHz}$ |  | 30 |  | 60 |  | 100 | $\Omega$ |
| $\mathrm{C}_{\text {is }}$ | Common-Source Short-Circuit Input Capacitance | $V_{D S}=20 \mathrm{~V}$, | $V_{\text {GS }}=0$, | $f=1 \mathrm{MHz},$ <br> See Note 3 |  | 14 |  | 14 |  | 14 | pF |
| $C_{r s}$ | Common-Source Short-Circuit Reverse Iransfer Capacitance | $V_{\text {DS }}=0$, | $V_{G S}=-12$ | $f=1 \mathrm{MHz}$ |  | 3.5 |  |  |  |  | pF |
|  |  | $V_{D S}=0$, | $V_{G S}=-7$ | $\mathrm{f}=1 \mathrm{MHz}$ |  |  |  | 3.5 |  |  |  |
|  |  | $V_{\text {DS }}=0$, | $V_{G S}=-5$ | $\mathrm{f}=1 \mathrm{MHz}$ |  |  |  |  |  | 3.5 |  |

*switching characteristics at $\mathbf{2 5}{ }^{\circ} \mathrm{C}$ free-air temperature

| PARAMETER |  | TEST CONDITIONS |  | 2N4391 |  | 2N4392 |  | 2N4393 |  | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | TYP | MAX | TYP | MAX | TYP | MAX |  |
| $t_{r}$ | Rise Time |  |  | $\begin{aligned} & v_{D D}=10 \mathrm{~V}, \\ & V_{G S(o n)}=0, \end{aligned}$ <br> See Figure I, |  | 2 | 5 | 3 | 5 | 4 | 5 | ns |
| $\mathrm{t}_{\text {m }}$ | Turn-On Time | 5.5 | 15 |  |  | 6.5 | 15 | 8 | 15 | ns |
| ${ }_{4}$ | Fall Time | 7 | 15 |  |  | 13 | 20 | 27 | 30 | ns |
| $t_{\text {off }}$ | Turn-Off Time | 10 | 20 |  |  | 18 | 35 | 31 | 50 | ns |

NOTES: 2. This parameter must be measured with bias voltages applied for less than 5 seconds to avoid overheating.
3. This parametor must be meosured using pulse techniques. $\mathrm{I}_{\mathrm{w}}=100 \mu \mathrm{~s}$, duty cycle $\leq 1 \%$.
†These are nominel volues; exact values very slightly with transistor parameters.

- JEDES ragistared deta.


# TYPES 2N4391 THRU 2N4393 N-CHANNEL SILICON JUNCTION FIELD-EFFECT TRANSISTORS 

## PARAMETER MEASUREMENT INFORMATION


(See Note a)
VOLTAGE WAVEFORMS

| TYPES | $R_{\mathrm{L}}$ | $V_{\text {GS(off) }}$ |
| :---: | :---: | :---: |
| $2 N 4391$ | $750 \Omega$ | -12 V |
| 2 N 4392 | $1.54 \mathrm{k} \Omega$ | -7 V |
| 2 N 4393 | $3.16 \mathrm{k} \Omega$ | -5 V |

NOTE a: An equivalent generator and oscilloscope may be used. The oscilloscope must have a $\mathbf{5 0} \mathbf{0} \boldsymbol{\Omega}$ input impedance.

FIGURE 1

## SILECT ${ }^{\dagger}$ TRANSISTORS $\ddagger$

- For Low-Level, Small-Signal, General Purpose Amplifier and Switching Applications
- Rugged One-Piece Construction with In-Line Leads or Standard TO-18 100-mil Pin-Circle Configuration


## mechanical data

These transistors are encapsulated in a plastic compound specifically designed for this purpose, using a highly mechanized process developed by Texas Instruments. The case will withstand soldering temperatures without deformation. These devices exhibit stable characteristics under high-humidity conditions and are capable of meeting MIL-STD-202C, Method 106B. The transistors are insensitive to light.

absolute maximum ratings at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)


NOTES: 1. This value applies between 0 and 50 mA when the base-emitter diode is open-circuited.
2. Derate the $625-\mathrm{mW}$ rating linearly to $150^{\circ} \mathrm{C}$ free-air temperature at the rate of $5 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$. Derate the $310-\mathrm{mW}$ (JEDEC registered) rating linearly to $135^{\circ} \mathrm{C}$ free-air temperature at the rate of $2.82 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$.

* The asterisk identifies JEDEC registered data for the 2 N 4402 and 2 N 4403 only. This data sheer contains all applicable registered data in effect at the time of publication.
${ }^{\dagger}$ Trademark of Texas Instruments
$\ddagger$ U.S. Patent No. 3,439,238
§ Texas Instruments guarentees these values in addition to the JEDEC registered values which are also shown.
*electrical characteristics at $\mathbf{2 5}{ }^{\circ} \mathrm{C}$ free-air tamperature

| PARAMETER |  | TEST CONDITIONS |  | $\begin{gathered} \text { 2N4402 } \\ \text { A5T4402 } \\ \hline \end{gathered}$ | $\begin{gathered} \hline \text { 2N4403 } \\ \text { A5T4403 } \\ \hline \end{gathered}$ | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | MIN MAX | MiN MAX |  |
| $V_{\text {(BR) }}$ CBO | Collector-Base Breakdown Voltage |  |  | ${ }^{\prime} C=-100 \mu A, I_{E}=0$ |  | -40 | -40 | V |
| V(BR)CEO | Collector-Emitter Breakdown Voltage | $\mathrm{I}^{\prime}=-1 \mathrm{~mA}, \quad \mathrm{I}_{\mathrm{B}}=0$, | See Note 3 | -40 | -40 | V |
| $V_{\text {(BR)EBO }}$ | Emitter-Base Breakdown Voltage | $\mathrm{I}_{E}=-100 \mu \mathrm{~A}, \mathrm{I}^{\prime}=0$ |  | -5 | -5 | V |
| ICEV | Collactor Cutoff Current | $\mathrm{V}_{\mathrm{CE}}=-35 \mathrm{~V}, \mathrm{~V}_{\mathrm{BE}}=0.4 \mathrm{~V}$ |  | -100 | -100 | nA |
| IBEV | Base Cutoff Current | $V_{C E}=-35 \mathrm{~V}, \mathrm{~V}_{\mathrm{BE}}=0.4 \mathrm{~V}$ |  | 100 | 100 | nA |
| hfe | Static Forward Current Transfer Ratio | $V_{C E}=-1 \mathrm{~V}, 1 \mathrm{I}=-100 \mu \mathrm{~A}$ |  |  | 30 |  |
|  |  | $\mathrm{V}_{\text {CE }}=-1 \mathrm{~V}, \quad{ }^{\mathrm{I}} \mathrm{C}=-1 \mathrm{~mA}$ |  | 30 | 60 |  |
|  |  | $\mathrm{V}_{\text {CE }}=-1 \mathrm{~V}, \mathrm{I}^{\text {c }}=-10 \mathrm{~mA}$ | See Note 3 | 50 | 100 |  |
|  |  | $\mathrm{V}_{\text {CE }}=-2 \mathrm{~V}, \mathrm{I}^{\prime}=-150 \mathrm{~mA}$ |  | $50 \quad 150$ | $100 \quad 300$ |  |
|  |  | $\mathrm{V}_{C E}=-2 \mathrm{~V}, \mathrm{I}^{\prime}=-500 \mathrm{~mA}$ |  | 20 | 20 |  |
| $V_{B E}$ | Base-Emitter Voltage | $\mathrm{I}_{B}=-15 \mathrm{~mA}, \mathrm{I}_{\mathrm{C}}=-150 \mathrm{~mA}$ | See Note 3 | -0.75-0.95 | -0.75-0.95 | V |
|  |  | $\mathrm{I}_{\mathrm{B}}=-50 \mathrm{~mA}, \mathrm{I}_{\mathrm{C}}=-500 \mathrm{~mA}$ |  | -1.3 | -1.3 |  |
| $V_{C E}$ (sat) | Collector-Emitter Saturation Voltage | $\mathrm{I}_{\mathrm{B}}=-15 \mathrm{~mA}, \mathrm{I}_{\mathrm{C}}=-150 \mathrm{~mA}$ | See Note 3 | -0.4 | -0.4 | V |
|  |  | $\mathrm{I}_{B}=-50 \mathrm{~mA}, \mathrm{I}^{\prime}=-500 \mathrm{~mA}$ |  | -0.75 | -0.75 |  |
| $h_{\text {ie }}$ | Small-Signal Common-Emitter Input Impedance | $V_{C E}=-10 \mathrm{~V}, \mathrm{l} C=-1 \mathrm{~mA}, \quad f=1 \mathrm{kHz}$ |  | $0.75 \quad 7.5$ | 1.515 | $k \Omega$ |
| $h_{\text {fe }}$ | Small-Signal Common-Emitter Forward Current Transfer Ratio |  |  | $30 \quad 250$ | $60 \quad 500$ |  |
| $h_{\text {re }}$ | Small-Signal Common-Emitter Reverse Voltage Transfer Ratio |  |  | $0.1 \times$ $8 \times$ <br> $10^{-4}$ $10^{-4}$ | $0.1 \times$ $8 \times$ <br> $10^{-4}$ $10^{-4}$ |  |
| $h_{\text {oe }}$ | Small-Signal Common-Emitter Output Admittance |  |  | - 1100 | 1100 | $\mu \mathrm{mho}$ |
| Prel | Small-Signal Common-Emitter Forward Current Transfer Ratio | $V_{C E}=-10 \mathrm{~V}, \mathrm{I}^{\mathrm{C}}=-20 \mathrm{~mA}$, | $\mathrm{f}=100 \mathrm{MHz}$ | 1.5 | 2 |  |
| $\mathrm{C}_{\mathbf{c b}}$ | Collector-Base Capacitance | $V_{C B}=-10 \vee, I_{E}=0,$ <br> See Note 4 | $f=140 \mathrm{kHz},$ | 8.5 | 8.5 | pF |
| $\mathrm{C}_{\text {eb }}$ | Emitter-Base Capacitance | $V_{E B}=-0.5 \mathrm{~V}, \mathrm{I}_{\mathrm{C}}=0$ <br> See Note 4 | $f=140 \mathrm{kHz},$ | 30 | 30 | pF |

NOTES: 3. These parameters must be measured using puise techniques. $\mathbf{t}_{\mathbf{w}}=\mathbf{3 0 0} \mu_{5}$, duty eycle $<\mathbf{2 \%}$.
4. $\mathrm{C}_{\mathrm{cb}}$ and $\mathrm{C}_{\mathrm{sb}}$ measurements employ a three-terminal capacitance bridge incorporating a guard circuit. The third electrode (emitter or collector, respectivety) is connected to the guard terminal of the bridge.

- The asterisk identifies JEDEC registered data for the 2N4402 and 2N4403 only.


## TYPES 2N4402, 2N4403, A5T4402, A5T4403 P-N-P SILICON TRANSISTORS

*switching characteristics at $25^{\circ} \mathrm{C}$ free-air temperature

|  | PARAMETER | TEST CONDITIONS ${ }^{\text {t }}$ | MAX | UNIT |
| :---: | :---: | :---: | :---: | :---: |
| $t_{d}$ | Delay Time | $\mathrm{V}_{\mathrm{CC}}=-30 \mathrm{~V}, \mathrm{I}_{\mathrm{C}}=-150 \mathrm{~mA}, \mathrm{I}_{\mathrm{B}(1)}=-15 \mathrm{~mA}$, | 15 | ns |
| ${ }_{\text {t }}$ | Rise Time | $\mathrm{V}_{\mathrm{BE}(\mathrm{off})}=2 \mathrm{~V}$, See Figure 1 | 20 | ns |
| $t_{s}$ | Storage Time | $\mathrm{V}_{\mathrm{CC}}=-30 \mathrm{~V}, \mathrm{I}^{\text {c }}=-150 \mathrm{~mA}, \mathrm{I}_{\mathrm{B}(1)}=-15 \mathrm{~mA}$, | 225 | ns |
| $\mathrm{t}_{\mathrm{f}}$ | Fall Time | $\mathrm{I}_{\mathrm{B}(2)}=15 \mathrm{~mA}$, See Figure 2 | 30 | ns |

$\dagger$ Vottage and current values shown are nominal; exact values vary slightiy with transistor parameters.
*The asterisk identifies JEDEC registered date for the 2N4402 and 2N4403 only.

## PARAMETER MEASUREMENT INFORMATION



TEST CIRCUIT


VOLTAGE WAVEFORMS

Figure t-delay and rise times


FIGURE 2-STORAGE AND FALL TIMES

NOTES: a. The input waveforms are supplied by a generator with the following characteristics: $Z_{\text {out }}=50 \Omega$, duty cycle $=2 \%$.
b. Waveforms are monitored on an oscilloscope with the following characteristics: $t_{r} \leqslant 4 \mathrm{~ns}, \mathrm{R}_{\mathrm{in}}=10 \mathrm{M} \Omega$.
c. $C_{T}$ includes capacitance of test jig, connectors, and oscilloscope.

## SILECT ${ }^{\dagger}$ TRANSISTORS $\ddagger$ <br> FOR MEDIUM-CURRENT AMPLIFIER APPLICATIONS

- High-Voltage Indicator and Display Control
- Rugged One-Piece Construction with In-Line Leads or Standard TO-18 100-mil Pin-Circle Configuration


## mechanical data

These transistors are encapsulated in a plastic compound specifically designed for this purpose, using a highly mechanized process developed by Texas Instruments. The case will withstand soldering temperatures without deformation. These devices exhibit stable characteristics under high-humidity conditions and are capable of meeting MIL-STD-202C, Method 106B. The transistors are insensitive to light.

absolute maximum ratings at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)


NOTES: 1. These values apply between 0 and 50 mA when the base-emitter diode is open-circuited.
2. Derate the $625-\mathrm{mW}$ rating linearly to $150^{\circ} \mathrm{C}$ free-air temperature at the rate of $5 \mathrm{~mW} /^{\circ} \mathrm{C}$. Derate the $310-\mathrm{mW}$ (JEDEC registered) rating linearly to $135^{\circ} \mathrm{C}$ free-air temperature at the rate of $2.82 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$.

* The asterisk identifies JEDEC registered data for the $2 N 4409$ and $2 N 4410$ only. This data sheet containg all applicable registered data in effect at the time of publication.
$\dagger$ Trademark of Texas Instruments
$\ddagger$ U.S. Patent No. 3,439,238
§ Texas instruments guarantees these values in addition to the JEDEC registered values which are also shown.


## TYPES 2N4409, 2N4410, A5T4409, A5T4410 N-P-N SILICON TRANSISTORS

*electrical characteristics at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

| PARAMETER |  | TEST CONDITIONS |  |  | 2N4409 A5T4409 |  | 2N4410 A5T4410 |  | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | MIN | MAX | MIN | MAX |  |
| $V_{\text {(BR) }}$ CBO | Collector-Base Breakdown Voltage |  |  |  | $\mathrm{I}_{\mathrm{C}}=10 \mu \mathrm{~A}$, | $\mathrm{I}_{\mathrm{E}}=0$ |  | 80 |  | 120 |  | V |
| $V_{\text {(BR) }}$ CEO | Collector-Emitter Breakdown Voltage | $\mathrm{I}_{\mathrm{C}}=1 \mathrm{~mA}$, | $\mathrm{I}_{\mathrm{B}}=0$, | See Note 3 | 50 |  | 80 |  | V |
| $V_{\text {(BR) }} \mathrm{V}^{\text {(BRX }}$ | Collector-Emitter Breakdown Voltage | $I_{C}=500 \mu \mathrm{~A}$, | $\mathrm{R}_{\mathrm{B}}=8.2 \mathrm{k} \Omega$ | $-5 \mathrm{~V}$ | 80 |  | 120 |  | V |
| $V$ (BR)EBO | Emitter-Base Breakdown Voltage | $\mathrm{I}_{\mathrm{E}}=10 \mu \mathrm{~A}$, | $\mathrm{I}_{\mathrm{C}}=0$ |  | 5 |  | 5 |  | V |
| ${ }^{\prime} \mathrm{CBO}$ | Collector Cutoff Current | $\mathrm{V}_{\mathrm{CB}}=60 \mathrm{~V}$, | $\mathrm{I}_{\mathrm{E}}=0$ |  |  | 10 |  |  | nA |
|  |  | $V_{C B}=100 \mathrm{~V}$, | $\mathrm{I}_{E}=0$ |  |  |  |  | 10 |  |
|  |  | $\mathrm{V}_{\mathrm{CB}}=60 \mathrm{~V}$, | $\mathrm{I}_{\mathrm{E}}=0$, | $\mathrm{T}_{\mathrm{A}}=100^{\circ} \mathrm{C}$ |  | 1 |  |  | $\mu \mathrm{A}$ |
|  |  | $V_{C B}=100 \mathrm{~V}$, | $\mathrm{I}_{\mathrm{E}}=0$, | $T_{A}=100^{\circ} \mathrm{C}$ |  |  |  | 1 |  |
| IEBO | Emitter Cutoff Current | $\mathrm{V}_{\text {EB }}=4 \mathrm{~V}$, | $\mathrm{I}_{\mathrm{C}}=0$ |  |  | 100 |  | 100 | nA |
| hfe | Static Forward Current Transfer Ratio | $\mathrm{V}_{C E}=1 \mathrm{~V}$, | $1 \mathrm{C}=1 \mathrm{~mA}$ |  | 60 |  | 60 |  |  |
|  |  | $\mathrm{V}_{C E}=1 \mathrm{~V}$, | $\mathrm{IC}_{\mathrm{C}}=10 \mathrm{~mA}$, | See Note 3 | 60 | 400 | 60 | 400 |  |
| VBE | Base-Emitter Voltage | $\mathrm{I}_{\mathrm{B}}=0.1 \mathrm{~mA}$, | $\mathrm{I}_{\mathrm{C}}=1 \mathrm{~mA}$ |  |  | 0.8 |  | 0.8 | V |
|  |  | $V_{C E}=5 \mathrm{~V}$, | $\mathrm{I}_{\mathrm{C}}=1 \mathrm{~mA}$ |  |  | 0.8 |  | 0.8 |  |
| $\mathbf{V}_{\text {CE(sat) }}$ | Collector-Emitter Saturation Voltage | $\mathrm{I}_{\mathrm{B}}=0.1 \mathrm{~mA}$, | $\mathrm{I}_{\mathrm{C}}=1 \mathrm{~mA}$ |  |  | 0.2 |  | 0.2 | V |
| Prel | Small-Signal Common-Emitter <br> Forward Current Transfer Ratio | $V_{C E}=10 \mathrm{~V}$, | $\mathrm{I}_{\mathrm{C}}=10 \mathrm{~mA}$, | $\mathrm{f}=\mathbf{3 0} \mathbf{M H z}$ | 2 | 10 | 2 | 10 |  |
| $\mathrm{C}_{\mathrm{cb}}$ | Collector-Base Capacitance | $v_{C B}=10 \mathrm{~V} .$ <br> See Note 4 | $\mathrm{I}_{\mathrm{E}}=0,$ | $f=140 \mathrm{kHz}$ |  | 12 |  | 12 | pF |

NOTES: 3. Thase parameters must be measured using pulse techniques. $t_{w}=300 \mu \mathrm{~s}$, duty cycle $\leqslant \mathbf{2 \%}$.
4. $\mathrm{C}_{\mathrm{cb}}$ measurement employs a three-terminal capacitance bridge incorporating a guard circuit. The emitter is connected to the guard terminal of the bridge.
*The asterisk identifies JEDEC registered data for the 2 N 4409 and 2 N 4410 only.

## THERMAL INFORMATION



FIGURE 1

## FOR VHF AMPLIFIER AND MIXER APPLICATIONS

- High Power Gain... 10 dB Min at 400 MHz
- Low Noise Figure ... 4 dB Max at 400 MHz
- High Transconductance . . $4000 \mu \mathrm{mhe}$ Min at $\mathbf{4 0 0} \mathbf{~ M H z}$
- Low Cras ... 0.8 pF Max
- High $\left|\boldsymbol{y}_{\mathbf{h}}\right| / \mathrm{C}_{\text {iss }}$ Ratio (High-Frequency Figure-of-Merit)
- Cross-Modulation Minimized by Square-Law Transfer Characteristic
- Recommended for Use in VHF-UHF Bandpass Amplifiers
- Excellent for General Purpose Amplifier and Chopper Applications
*mechanical data

absolute maximum ratings af $\mathbf{2 5}^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)


NOTES: 1 . Derale linearly to $200^{\circ} \mathrm{C}$ fres-air temperature at the rate of $1.7 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$.
2. Derote lineerly to $200^{\circ} \mathrm{C}$ case temperature of the rate of $6 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$.
*Indicates JEDEC registered data

## TYPES 2N4416, 2N4416A <br> N-CHANNEL SILICON JUNCTION FIELD-EFFECT TRANSISTORS

electrical characteristics at $25^{\circ} \mathrm{C}$ freenair temperature (unless otherwise noted)

\begin{tabular}{|c|c|c|c|c|c|c|}
\hline \multicolumn{2}{|r|}{\multirow[t]{2}{*}{PARAMETER}} \& \multicolumn{2}{|r|}{\multirow[t]{2}{*}{TEST CONDITIONS ${ }^{\ddagger}$}} \& 2N4416 \& 2N4416A \& \multirow[t]{2}{*}{Unit} <br>
\hline \& \& \& \& MIN MAX \& MIN MAX \& <br>
\hline $V_{\text {IBRIGSS }}$ \& Gate-Source Breakdown Voltage \& $\mathrm{I}_{6}=-1 \mu \mathrm{~A}$, \& $V_{\text {DS }}=0$ \& -30* \& -35* \& $V$ <br>
\hline $V_{\text {g Sf }}$ \& Gate-Source Forward Voltage \& $\mathrm{I}_{\mathrm{s}}=1 \mathrm{~mA}$, \& $V_{\text {DS }}=0$ \& ${ }^{*}$ \& $1{ }^{*}$ \& $V$ <br>
\hline \multirow[b]{2}{*}{Igss} \& \multirow[b]{2}{*}{Gate Reverse Current} \& $V_{\text {GS }}=-20 \mathrm{~V}$, \& $\mathrm{V}_{\mathrm{DS}}=0$ \& -0.1* \& -0.1* \& nA <br>
\hline \& \& $\mathbf{V G S}^{\text {c }}=\mathbf{- 2 0 ~ V}$, \& $V_{D S}=0, T_{A}=150^{\circ} \mathrm{C}$ \& ${ }_{\text {- }}^{-0.12^{*}}$ \& $$
\begin{aligned}
& -0.2^{*} \\
& -0.1^{\dagger}
\end{aligned}
$$ \& $\mu \mathrm{h}$ <br>
\hline $V_{\text {GS }}$ (off \& Gate-Source Cutoff Voltage \& $V_{\text {DS }}=15 \mathrm{~V}$, \& $\mathrm{I}_{\mathrm{D}}=1 \mathrm{nA}$ \& -6* \& -2.5* ${ }^{\text {* }}$-6* ${ }^{\text {* }}$ \& V <br>
\hline $V_{\text {GS }}$ \& Gate-Source Voltage \& $V_{D S}=15 \mathrm{~V}$, \& $\mathrm{l}_{\mathrm{D}}=0.5 \mathrm{~mA}$ \& - - $^{*}-5.5^{*}$ \& -1* $-5.5{ }^{*}$ \& $V$ <br>
\hline loss \& Zero-Gate-Voltage Drain Current \& $V_{\text {OS }}=15 V_{\text {, }}$ \& $V_{G S}=0$, See Note 3 \& $5^{*} 15^{*}$ \& 5* 15* \& mA <br>
\hline $\left|y_{f s}\right|$ \& Small-Signal Common-Source Forward Transter Admittance \& \multirow[t]{2}{*}{$\mathrm{V}_{\mathrm{DS}}=15 \mathrm{~V}$} \& \multirow[b]{2}{*}{$V_{\text {GS }}=0$,} \& 4.5* 7.5* \& 4.5* 7.5* \& \multirow[b]{2}{*}{mmho} <br>
\hline |Yos ${ }^{\text {c }}$ \& Small-Signal Common-Sourte Output Admittance \& \& \& 0.05* \& 0.05* \& <br>
\hline $\mathrm{C}_{\text {iss }}$ \& Common-Source Short-Gircuit Input Capacitance \& \multirow[t]{3}{*}{$V_{\text {DS }}=15 \mathrm{~V}$,} \& \multirow[b]{3}{*}{$\begin{aligned} & V_{G S}=0, \\ & f \\ & \\ &=1 \mathrm{mHz}\end{aligned}$} \& 4* \& 4* \& \multirow{3}{*}{pF} <br>
\hline $\mathrm{Crss}^{\text {c }}$ \& Common-Source Short-Cirtuif Reverse Transfer Capacitance \& \& \& 0.8* \& $0.8{ }^{*}$ \& <br>
\hline Coss \& Common-Source Short-Circuit Output Capacitonce \& \& \& 2* \& 2* \& <br>
\hline $\mathrm{Re}\left(y_{\text {is }}\right)$ \& Small-Signal Common-Source Input Conductance \& \multirow{4}{*}{$V_{\text {DS }}=15 \mathrm{~V}$,} \& \multirow{4}{*}{$V_{G S}=0$,

$\quad f=100 \mathrm{MHz}$} \& $0.1 *$ \& $0.1 *$ \& \multirow{4}{*}{mmho} <br>
\hline $\operatorname{Im}\left(y_{i s}\right)$ \& Small-Signal Common-Sourte Input Susceptance \& \& \& 2.5* \& 2.5* \& <br>
\hline $\mathrm{Re}\left(\mathrm{Y}_{\text {os }}\right)$ \& Small-Signal Common-Source Output Conductance \& \& \& 0.075* \& 0.075* \& <br>
\hline Im( $y_{\text {os }}$ ) \& Small-Signal Common-Source Output Susceptance \& \& \& $1 *$ \& 1* \& <br>
\hline $\mathrm{Re}\left(y_{i s}\right)$ \& Smail-Signal Common-Source Input Conductance \& \multirow{5}{*}{$V_{D S}=15 \mathrm{~V}$,} \& \multirow{5}{*}{$V_{\text {GS }}=0$,

$\quad f=400 \mathrm{MHz}$} \& J* \& 1* \& \multirow{5}{*}{mmho} <br>
\hline $\operatorname{Im}\left(y_{\text {is }}\right)$ \& Small-Signol Common-Source Input Susceptance \& \& \& 10* \& 10* \& <br>
\hline Re( $y_{\text {fs }}$ ) \& Small-Signal Common-Source Forward Transfer Conductance \& \& \& 4* \& 4* \& <br>
\hline $\mathrm{Re}\left(y_{\text {os }}\right)$ \& Small-Signal Common-Source Output Conductance \& \& \& $0.1 *$ \& $0.1 *$ \& <br>
\hline Im( $y_{\text {os }}$ ) \& Small-Signol Common-Source Output Susceptance \& \& \& 4* \& 4* \& <br>
\hline
\end{tabular}

NOTE 3: This parameter must be measured using pulse techniques. $t_{p}=300 \mu \mathrm{~s}$, duly cysle $\leq 1 \%$.
†Texas Instruments guaranteas this valve in addition to the JEDEC registered valus, which is also shown.
*operating characteristics at $25^{\circ} \mathrm{C}$ free-air temperature

|  | PARAMETER | TEST CONDITIONS $\ddagger$ | MUN | MAX | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: |
| $G_{p s}$ | Small-Signal Common-Source Neutralized Insertion Power Gain | $\begin{array}{ll} V_{D S}=15 \mathrm{~V}, & I_{D}=5 \mathrm{~mA}, \\ R_{G}^{\prime}=1 \mathrm{k} \Omega, & \text { See Figure } 10 \mathrm{MHz}, \end{array}$ | 18 |  | dB |
|  |  | $\begin{aligned} & \begin{array}{l} V_{D S}=15 \mathrm{~V}, \mathrm{I}_{\mathrm{D}}=5 \mathrm{~mA}, \\ \mathrm{R}_{G}^{\prime}=1 \mathrm{k} \Omega, \\ =100 \mathrm{mHz}, \\ \hline \end{array} \quad \text { See Figure } 1 \\ & \hline \end{aligned}$ | 10 |  |  |
| NF | Spot Noise Figure | $\begin{aligned} & V_{D S}=15 \mathrm{~V}, I_{D}=5 \mathrm{~mA}, \quad \begin{array}{l} =100 \mathrm{MHz}, \\ R_{G}^{\prime}=1 \mathrm{k} \Omega, \end{array} \quad \text { See figure } 1 \end{aligned}$ |  | 2 | dB |
|  |  |  |  | 4 |  |

[^90]
## TYPES 2N4416, 2N4416A N-CHANNEL SILICON JUNCTION FIELD-EFFECT TRANSISTORS

PARAMETER MEASUREMENT INFORMATION


| CIRCUIT COMPONENT INFORMATION (See Note 4) |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: |
| CAPACITORS |  |  | COILS |  |  |
|  | 100 MHz | 400 MHz |  | 100 MHz | 400 MHz |
| $C_{1}$ | 7 pF | 1.8 pF | L, | $0.14 \mu \mathrm{H}, 3.5 \mathrm{~T}$, \#18 enameled | $0.022 \mu \mathrm{H}, 5 / \mathrm{B}^{\prime \prime}$ of \#16 copper |
| $\mathrm{C}_{2}$ | $0.0015 \mu \mathrm{~F}$ | $0.001 \mu \mathrm{~F}$ | 4 | copper wire, 3/8 I.D., $1 / 4$ long | wire formed to $0.5 \mathrm{~T}, 1 / 4$ I.D. |
| $C_{3}$ | 1-12 pF | 0.8-8 pF |  | $3 \mu \mathrm{H}, 17 \mathrm{I}$, \#28 enameled | $0.2 \mu \mathrm{H}, 6 \mathrm{~T}$, \#24 enometed copper |
| $C_{4}$ | 1000 pF | 27 pF | $\mathrm{l}_{2}$ | copper wire, close wound, 9/32 | wire, close wound, $1 / 32$ I.D., |
| $\mathrm{C}_{5}$ | 1-12 pF | 0.8-8 pF |  | 1.D., powdered iron slug | aluminum slug |
| $C_{6}$ | $0.0015 \mu \mathrm{~F}$ | $0.001 \mu \mathrm{~F}$ | 13 | $0.25 \mu \mathrm{H}, 4.5 \mathrm{~T}, \# 18$ enameled | $0.03 \mu \mathrm{H}, 11 / 2^{\prime \prime}$ of \#16 enameled copper wire formed to I T, 3/8" I.D. |
| $\mathrm{C}_{7}$ | 3 pF | 1 pF | 3 | copper wire, 3/8" I.D., /6" long |  |

FIGURE 1-NEUTRALIZED POWER GAIN AND SPOT NOISE FIGURE TEST CIRCUIT
NOTE 4: Fransformed equivalent source resistance $\left(R_{G}{ }^{\prime}\right)$ is $1000 \Omega$ at 100 MHz for $100-\mathrm{MHz}$ omplifier, and $1000 \Omega$ al 400 MHz for $400-\mathrm{MHz}$ amplifier
THERMAL INFORMATION


## SILECT $\dagger$ TRANSISTOR FOR HIGH-SPEED SWITCHING APPLICATIONS

## - Electrically Similar to the 2N2894

- Rugged, One-Piece Construction with Standard T0-18 100-mil Pin Circle


## mochanical data

This transistor is encapsulated in a plastic compound specifically designed for this purpose, using a highly mechanized process developed by Texas Instruments. The case will withstand soldering temperatures without deformation. This device exhibits stable characteristics under high-humidity conditions and is capable of meeting MIL-STD-202C, Method 106B. The transistor is insensitive to light.

*absolute maximum ratings at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)
Collector-Base Voltage
Collector-Emitter Voltage (See Note 1). . . . . . . . . . . . . . . . . . . . - 12 V
Collector-Emitter Voltage (See Note 2) . . . . . . . . . . . . . . . . . . . . - 12 C
Emitter-Base Voltage . . . . . . . . . . . . . . . . . . . . . . . . . . - - V
Continuous Collector Current Continuous Devict Dission $25^{\circ}{ }^{\circ}$. . . . . . . . . . . . . . . 200 mA
Continuous Device Dissipation at (or below) $25^{\circ} \mathrm{C}$ Free-Air Temperature (See Note 3) . . . . 360 mW
Continuous Device Dissipation at (or below) $25^{\circ} \mathrm{C}$ Lead Temperature (See Note 4) . . . . 500 mW
Storage Temperature Range . . . . . . . . . . . . . . . . . . . $-65^{\circ} \mathrm{C}$ to $150^{\circ} \mathrm{C}$
Lead Temperature $\mathrm{K}_{6}$ Inch from Case for 10 Seconds . . . . . . . . . . . . . . $260^{\circ} \mathrm{C}$
*electrical characteristics at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

| PARAMETER |  | TEST CONDITIONS |  | MIN MAX | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: |
| $V_{\text {(m) }}$ | Coliector-Base Breakdown Voltage | $\mathrm{I}_{\mathrm{C}}=-10 \mu \mathrm{~A}, \mathrm{I}_{\mathrm{E}}=0$ |  | -12 | $V$ |
| $V_{\text {(xix) }}$ | Collector-Emitter Breakdown Valtoge | $\mathrm{I}_{\mathrm{c}}=-10 \mathrm{~mA}, \quad \mathrm{I}_{1}=0$, | Soe Nofe 5 | -12 | $V$ |
| $V_{\text {Ifices }}$ | Collector-Emilter Breakdown Voltage | $l_{c}=-10 \mu \mathrm{~A}, \quad V_{\text {EE }}=0$ |  | -12 | $V$ |
|  | Emitter-Sase Breekdown Voliage | $\mathrm{I}_{\mathrm{E}}=-100 \mu \mathrm{~A}_{1} \quad \mathrm{I}_{\mathrm{c}}=0$ |  | -4 | $V$ |
| $\mathrm{l}_{\text {cmo }}$ | Collector Cutolf Current | $V_{C E}=-6 V^{\prime}, \quad T_{E}=0$, | $\mathrm{T}_{\mathrm{A}}=70^{\circ} \mathrm{C}$ | -1 | $\mu \mathrm{h}$ |
| ICEs | Collector Cutoff Current | $V_{C E}=-6 V_{1} \quad V_{E E}=0$ |  | $-80$ | na |
| $\mathrm{l}_{\text {ELO }}$ | Emitter Cutoff Current | $V_{E E}=-3 V_{1}, \quad I_{C}=0$ |  | -20 | W |
| $h_{\text {re }}$ | Staik Forword Current Transfer Ratio | $V_{\text {ce }}=-0.3 \mathrm{~V}, \quad \mathrm{I}_{\mathbf{C}}=-10 \mathrm{~mA}$ | $\begin{gathered} \text { See } \\ \text { Mote } \\ 5 \end{gathered}$ | 30 |  |
|  |  | $V_{C E}=-0.5 \mathrm{~V}, \quad \mathrm{I}_{\mathrm{C}}=-30 \mathrm{~mA}$ |  | $40-150$ |  |
|  |  | $\mathrm{V}_{\mathrm{CE}}=-1 \mathrm{~V}, \quad \mathrm{I}_{\mathrm{C}}=-100 \mathrm{~mA}$ |  | 20 |  |
| $V_{\text {re }}$ | Bose-Emitter Voltoge | $\mathrm{I}_{\mathrm{E}}=-1 \mathrm{~mA}, \quad \mathrm{I}_{\mathrm{c}}=-10 \mathrm{~mA}$ | $\begin{gathered} \hline \text { See } \\ \text { Nofe } \\ 5 \end{gathered}$ | -0.76 -0.98 | $v$ |
|  |  | $\mathrm{I}_{\mathrm{E}}=-3 \mathrm{~mA}, \quad \mathrm{I}_{\mathrm{c}}=-30 \mathrm{~mA}$ |  | $\begin{array}{ll}-0.82 & -1.2\end{array}$ |  |
|  |  | $I_{s}=-10 \mathrm{~mA}, \quad \mathrm{I}_{C}=-100 \mathrm{~mA}$ |  | -1.7 |  |
| $V_{\text {ckin+ }}$ | Collector-Emitter Suturotion Yolinga | $\mathrm{I}_{1}=-1 \mathrm{~mA}, \quad \mathrm{I}_{\mathrm{C}}=-10 \mathrm{~mA}$ | $\begin{gathered} \hline \text { See } \\ \text { Note } \\ 5 \end{gathered}$ | -0.15 | $v$ |
|  |  | $\mathrm{I}_{\mathrm{s}}=-3 \mathrm{~mA}, \quad \mathrm{l}_{\mathrm{C}}=-30 \mathrm{~mA}$ |  | -0.2 |  |
|  |  | $\mathrm{I}_{1}=-10 \mathrm{~mA}, \quad I_{C}=-100 \mathrm{~mA}$ |  | -0.5 |  |

MOTES: 1. This valve applies when the bast-emitter diad is shert-drcuitod.
 be simultamoously applied provided the time of application is $10 \mu$ sy less ead the dinty cycte is $\mathbf{2 \%}$ of less.
3. Derale finearty to $150^{\circ} \mathrm{C}$ free-air tomperature at the rate of $2.80 \mathrm{~mm} / \mathrm{deg}$.
-Imdientes JEDEC ragisterad deta
4. Derate linearly to $150^{\circ} \mathrm{C}$ lead tomporature at the rete of $4 \mathrm{~mW} / \mathrm{dag}$. Leod temperature is measured on ine collester lood $1 / 16$ inch from the cast.


## *electrical characteristics at $25^{\circ} \mathrm{C}$ free-air temperature

| PARAMETER | TEST CONDITIONS |  | MIN MAX | UNIT |
| :---: | :---: | :---: | :---: | :---: |
| $\left\|h_{\text {to }}\right\| \begin{aligned} & \text { Small-Signol Common-Emither } \\ & \text { Forward Current Transier Ratio }\end{aligned}$ | $V_{C E}=-5 \mathrm{~V}, \quad \mathrm{I}_{\mathrm{C}}=-30 \mathrm{~mA}, \mathrm{i}=100 \mathrm{mHz}$ |  | 4 |  |
| $C_{c b}$ Coilector-Base Copactance | $\mathbf{V}_{C E}=-5 \mathbf{V}, l_{E}=0$, | $f=1 \mathrm{MHz},$ <br> See Note 6 | 6 | pf |
| $C_{06}$ Emitter-Base Capocitonce | $\mathrm{V}_{\mathrm{EB}}=-0.5 \mathrm{~V}, \mathrm{l}_{\mathrm{C}}=0$, | $\mathrm{f}=1 \mathrm{MHz},$ <br> See Note 6 | 6 | pF |


*switching characteristics at $25^{\circ} \mathrm{C}$ free-air temperature

| PARAMETER | TEST CONDITIONS $\dagger$ |  | MAX | UNIT |
| :---: | :---: | :---: | :---: | :---: |
| $\mathrm{t}_{\text {d }}$ Delay Time | $\begin{aligned} & I_{C}=-30 \mathrm{~mA}, I_{m(1)}=-3 \mathrm{~mA}, \\ & R_{L}=93 \Omega, \end{aligned}$ | See Figure 1 | 15 | ns |
| $t_{r}$ R Rise Iime |  |  | 30 | ns |
| $t_{\text {an }}$ Tum-On Time |  |  | 40 | ns |
| $t_{1}$ Storage Tlme | $\begin{aligned} & I_{c}=-30 \mathrm{~mA}, I_{(x)}=-3 \mathrm{~mA}, \\ & R_{L}=93 \Omega, \end{aligned}$ | $I_{\text {mil }}=3 \mathrm{~mA},$ <br> See Figure 2 | 40 | ns |
| $\mathrm{t}_{\mathrm{f}}$ Foll Time |  |  | 15 | ms |
| $t_{\text {off }}$ Tum-Off Time |  |  | 50 | ns |

†Voltoye end current values shown are neminal; exect veluos vary slightly with transistor paramaters.
*PARAMETER MEASUREMENT INFORMATION


TEST CIRCUIT


FIOURE 1

test circuit


FIGURE 2

b. Woveforman are moniterad on en ascilloscepe with the following characteristics: $t_{f} \leq 1 \mathrm{~ms}, \mathrm{a}_{\mathrm{in}} \geq 100 \mathrm{k} \Omega, \mathrm{c}_{\mathrm{m}} \leq 10 \mathrm{pF}$.
-indicatos JEEEC registerned data

## TYPES 2N4851, 2N4852, 2N4853 P-N UNIJUNCTION SILICON TRANSISTORS

PLANAR UNIJUNCTION TRANSISTORS SPECIFICALLY CHARACTERIZED FOR A WIDE RANGE OF MILITARY, SPACE, AND INDUSTRIAL APPLICATIONS

## - Planar Process Ensures Low Leakage, High-Performance With Low Driving Currents, and Greatly Improved Reliability

## *mechanical data

Package outline is same as JEDEC TO-18 except for lead position. All TO-18 registration notes also apply to this outline.

*absolute maximum ratings at $\mathbf{2 5}{ }^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

*electrical characteristics at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

| PARAMETER |  | TEST CONDITIONS | 2N4851 |  | 2N4852 |  | 2N4853 |  | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | MIN | MAX | MiN | MAX | MIN | MAX |  |
| rBB | Static Interbase Resistance |  | $\mathrm{V}_{\mathrm{B} 2 \mathrm{~B} 1}=3 \mathrm{~V}$, IE0 | 4.7 | 9.1 | 4.7 | 9.1 | 4.7 | 9.1 | $k \Omega$ |
| $\alpha_{\mathrm{rBB}}$ | Interbase Resistance <br> Temperature Coefficient | $\begin{array}{ll} V_{B 2 B 1}=3 \mathrm{~V}, & I_{E}=0, \\ T_{A}=-65^{\circ} \mathrm{C} \text { to } 125^{\circ} \mathrm{C}, & \text { See Note } 4 \\ \hline \end{array}$ | 0.2 | 0.8 | 0.2 | 0.8 | 0.2 | 0.8 | $\%{ }^{\circ} \mathrm{C}$ |
| $\eta$ | Intrinsic Standoff Ratio | $\mathrm{V}_{\mathrm{B2B1}}=10 \mathrm{~V}$, See Figure 3 | 0.56 | 0.75 | 0.7 | 0.85 | 0.7 | 0.85 |  |
| 'EB2O | Emitter Reverse Current | $\mathrm{V}_{\mathrm{EB2}}=30 \mathrm{~V}$, $\mathrm{I}_{\mathrm{B} 1}=0$ |  | 100 |  | 100 |  | 50 | nA |
| Ip | Peak-Point Emitter Current | $\mathrm{V}_{\mathrm{B} 2 \mathrm{~B} 1}=25 \mathrm{~V}$ |  | 2 |  | 2 |  | 0.4 | $\mu \mathrm{A}$ |
| IV | Valley-Point Emitter Current | $\mathrm{V}_{\mathrm{B2B} 1}=25 \mathrm{~V}$ | 2 |  | 4 |  | 6 |  | mA |
| $\bar{V}_{\text {OB1 }}$ | Base-One Peak Pulse Voltage | See Figure 4 | 3 |  | 5 |  | 6 |  | V |
| $f_{\text {max }}$ | Maximum Frequency of Oscillation | See Figure 5 | 1 |  | 1 |  | 1 |  | MHz |

NOTES: 1. The interbase voltage rating is based upon allowable power dissipation: $V_{B 2 B 1}=\sqrt{r_{B B} * P_{T}}$.
2. The peak emitter current rating is based on the capability of the transistor to operate safely in the circuit of figure 4 .
3. Derate linearly to $125^{\circ} \mathrm{C}$ free-air temperature at the rate of $3 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$.
4. Temperature coefficient $\alpha_{r B B}$ is determined by the following formula:

$$
\alpha_{\mathrm{rBB}}=\left[\frac{\left(\mathrm{r}_{\mathrm{BB}} @ 125^{\circ} \mathrm{C}\right)-\left(\mathrm{r}_{\mathrm{BB}} @-65^{\circ} \mathrm{C}\right)}{r_{\mathrm{BB}} @ 25^{\circ} \mathrm{C}}\right] \frac{100 \%}{190^{\circ} \mathrm{C}} .
$$

To obtain $r_{B E}$ for a given temperature $T_{A(2)}$, use the following formula:

$$
r_{\mathrm{BB}}(2)=\left[\mathrm{r}_{\mathrm{BB}} @ 25^{\circ} \mathrm{C}\right]\left[1+\left(\alpha_{\mathrm{rBB}} / 100 \%\right)\left(\mathrm{T}_{\mathrm{A}(2)}-25^{\circ} \mathrm{C}\right)\right]
$$

[^91]
# TYPES 2N4851, 2N4852, 2N4853 P-N UNIJUNCTION SILICON TRANSISTORS 


$\eta$-Intrinsic Standoff Ratio- This parameter is defined in terms of the peak-point voltage, $V_{p}$, by means of the equation: $V_{p}=\eta$, $V_{B 2 B 1}+V_{F}$, where $V_{F}$ is about 0.49 volt at $25^{\circ} \mathrm{C}$ and decreases with temperature at about 2 millivolts ${ }^{\circ} \mathrm{C}$.

The circuit used to measure $\eta$ is shown in the figure. In this circuit, R1, C1 and the unijunction transistor form a relaxation oscillator, and the remainder of the circuit serves as a peak-voltage detector with the diode $D$ t automatically subtracting the voltage $V_{p}$. To use the circuit, the "cal" button is pushed, and R3 is adjusted to make the current meter M1 read full scale. The "cal" button then is released and the value of $\eta$ is read directly from the meter, with $\mathbf{N}=1$ corresponding to full-scale deflection of $10 \mu \mathrm{~A}$.
D1: 1 N457, or equivalent, with the following characteristics:
$V_{F}=0.49 \mathrm{~V}$ at $I_{F}=10 \mu \mathrm{~A}$
$I_{R} \leqslant 2 \mu A$ at $V_{R}=20 \mathrm{~V}$

FIGURE 3-TEST CIRCUIT FOR INTRINSIC STANDOFF RATIO ( $\eta$ )


FIGURE 4-VOB1 TEST CIRCUIT
-JEDEC registered data


R1 and C1 are adiusted to maximize the frequency of oscillation. FIGURE 5-f $\mathrm{fmax}^{\text {TEST CIRCUIT }}$

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II cannol ossume ony responsibility for ony circuits shown
of represent that they are fiee from patent infringement.
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## DESIGNED FOR COMPLEMENTARY MEDIUM-POWER HIGH-SPEED SWITCHING AND GENERAL PURPOSE AMPLIFIER APPLICATIONS

- 2N4854 Electrically Similar to 2N2222/2N2907
- 2N4855 Electrically Similar to 2N2221/2N2906
- hFE-Guaranteed from $\mathbf{1 0 0} \mu \mathrm{A}$ to $\mathbf{3 0 0} \mathbf{~ m A}$
- Low-Profile Case

*absolute maximum ratings at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted) ${ }^{\dagger}$
EACH TOTAL
TRIODE DEVICE
Collector-Base Voltage
60 V
Collector-Emitter Voltage (See Note 1) . . . . . . . . . . . . . . . . . . . . . . 40 V
Emitter-Base Voltage . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 5 V
Collector-1-Collector-2 Voltage $\pm 120 \mathrm{~V}$
Lead-to-Case Voltage . . . . . . . . . . . . . . . . . . . . . . . . . . . . . $\pm 120$ V
Continuous Collector Current
600 mA
Continuous Device Dissipation at (or below) $25^{\circ} \mathrm{C}$ Free-Air Temperature (See Note 2) . . . . 300 mW 600 mW
Continuous Device Dissipation at (or below) $\mathbf{2 5}{ }^{\circ} \mathrm{C}$ Case Temperature (See Note 3)
$1 \mathrm{~W} \quad 2 \mathrm{~W}$
Storage Temperature Range
$-65^{\circ} \mathrm{C}$ to $200^{\circ} \mathrm{C}$
Lead Temperature 1/16 Inch from Case for 10 Seconds
$\leftarrow 300^{\circ} \mathrm{C} \longrightarrow$

NOTES: 1. This value applies between 0 and 600 mA collector current when the base-emitter diode is open-circuited. 40 V and 600 mA collector current may be simultaneously applied provided the time of application is $\mathbf{1 0} \mu \mathrm{s}$ or less and the duty cycle is $\mathbf{2 \%}$ or less.
2. Derate linearly to $175^{\circ} \mathrm{C}$ free-air temperature at the rates of $2 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$ for each triode and $a \mathrm{~mW} /{ }^{\circ} \mathrm{C}$ for total device.
3. Derate linearly to $175^{\circ} \mathrm{C}$ case temperature at the rates of $6.67 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$ for each triode and $13.33 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$ for total device.
*JEDEC registered data. This data sheet contains all applicable registared data in effect at the time of publication.
tVoltages and currents apply to the N-P-N triode. For the P-N-P triode the values are the same, but the signs are reversed.

## TYPES 2N4854, 2N4855 N-P-N, P-N-P DUAL SILICON TRANSISTORS

## *electrical characteristics at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted) $\dagger$

individual triode characteristics (see note 4)

| PARAMETER | TEST CONDITIONS |  | 2N4854 | 2N4855 | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  | MIN MAX | MIN MAX |  |
| $\mathrm{V}_{(B R)} \mathbf{C B O}$ Collector-Base Breakdown Voltage | $I_{C}=10 \mu A, \quad I_{E}=0$ |  | 60 | 60 | V |
| $V_{\text {(BR)CEO }}$ Collector-Emitter Breakdown Voltage | $\mathrm{I}_{\mathrm{C}}=10 \mathrm{~mA}, \mathrm{I}_{\mathrm{B}}=0$, | See Note 5 | 40 | 40 | V |
| V(BR)EBO Emitter-Base Breakdown Voltage | $I_{E}=10 \mu A, \quad I_{C}=0$ |  | 5 | 5 | V |
| ICBO Collector Cutoff Current | $V_{C B}=50 \mathrm{~V}, \mathrm{~T}_{\mathrm{E}}=0$ |  | 10 | 10 | nA |
|  | $V_{C B}=50 \mathrm{~V}, \mathrm{I}_{\mathrm{E}}=0$, | $T A=150^{\circ} \mathrm{C}$ | 10 | 10 | $\mu \mathrm{A}$ |
| IEBO Emitter Cutoff Current | $\mathrm{V}_{\mathrm{EB}}=3 \mathrm{~V}, \mathrm{I}^{\text {c }}=0$ |  | 10 | 10 | nA |
| hfe Static Forward Current Transfer Ratio | $\mathrm{V}_{\mathrm{CE}}=1 \mathrm{~V}, \mathrm{I}_{\mathrm{C}}=150 \mathrm{~mA}$, | See Note 5 | 50 | 20 |  |
|  | $V_{C E}=10 \mathrm{~V}, \mathrm{I}_{\mathrm{C}}=100 \mu \mathrm{~A}$ |  | 35 | 20 |  |
|  | $V_{C E}=10 \mathrm{~V}, \mathrm{I}_{\mathrm{C}}=1 \mathrm{~mA}$ |  | 50 | 25 |  |
|  | $\mathrm{V}_{\text {CE }}=10 \mathrm{~V}, \mathrm{I}_{\mathrm{C}}=10 \mathrm{~mA}$, | See Note 5 | 75 | 35 |  |
|  | $V_{C E}=10 \mathrm{~V}$. $\mathrm{I}_{\mathrm{C}}=150 \mathrm{~mA}$, | See Note 5 | 100300 | $40 \quad 120$ |  |
|  | $V_{C E}=10 \mathrm{~V}, 1 \mathrm{C}=300 \mathrm{~mA}$, | See Note 5 | 35 | 20 |  |
| $\mathrm{V}_{\text {BE }} \quad$ Base-Emitter Voltage | $\mathrm{I}_{\mathrm{B}}=15 \mathrm{~mA}, \mathrm{I}^{\prime} \mathrm{C}=150 \mathrm{~mA}$, | See Note 5 | 0.751 .2 | 0.751 .2 | V |
| $\mathrm{V}_{\text {CE }}$ (sat) Collector-Emitter Saturation Valtage | $\mathrm{I}_{B}=15 \mathrm{~mA}, \mathrm{I}_{C}=150 \mathrm{~mA}$, | See Note 5 | 0.4 | 0.4 | V |
| hie $\quad$Small-Signal Common-Emitter <br> Input Impedance | $V_{C E}=10 \mathrm{~V}, \mathrm{l}^{\prime}=1 \mathrm{~mA}, \quad \mathrm{f}=1 \mathrm{kHz}$ |  | 1.59 | $0.75 \quad 4.5$ | k $\Omega$ |
|  Small-Signal Common-Emitter <br> $\mathbf{h f e}_{\text {fe }}$ Forward Current Transfer Ratio |  |  | 60300 | 30150 |  |
| hoe $\quad$ Small-Signal Common-Emitter Output Admittance |  |  | 50 | 25 | $\mu \mathrm{mho}$ |
| \|hfel Small-Signal Common-Emitter | $V_{C E}=10 \mathrm{~V}, \mathrm{I}^{\prime}=20 \mathrm{~mA}$, | $f=100 \mathrm{MHz}$ | 2 | 2 |  |
| $\mathrm{C}_{\mathrm{cb}} \quad$ Collector-Base Capacitance | $V_{C B}=10 \mathrm{~V}, \mathrm{I}_{\mathrm{E}}=0$. | $f=1 \mathrm{MHz},$ <br> See Note 6 | 8 | 8 | pF |

## *operating characteristics at $\mathbf{2 5}{ }^{\circ} \mathbf{C}$ free-air temperature ${ }^{\dagger}$

individual triode characteristics (see note 4)

| PARAMETER | TEST CONDITIONS | MAX | UNIT |
| :---: | :---: | :---: | :---: |
| ${ }^{\text {d }}$ d Delay Time | $\begin{aligned} & I_{C}=150 \mathrm{~mA}, I_{B(1)}=15 \mathrm{~mA}, V_{B E}(\text { off })=-0.5 \mathrm{~V}, \\ & R_{\mathrm{L}}=200 \Omega, \text { See Note } 7 \text { and Figure } 1 \end{aligned}$ | 20 | ns |
| $\mathrm{t}_{\mathbf{r}} \quad$ Rise Time |  | 40 | ns |
| $\mathrm{t}_{\mathbf{s}} \quad$ Storage Time | $\begin{aligned} & I_{C}=150 \mathrm{~mA}, I_{B}(1)=15 \mathrm{~mA}, I_{B(2)}=-15 \mathrm{~mA}, \\ & R_{L}=200 \Omega, \text { See Note } 7 \text { and Figure } 2 \end{aligned}$ | 280 | ns |
| tf Fall Time |  | 70 | ns |
| F Spot Noise Figure | $V_{C E}=10 \mathrm{~V}, \mathrm{I}_{\mathrm{C}}=100 \mu \mathrm{~A}, \mathrm{R}_{\mathrm{G}}=1 \mathrm{k} \Omega, \quad \mathrm{f}=1 \mathrm{kHz}$ | 8 | dB |

NOTES: 4. The terminals of the triode not under test are open-circuited for the measurement of these characteristics.
5. These parameters must be measured using pulse techniques. $t_{w}=300 \mu \mathrm{~s}$, duty cycle $\leqslant \mathbf{2 \%}$.
6. $\mathrm{C}_{\mathrm{cb}}$ measurement employs a three-terminal capacitance bridge incorporating a guard circuit. The emiter and case are connected to the guard terminal of the bridge.
7. Voltages and current values shown are nominal; exact values vary with device parameters.

## *JEDEC registered data

tVoltages and currents apply to the N-P-N triode. For the P-N-P triode the values are the same, but the signs are reversed.

## TYPES 2N4854, 2N4855 <br> N-P-N, P-N-P DUAL SILICON TRANSISTORS

## *PARAMETER MEASUREMENT INFORMATION



FIGURE 1-DELAY AND RISE TIMES


TEST CIRCUIT


VOLTAGE WAVEFORMS

FIGURE 2-STORAGE AND FALL TIMES

NOTES: a. The input waveforms have the following characteristics: For figure 1, $\mathbf{t}_{\mathrm{r}} \leqslant \mathbf{2} \mathbf{n s}, \mathrm{t}_{\mathbf{w}}=\mathbf{2 0 0} \mathbf{n s}$, duty cycle $\leqslant \mathbf{2 \%}$; for figure $\mathbf{2}$, $\mathrm{t}_{\mathrm{f}} \leqslant 5 \mathrm{~ns}, \mathrm{t}_{\mathrm{w}}=10 \mu \mathrm{~s}$, duty cycle $\leqslant 2 \%$
b. All waveforms are monitored on an oscilloscope with the following characteristics; $\mathrm{t}_{\mathrm{r}} \leqslant 5 \mathrm{~ns}, \mathrm{R}_{\mathrm{in}} \geqslant 100 \mathrm{k} \Omega, \mathrm{C}_{\mathrm{in}} \leqslant 12 \mathrm{pF}$

- JEDEC registered data


## TYPES 2N4856 THRU 2N4861, 2N4856A THRU 2N4861A N-CHANNEL SILICON JUNCTION FIELD-EFFECT TRANSISTORS

BULLETIN NO. DL-S 7311911 , JUNE 1973

## SYMMETRICAL N-CHANNEL FIELD-EFFECT TRANSISTORS FOR HIGH-SPEED COMMUTATOR AND CHOPPER APPLICATIONS

- Low $r_{\text {ds }}(o n)$. . $25 \Omega$ Max (2N4856, 2N4856A, 2N4859, 2N4859A)
- Low ID(off) . . . 0.25 nA Max
- Low rds(on) Ciss Product
*mechanical data

*absolute maximum ratings at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)
2N4856
2N4859
2N4860

NOTES: 1. Derate linearly to $200^{\circ} \mathrm{C}$ free-air temperature at the rate of $2.06 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$.
2. Derate linearly to $200^{\circ} \mathrm{C}$ case temperature at the rate of $10.3 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$.

## TYPES 2N4856 THRU 2N4861, 2N4856A THRU 2N4861A N-CHANNEL SILICON JUNCTION FIELD-EFFECT TRANSISTORS

2N4856 THRU 2N4861
*electrical characteristics at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

| PARAMETER |  | TEST CONDITIONS | 2N4856 |  | 2N4857 |  | 2N4858 |  | 2N4059 |  | 2N4860 |  | 2N4C61 |  | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | MIN | MAX | MIN | MAX | MIN | max | MIN | max | MIN | MAX | MIN | max |  |
| $\mathbf{v}_{\text {craless }}$ | Garte-Source Breakdown Voltage |  | $\mathrm{I}_{\mathrm{G}}=-1 \mu \mathrm{~A}, V_{\mathrm{DS}}=0$ | $-10$ |  | $-40$ |  | -40 |  | -30 |  | -30 |  | -30 |  | $v$ |
| Isss | Gate Reverse Curtont | $V_{G S}=-20 V_{V} V_{D S}=0$ |  | -0.25 |  | -0.25 |  | -0.25 |  |  |  |  |  |  | nA |
|  |  | $\begin{aligned} & V_{G S}=-20 V, V_{D S}=0, \\ & V_{A}=150^{\circ} \mathrm{C} \end{aligned}$ |  | -0.5 |  | -0.5 |  | -0.5 |  |  |  |  |  |  | $\mu A$ |
|  |  | $V_{G S}=-15 \mathrm{~V}, \mathrm{~V}_{\mathrm{DS}}=0$ |  |  |  |  |  |  |  | -0,25 |  | -0.25 |  | -0.25 | nA |
|  |  | $\begin{aligned} & \mathrm{V}_{\mathrm{GS}}=-15 \mathrm{~V}, \mathrm{v}_{\mathrm{DS}}=0, \\ & \mathrm{~T}_{\mathrm{A}}=150^{\circ} \mathrm{C} \end{aligned}$ |  |  |  |  |  |  |  | -0.5 |  | -0.5 |  | $-0.5$ | $\mu \mathrm{h}$ |
| ${ }^{\text {DIoff }}$ | Drain Cutoff Currant | $V_{D S}=15 \mathrm{~V}, \quad \mathrm{~V}_{6 S}=-10 \mathrm{~V}$ |  | 0.25 |  | 0.25 |  | 0.25 |  | 0.25 |  | 0.25 |  | 0.25 | nA |
|  |  | $\begin{aligned} & V_{D S}=15 \mathrm{~V} \quad V_{G S}=-10 \mathrm{~V} \\ & \mathrm{~T}_{\mathrm{A}}=150^{\circ} \mathrm{C} \end{aligned}$ |  | 0.5 |  | 0.5 |  | 0.5 |  | 0.5 |  | 0.5 |  | 0.5 | $\mu \lambda$ |
| $V_{\text {estoff }}$ | Gate-Source Cutoff Yoltege | $v_{D S}=15 \mathrm{~V}, \quad \mathrm{~J}_{\mathrm{D}}=0.5 \mathrm{nA}$ | -4 | -10 | -2 | -6 | -0.8 | $-4$ | -4 | -10 | -1 | -6 | -0.0 | $-4$ | V |
| Ioss | Zero Galo- <br> Voligge <br> Droin Current | $v_{D S}=15 v, \quad v_{G S}=0,$ <br> See Nete 3 | 50 |  |  | 100 |  | 80 | 50 |  |  | 100 | 8 | 80 | mA |
| $V_{\text {DSionl }}$ | Drain-Souvce <br> On-State <br> Volitage | $\mathrm{I}_{\mathrm{D}}=20 \mathrm{~mA}, \quad V_{G S}=0$ |  | 0.75 |  |  |  |  |  | 0.75 |  |  |  |  | $v$ |
|  |  | $\mathrm{I}_{\mathrm{D}}=10 \mathrm{~mA}, \quad \mathrm{~V}_{\mathrm{GS}}=0$ |  |  |  | 0.5 |  |  |  |  |  | 0.5 |  |  |  |
|  |  | $\mathrm{I}_{\mathrm{D}}=5 \mathrm{~mA}, \quad \mathrm{v}_{\mathrm{GS}}=0$ |  |  |  |  |  | 0.5 |  |  |  |  |  | 0.5 |  |
| ${ }^{\text {d }}$ dston) | Small-Signal <br> Drain-Saurte <br> On-State <br> Resistence | $\begin{aligned} & v_{G S}=0, \quad I_{D}=0, \\ & f=1 \mathrm{kHz} \end{aligned}$ |  | 25 |  | 40 |  | 60 |  | 25 |  | 40 |  | 0 | 0 |
| $c_{\text {iss }}$ | Common-Source <br> Short-Circuit <br> Input <br> Capacitance | $\begin{aligned} & V_{D S}=0, V_{G S}=-10 \mathrm{~V}, \\ & f=1 \mathrm{mHz} \end{aligned}$ |  | 18 |  | 18 |  | 18 |  | 18 |  | 18 |  | 14 | pF |
| $C_{\text {rss }}$ | Common-Source <br> Short-Circuilt <br> Revorse Transior <br> Capacitance | $\begin{aligned} & V_{D S}=0, v_{G S}=-10 v, \\ & f=1 \mathrm{mHz} \end{aligned}$ |  | 8 |  | 1 |  | 8 |  | 8 |  | 8 |  | 4 | pF |

*switching characteristics af $25^{\circ} \mathrm{C}$ free-air temperature

| PARAMETER |  | TEST CONDITIONS |  | $\begin{array}{r} \hline 2 N 4856 \\ 2 N 4859 \\ \hline \end{array}$ | $\begin{aligned} & \text { 2N4857 } \\ & \text { 2N4860 } \\ & \hline \end{aligned}$ | 2N4858 2N4861 | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | MAX | MAX | MAX |  |
| ${ }^{\text {d dion) }}$ | Turn-an <br> Delay Iime |  |  |  |  | 6 | 6 | 10 | ms |
| ${ }^{1}$ | Rise Itime | 3 | 4 |  |  | 10 | ns |
| 'off | Turn-0ff Time | 25 | 50 |  |  | 100 | m |

MOTE 3: This paramater must be measurad using pulse tectniques. $\mathrm{t}_{\mathrm{w}} \approx 100 \mathrm{~ms}$, duty cycle $\leq 10 \%$.
†These are nominal valuos; exact values vary slightly with transistor parameters.
*JEDEC registorad date

## TYPES 2N4856 THRU 2N4861, 2N4856A THRU 2N4861A N-CHANNEL SILICON JUNCTION FIELD-EFFECT TRANSISTORS

## 2N4856A THRU 2N4861A

*electrical characteristics of $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

| PARAMETER |  | TEST CONDITIONS | 2N4856A | 2N4857A | 2N4858A | 2N4859A | 2N4860A | 2N4861A | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | MIN MAX | MIN MAX | MIN MAX | MIN MAX | MIN MAX | MIN MAX |  |
| Vimjass | Gate-Source Brakdown Voltage |  | $\mathrm{I}_{G}=-1 \mu \mathrm{~A}, \quad V_{\text {OS }}=0$ | $-40$ | -40 | -40 | -30 | -30 | -30 | $V$ |
| Igss | Gate Reverse Current | $V_{G S}=-20 . \quad V, V_{D S}=0$ | -0.25 | -0.25 | -0.25 |  |  |  | nî |
|  |  | $\begin{aligned} V_{G S}=-20 \mathrm{~V}, & V_{D S}=0 \\ T_{A} & =150^{\circ} \mathrm{C} \end{aligned}$ | -0.5 | -0.5 | -0.5 |  |  |  | $\mu \mathrm{A}$ |
|  |  | $V_{G S}=-15 V, V_{D S}=0$ |  |  |  | $-0.25$ | -0.25 | $-0.25$ | nA |
|  |  | $\begin{array}{ll} V_{G S}=-15 \mathrm{~V}, & V_{D S}=0 \\ T_{A}=150^{\circ} \mathrm{C} \end{array}$ |  |  |  | -0.5 | -0.5 | -0.5 | $\mu \mathrm{A}$ |
| $l_{\text {DIofi }}$ | Drain Cutoff Current | $V_{D S}=15 \mathrm{~V}, \quad V_{G 5}=-10 \mathrm{~V}$ | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | nA |
|  |  | $\begin{array}{ll} V_{D S}=15 \mathrm{~V}, & V_{G S}=-10 \mathrm{~V} \\ & \mathrm{I}_{\mathrm{A}}=150^{\circ} \mathrm{C} \end{array}$ | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | $\mu \mathrm{A}$ |
| $V_{\text {SSOFIf }}$ | Gote-Source Cutoff Voltage | $V_{\text {DS }}=15 \mathrm{~V}, \quad \mathrm{I}_{\mathrm{D}}=0.5 \mathrm{nA}$ | -4 -10 | $-2 \quad-6$ | -0.8 -4 | -4 -10 | -2 -6 | -0.8 -4 | V |
| IDss | Zero-Gate- <br> Voltage <br> Drain Current | $\begin{array}{ll} V_{D S}=15 \mathrm{Y}, & \begin{array}{l} \mathbf{Y}_{G S}=0 \\ \text { See Note } 3 \end{array} \end{array}$ | 50 | $20 \quad 100$ | 880 | 50 | $20 \quad 100$ | 880 | mA |
| $V_{\text {DS }}(\mathrm{mm})$ | Drain-Source <br> On-State <br> Voltage | $\mathrm{I}_{\mathrm{D}}=20 \mathrm{~mA}, \quad V_{\text {GS }}=0$ | 0.75 |  |  | 0.75 |  |  | $V$ |
|  |  | $\mathrm{I}_{\mathrm{D}}=10 \mathrm{~mA}, \quad V_{G S}=0$ |  | 0.5 |  |  | 0.5 |  |  |
|  |  | $I_{D}=5 \mathrm{~mA}, \quad V_{G S}=0$ |  |  | 0.5 |  |  | 0.5 |  |
| Pdsions | Small-Signal Drain-Source On-State Resistance | $\begin{array}{ll} v_{G S}=0, & I_{D}=0_{1} \\ & f=1 \mathrm{kHz} \end{array}$ | 25 | 40 | 60 | 25 | 40 | 60 | $\boldsymbol{\Omega}$ |
| $C_{\text {st }}$ | Common-Source Short-Gircuit Input Capacitance | $\begin{array}{ll} V_{D S}=0, & V_{G S}=-10 V_{4} \\ I=1 \mathrm{MHz} \end{array}$ | 10 | 10 | 10 | 10 | 10 | 10 | pF |
| $C_{5 \times}$ | Common-Sourte Short-Circuit Reverse Transler Copacitance | $\begin{array}{ll} V_{D S}=0, & V_{G S}=-10 V_{1} \\ & f=1 \mathrm{MHz} \end{array}$ | 4 | 3.5 | 3.5 | 4 | 3.5 | 3.5 | , $\mathbf{F}$ |

## *switching characteristics at $\mathbf{2 5}{ }^{\circ} \mathrm{C}$ free-air temperature

| PARAMETER | TEST CONDITIONS | $\begin{aligned} & \text { 2N4856A } \\ & 2 N 4859 A \end{aligned}$ | $\begin{aligned} & \text { 2N4857A } \\ & \text { 2N4860A } \\ & \hline \end{aligned}$ | $\begin{aligned} & \text { 2N4858A } \\ & \text { 2N4861A } \\ & \hline \end{aligned}$ | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | TYP MAX | TYP MAX | TYP MAX |  |
|  Turn-On <br> Delay Time |  | 5 | 6 | 8 | ns |
| 1r Rise Time |  | 3 | 4 | 8 | ns |
| toft Turn-0ff Time |  | 20 | 40 | 80 | ns |
| tr Rise Time |  | 2 | 3 | 4 | ns |
| $t_{\text {en }} \quad$ Turn-On Time |  | 5.5 | 6.5 | 8 | ns |
| $t_{4} \quad$ Fall Time |  | 7 | 13 | 27 | m |
| toff Turn-0ff Time |  | 10 | 18 | 31 | ns |

[^92]
## TYPES 2N4856 THRU 2N4861, 2N4856A THRU 2N4861A N-CHANNEL SILICON JUNCTION FIELD-EFFECT TRANSISTORS

## PARAMETER MEASUREMENT INFORMATION



TEST CIRCUIT


| TYPES | $\mathbf{R}_{\mathrm{L}}$ | V $_{\text {GS(off) }}$ |
| :---: | :---: | :---: |
| 2N4856A, 2N4859A | $464 \Omega$ | -10 V |
| 2N4857A, 2N4860A | $953 \Omega$ | -6 V |
| 2N4858A, 2N4861A | $1910 \Omega$ | -4 V |

NOTES: a. The input waveforms are supplied by a generator with the following characteristics: $Z_{\text {out }}=50 \Omega$, duty cycle $\approx 2 \%$. b. Waveforms are monitored on an oscilloscope with the following characteristics: $t_{r} \leqslant 0.75 \mathrm{~ns}, \mathrm{R}_{\mathrm{in}} \geqslant 1 \mathrm{M} \Omega, \mathrm{C}_{\mathrm{in}} \leqslant 2.5 \mathrm{pF}$.

Figure 1


NOTE a: An equivalent generator and oscilloscope may be used. The oscilloscope must have a $50-\Omega$ input impedance.
FIGURE 2

# PLANAR UNIJUNCTION SILECT ${ }^{\dagger}$ TRANSISTORS $\ddagger$ FOR APPLICATION IN SCR DRIVERS, MOTOR-SPEED CONTROLS, TIMERS, WAVEFORM GENERATORS, MULTIVIBRATORS, RING COUNTERS, ELECTRONIC ORGANS, AND MILITARY FUZES 

- Low Leakage Allows More Accurate Timing Circuit Design
- High Performance Capability at Low Drive Currents
- Provides Wider Range of Design Applications than Bar-Type Unijunction Transistors
- Rugged, One-Piece Construction Features Standard 100-mil TO-18 Pin-Circle


## mechanical data

These transistors are encapsulated in a plastic compound specifically designed for this purpose, using a highly mechanized process developed by Texas Instruments. The case will withstand soldering temperatures without deformation. These devices exhibit stable characteristics under high-humidity conditions and are capable of meeting MIL-STD-202C, Method 106B. The transistors are insensitive to light.

*absolute maximum ratings af $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)
Emitter - Base-Two Reverse Voltage
Interbase Voltage
Continuous Emitter Current.

NOTES: 1. Intervase voltage is limited solely by power dissipation, $\mathrm{V}_{\mathrm{B} 2-\mathrm{B} 1}=\sqrt{\mathrm{r}_{\mathrm{BB}} \cdot \mathrm{P}_{\mathrm{T}}}$.
2. This value applies for a capacitor discharge through the emitter-baseone diode. Current must fall to 0.37 A within 3 ms and pulse-repetition rate must not exceed 10 pps.
3. Derate linearly to $150^{\circ} \mathrm{C}$ free-air temperature at the rate of $2.88 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$.

[^93]
## TYPES 2N4891 THRU 2N4894 P-N PLANAR SILICON UNIJUNCTION TRANSISTORS

*electrical characteristics at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

|  | PARAMETER | TEST CONDITIONS | $\begin{array}{\|c\|} \hline \text { 2N4891 } \\ \hline \text { MIN MAX } \\ \hline \end{array}$ | $\begin{array}{\|c\|} \hline \text { 2N4892 } \\ \hline \text { MIN MAX } \\ \hline \end{array}$ | $\begin{array}{\|l\|} \hline \text { 2N4893 } \\ \hline \text { MINMAX } \\ \hline \end{array}$ | N MAX | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| $\mathrm{r}_{\mathrm{B}}$ | Static Interbase Resistance | $V_{B 2-81}=3 V_{V} I_{E}=0$ | 49.1 | 49.1 | $4 \quad 12$ | $4 \quad 12$ | $\mathrm{k} \Omega$ |
| $\alpha_{\text {rab }}$ | Interbase Resistance Temperature Coefficient | $\begin{aligned} & V_{E_{2}-81}=3 V_{1} \quad I_{\xi}=0, \\ & T_{A}=-55^{\circ} \mathrm{C} \text { to } 100^{\circ} \mathrm{C}, \quad \text { See Note } 4 \end{aligned}$ | 0.10 .9 | 0.10 .9 | 0.10 .9 | 0.10 .9 | \%/deg |
| $\eta$ | Intrinsic Stondoff Ratio | $V_{\text {B2-b1 }}=10 \mathrm{~V}$, See Figure 1 | $0.55 \quad 0.82$ | $0.51 \quad 0.69$ | 0.55 0.82 | $0.74 \quad 0.86$ |  |
| 182 mod) | Modulated Interbase Current | $V_{\text {B2-B1 }}=10 \mathrm{~V}, \mathrm{I}_{\mathrm{E}}=50 \mathrm{~mA}$, See Note 5 | 10 | 10 | 10 | 10 | mA |
| $\mathrm{l}_{\text {E } 210}$ | Emitter Reverse Current | $\mathrm{V}_{\mathrm{EB2}}=-30 \mathrm{~V}, \mathrm{I}_{\mathrm{BI}^{\prime}}=0$ | -10 | -10 | -10 | -10 | nA |
| Ip | Peak-Point Emitter Current | $V_{82-81}=25 \mathrm{~V}$ | 5 | 2 | 2 | 1 | $\mu A$ |
| $V_{\text {EB }}($ (at) $)$ | Emitter - Bass-One Saturation Voltage |  | 4 | 4 | ${ }^{4}$ | 4 | V |
| IV | Valiey-Point Emitter Current | $\mathrm{V}_{\mathrm{ER}-81}=20 \mathrm{~V}$ | 2 | 4 | 2 | 2 | mA |
| Vom | Base-One Peak Pulse Volfage | See figure 2 | 3 | 3 | 6 | 3 | V |

NOTES: 4. Temperature confficieni, $\alpha_{\text {reas }}$ is datermined by the folliowing formula:

$$
\begin{aligned}
\alpha_{\mathrm{rBB}}=\left[\frac{\left(\mathrm{r}_{\mathrm{BE}} @ 100^{\circ} \mathrm{C}\right)-\left(\mathrm{r}_{\mathrm{BE}} @-55^{\circ} \mathrm{C}\right)}{\left(\mathrm{r}_{\mathrm{BE}} @ 25^{\circ} \mathrm{C}\right.}\right] \frac{100 \%}{155 \mathrm{deg}} \\
\mathrm{r}_{\mathrm{BE}(2)}=\left[\mathrm{r}_{\mathrm{BE}} @ 25^{\circ} \mathrm{C}\right]\left[1+\left(\alpha_{\mathrm{rBB}} / 100\right)\left(\mathrm{T}_{\mathrm{A}|2|}-25^{\circ} \mathrm{C}\right)\right]
\end{aligned}
$$

To obtain rase for a given semperature $T_{A\{2]}$, use the following formula:
5. Thase parameters must be measured using pulse tochniques. $t_{p}=300 \mu s$, duty cycle $\leq 2 \%$.
*JEDEC registerad data
PARAMETER MEASUREMENT INFORMATION

$\boldsymbol{\eta}$-Intrinsic Standoff Ratio - This parameter is defined in torms of the peak-point voltage, $V_{p}$ by means of the equation: $V_{p}=\eta$ $V_{82 m}+V_{F}$, where $V_{F}$ is about 0.56 volt at $25^{\circ} \mathrm{C}$ and decreases with temperature at about 2 millivolts/deg.

The circuit used to measure $\eta$ is shown in the figure. In this circuit, $R_{1}, C_{1}$ and the unijunction transistor form a relaxation ascillator, and the remoinder of the circuit serves as a peak-voltage detector with the diode $D_{1}$ automatically subtracting the voltaga $V_{F}$. To use the circuit, the "cal"' button is pushed, and $R_{3}$ is adjusted to make the current meter $M_{1}$ read full scale. The "cal" button then is released and the value of $\eta$ is read directly from the mater, with $\eta=1$ corresponding to full.seale deflection of $100 \mu \mathrm{~A}$.
$D_{1}$ : IN457, or equivalant, with the following characteristics:
$V_{\mathrm{F}}=0.565 \mathrm{~V}_{\text {at }} \mathrm{I}_{\mathrm{F}}=50 \mu \mathrm{~h}$,
$\mathrm{I}_{\mathrm{R}} \leq 2 \mu \mathrm{~A}$ at $\mathrm{V}_{\mathrm{R}}=20 \mathrm{~V}$
FIGURE 1 - TEST CIRCUIT FOR INTRINSIC STANDOFF RATIO ( $\eta$ )


EMITTER-BASE-ONE VOLTAGE
vs
EMITTER CURRENT


FIGURE 3 - GENERAL STAIIC EMITTER CHARACTERISTIC CURVE

# PLANAR UNIJUNCTION TRANSISTORS SPECIFICALLY CHARACTERIZED FOR A WIDE RANGE OF MILITARY, SPACE, AND INDUSTRIAL APPLICATIONS: <br> 2N3980 for General-Purpose UJT Applications <br> 2N4947 for High-Frequency Relaxation-Oscillator Circuits <br> 2N4948 for Thyristor (SCR) Trigger Circuits <br> 2N4949 for Long-Time-Delay Circuits 

- Planar Process Ensures Extremely Low Leakage, High Performance with Low Driving Currents, and Greatly Improved Reliability


## *mechanical data

Package outline is same as JEDEC TO-18 except for lead position. All TO-18 registration notes also apply to this outline.


NOIES: 1. Interbase voltage is limited salely by power dissipation, $\boldsymbol{V}_{\mathbf{B 2}-\mathrm{Bl}}=\sqrt{\mathrm{r}_{\mathrm{BB}}{ }^{*} \mathrm{P}_{\mathrm{T}}}$
2. This value applies for a capaciter discharge through the emitter-base-one diode. Current must fall to 0.37 a within 3 ms and pulse-repesition rate must nof exceed 10 pps.
3. Derate linearly to $175^{\circ} \mathrm{C}$ free-air temperature at the rate of $2.4 \mathrm{~mW} / \mathrm{deg}$.
*Indicates JEDEC registered data

## TYPES 2N3980, 2N4947 THRU 2N4949 <br> P-N PLANAR SILICON UNLJUNCTION TRANSISTORS

*electrical characteristics at $25^{\circ} \mathrm{C}$ free-air temparature (unless otherwise noted)

| PARAMETER |  | TEST CONDITIONS | 2N3980 | 2N4947 | 2N4948 | 2N4949 | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | MIN MAX | MIN MAX | MIN MAX | MIN MAX |  |
| ${ }^{\text {fab }}$ | Slatic Interbese Resistance |  | $\mathbf{V}_{\mathrm{E} 2-\mathrm{B} 1}=3 \mathrm{~V}, \quad \mathrm{I}_{\mathrm{E}}=0$ | 48 | 49.1 | 112 | 412 | $\mathrm{k} \Omega$ |
| $\alpha_{\text {reb }}$ | Interbase Resistance <br> Temperature Coefficient | $\begin{aligned} & V_{B 2-B 1}=3 V, \quad I_{E}=0, \\ & T_{A}=-65^{\circ} \mathrm{C} \text { to } 100^{\circ} \mathrm{C}, \end{aligned}$ <br> Sod Hote 4 | 0.40 .9 | 0.10 .9 | 0.10 .9 | 0.10 .9 | \%/deg |
| $\boldsymbol{\eta}$ | Intrinsic Standoff Retio | $\mathbf{V}_{\text {B2-B1 }}=10 \mathrm{~V}^{\text {, }} \quad$ See Figure I | $0.68 \quad 0.82$ | 0.510 .69 | 0.550 .82 | $0.74 \quad 0.86$ |  |
| $\mathrm{I}_{\mathrm{B} 2 \text { madj }}$ | Modulated Interbase Current | $\mathbf{V}_{\mathrm{B2}-\mathrm{B1}}=10 \mathrm{~V}, \mathrm{I}_{\mathbf{E}}=50 \mathrm{~mA}$, See Mate 5 | 12 | 12 | 12 | 12 | mA |
| ${ }^{\text {I E E2O }}$ | Emitter Ravarse Curvent | $\mathrm{V}_{\mathrm{EB} 2}=-30 \mathrm{~V}, \quad \mathrm{I}_{\mathrm{B} 1}=0$ | -10 | -10 | $-10$ | -10 | nh |
|  |  | $\mathrm{V}_{\mathrm{EB2} 2}=-30 \mathrm{~V}, \quad \mathrm{I}_{\mathrm{B} 1}=0, \quad \mathrm{~T}_{\mathrm{A}}=125^{\circ} \mathrm{C}$ | -1 | -1 | -1 | -1 | $\mu \mathrm{A}$ |
| ${ }^{1} \mathrm{p}$ | Peak-Point Emilter Current | $\mathrm{V}_{82 \cdot \mathrm{Bl}}=25 \mathrm{~V}$ | 2 | 2 | 2 | 1 | $\mu \mathrm{A}$ |
| VE8)(sent | Emittry - Bess-One <br> Saturation Yeltage | $\mathbf{V}_{\mathbf{B 2}-\mathrm{BI}}=10 \mathrm{~V}, \quad \mathrm{I}_{\mathbf{E}}=50 \mathrm{~mA}, \mathrm{Sec}$ Nole 5 | 3 | 3 | 3 | 3 | $V$ |
| Iv | Valloy-Point Emitier Current | $\mathrm{V}_{\mathrm{B2}-\mathrm{B1}}=20 \mathrm{~V}$ | 110 | 4 | 2 | 2 | mA |
| $Y_{\text {osi }}$ | Cose-One Peak Pulse Yoltage | See Figure 2 | 6 | 3 | 6 | 3 | V |

NOTES: 4. Temperature confficient $\alpha_{r}$ be determined by the following formula:

To abtrin r $_{\text {Be }}$ for a given temperature $T_{A \mid 22}$, wse the following tormula:

$$
\left.{ }_{\mathrm{BB}(2]}=\left[\mathrm{r}_{\mathrm{BB}} @ 25^{\circ} \mathrm{C}\right]\left[1+\left(\alpha_{\mathrm{rB}} / 100 \%\right) \mathrm{Hf}_{\mathrm{A}(2)^{2}}-25^{\circ} \mathrm{C}\right]\right]
$$

5. Thase parameters are measured using pulse techniques. $t_{p}=300 \mu \mathrm{~s}$, duty cycle $\leq \mathbf{2 \%}$.
*PARAMETER MEASUREMENT INFORMATION


EMITTER-bASE-ONE VOLTAGE
vs
emitter Current

figure 3 - general static emitter charactenistic curve

# HIGH-FREQUENCY SILECT ${ }^{\dagger}$ TRANSISTORS $\ddagger$ FOR TUNER AND IF-AMPLIFIER STAGES IN FM AND AM/FM STEREO-MULTIPLEX RECEIVERS 

\author{

- Rugged, One-Piece Construction with Standard TO-18 100-mil Pin-Circle
}


## mechanical data

These transistors are encapsulated in a plastic compound specifically designed for this purpose, using a highly mechanized process developed by Texas Instruments. The case will withstand soldering temperatures without deformation. These devices exhibit stable characteristics under high-humidity conditions and are capable of meeting MIL-STD-202C, Method 106B. The transistors are insensitive to light.


* absolute maximum ratings at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)


NOTES: 1. This value applies when the base-emitter diode is open-circuited. 2. Derate linearly to $150^{\circ} \mathrm{C}$ free-air temperature at the rate of $2 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$.
*JEDEC registered data
${ }^{1}$ Trademark of Texas Instruments
キU.S. Patent No. 3,439,238

## TYPES 2N4996, 2N4997 <br> N-P-N SILICON TRANSISTORS

*electrical characteristics at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

| PARAMETER | TEST CONDITIONS | 2N4996 | 2N4997 | UNIT |
| :---: | :---: | :---: | :---: | :---: |
|  |  | MIN TYP MAX | MIN TYP MAX |  |
| $\mathbf{V}_{(0 \times) \text { cio }}$ Collector-Base Breakdown Voltage | $\mathrm{I}_{\mathrm{C}}=10 \mu \mathrm{~A}, \mathrm{I}_{\mathrm{E}}=0$ | 30 | 30 | $v$ |
|  | $\mathrm{I}_{\mathrm{C}}=2 \mathrm{~mA}, \mathrm{I}_{\mathrm{B}}=0, \quad$ See Note 3 | 18 | 18 | $V$ |
|  | $\mathrm{I}_{\mathrm{E}}=10 \mu \mathrm{~A}, \mathrm{I}_{\mathrm{C}}=0$ | 4 | 4 | $V$ |
| Collector Cutoff Current | $V_{C E}=15 \mathrm{~V}, \mathrm{I}_{\mathrm{E}}=0$ | 100 | 100 | nA |
|  | $V_{C B}=15 \mathrm{~V}, \mathrm{I}_{\mathrm{E}}=0, \quad \mathrm{~T}_{\mathrm{A}}=85^{\circ} \mathrm{C}$ | 10 | 10 | $\mu \mathrm{A}$ |
| het Static Forward Current Iranseer Ratio | $V_{C E}=10 \mathrm{~V}, \mathrm{I}_{\mathrm{C}}=2 \mathrm{~mA}$ | 50 | $30 \quad 150$ |  |
| $\left\|h_{\text {to }}\right\| \quad$Small-Signal Common-Emitter <br> Forward Current Tronsfer Ratio | $\mathrm{V}_{\text {CE }}=10 \mathrm{~V}, \mathrm{I}_{\mathrm{c}}=2 \mathrm{~mA}, 1=100 \mathrm{mHz}$ | 614 | $6 \quad 14$ |  |
| $\left\|\boldsymbol{Y}_{\mathrm{f}}\right\| \quad$Small-Signal Common-Emilter <br> Forward Transfer Admittance | $\mathrm{V}_{\mathrm{CE}}=10 \mathrm{~V}, \mathrm{I}_{\mathrm{C}}=2 \mathrm{~mA}, f=10 \mathrm{mHz}$ |  | 70 | mmho |
| $\mathrm{C}_{\mathrm{cb}} \quad$ Collector-Base Capacitance | $\begin{array}{lll}V_{C B}=10 \mathrm{~V}, \mathrm{I}_{\mathrm{E}}=0, & \begin{array}{l}f=1 \\ \text { See Note 4z, }\end{array}\end{array}$ | 0.10 .65 | 0.10 .65 | pf |
| Toap Parallel-Equivalent Common-Emitter <br> Short-Circuit Output Resistance | $V_{C E}=10 \mathrm{~V}, \mathrm{I}_{\mathrm{C}}=2 \mathrm{~mA}, \mathrm{f}=10 \mathrm{MHz}$ |  | 50 | k $\Omega$ |
| $\mathrm{r}_{\mathrm{b}}{ }^{\prime} \mathrm{C}_{\mathrm{c}}$ Colllector-Base Jime Constant | $\mathrm{V}_{C B}=10 \mathrm{~V}, \mathrm{I}_{\mathrm{E}}=-2 \mathrm{~mA}, \mathrm{f}=79.8 \mathrm{mHz}$ | $14 \quad 20$ | 1420 | ps |

operating characteristics af $25^{\circ} \mathrm{C}$ free-air temperafure

| PARAMETER | TEST CONDITIONS | $\frac{\text { 2N4996 }}{\text { TYP }}$ | UNIT |
| :---: | :---: | :---: | :---: |
| NF Spot Noise Figure | $V_{\text {CE }}=10 \mathrm{~V}, \mathrm{I}_{\mathrm{C}}=2 \mathrm{~mA}, R_{G}=100 \Omega, f=100 \mathrm{mHz}$ | 2.5 | dB |

NOTES: 3. This parameter must be measured using pulse techniques. $t_{w}=300 \mu s$, duty cycle $\leqslant 2 \%$.
4. Ccb masurement employs a three-terminal capacitance bridge incorporating a guard cirucit. The emitter is connected to the guard terminal of the bridge.
*JEDEC registered data

## MATCHED FIELD-EFFECT TRANSISTORS

- High |yfs $/ / C_{i s s}$ Ratio (High-Frequency Figure-of-Merit)
- Low Input Capacitance Ciss . . . 8 pF Max
- Low Gate Reverse Current Differential . . . 10 nA Max at $\mathrm{T}_{\mathrm{A}}=\mathbf{1 0 0}^{\circ} \mathrm{C}$
- Recommended for Low-Level D-C Amplifiers, Sample-Hold Circuits, and Series-Shunt Choppers


## *mechanical data


*absolute maximum ratings at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)
EACH
TOTAL

NOTE 1: Derate linearly to $175^{\circ} \mathrm{C}$ free-air temperature at the rates of $1.67 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$ for each triode and $2.67 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$ for the total device. *JEDEC registered data. This data sheet contains all appllcable registered deta in effect at the time of publication.

## TYPES 2N5045, 2N5046, 2N5047 <br> DUAL N-CHANNEL SILICON JUNCTION FIELD-EFFECT TRANSISTORS

*electrical characteristics at $\mathbf{2 5} \mathbf{}{ }^{\mathbf{C}} \mathbf{C}$ free-air temperature (unless otherwise noted)
individual triode characteristics (see note 2)

| PARAMETER | TEST CONDITIONS |  | MIN MAX | UNIT |
| :---: | :---: | :---: | :---: | :---: |
| 'GSS Gate Reverse Current | $V_{\text {GS }}=-50 \mathrm{~V}, \mathrm{~V}_{\text {DS }}=0$ |  | -1 | $\mu \mathrm{A}$ |
|  | $\mathrm{V}_{\mathrm{GS}}=-30 \mathrm{~V}, \mathrm{~V}_{\mathrm{DS}}=0$ |  | -0.25 | nA |
|  | $V_{G S}=-30 \mathrm{~V}, \mathrm{~V}_{\mathrm{DS}}=0$, | $\mathrm{T}_{\mathrm{A}}=150^{\circ} \mathrm{C}$ | -250 | nA |
| VGS(off) Gate-Source Cutoff Voltage | $V_{D S}=15 \mathrm{~V}, \mathrm{I}_{\mathrm{D}}=0.5 \mathrm{nA}$ |  | -0.5 -4.5 | V |
| IDSS Zero-Gate-Voltage Drain Current | $\mathrm{V}_{\text {DS }}=15 \mathrm{~V}, \mathrm{~V}_{\mathrm{GS}}=0$ |  | 0.58 | mA |
| $\left\lvert\, \begin{array}{ll}\text { fi } \\ \text { Small-Signal Common-Source Forward Transfer Admittance }\end{array}\right.$ | $\mathrm{V}_{\mathrm{DS}}=15 \mathrm{~V}, \quad \mathrm{~V}_{\mathrm{GS}}=0$, | $\mathrm{f}=1 \mathrm{kHz}$ | 1.56 | mmho |
| Vos Small-Signal Common-Source Output Admittance | $V_{\mathrm{DS}}=15 \mathrm{~V}, \quad \mathrm{~V}_{\mathrm{GS}}=0$, | $f=1 \mathrm{kHz}$ | 25 | $\mu \mathrm{mho}$ |
| $\mathrm{C}_{\text {iss }}$ Small-Signal Common-Source Input Capacitance | $V_{\text {DS }}=15 \mathrm{~V}, \mathrm{~V}_{\text {GS }}=0$, | $\mathrm{f}=1 \mathrm{MHz}$ | 8 | pF |
| $\mathrm{Crgs}_{\text {rss }} \quad$ Small-Signal Common-Source Reverse Transfer Capacitance | $V_{D S}=15 \mathrm{~V}, \mathrm{~V}_{\mathrm{GS}}=0$, | $\mathrm{f}=1 \mathrm{MHz}$ | 4 | pF |
|  | $V_{D S}=15 \mathrm{~V}, \mathrm{~V}_{\mathrm{GS}}=0$, | $f=100 \mathrm{MHz}$ | 1.5 | mmho |

triode matching characteristics

| PARAMETER |  | TEST CONDITIONS | 2N5045 |  | 2N5046 |  | 2N5047 |  | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | MIN | MAX | MIN | MAX | MIN | MAX |  |
| $\left\|\mathbf{I G S S 1}^{-1} \mathbf{G S S} 2\right\|$ | Gate-Reverse-Current Differential |  | $\begin{array}{r} V_{G S}=-15 \mathrm{~V}, \\ V_{D S}=0, \\ T_{A}=100^{\circ} \mathrm{C} \end{array}$ |  | 10 |  | 10 |  | 10 | nA |
| $N_{G S 1}-V_{G S 2} \mid$ | Gate-Source-Voltage Differential | $V_{D S}=15 \mathrm{~V}, \quad 1 \mathrm{D}=50 \mu \mathrm{~A}$ |  | 5 |  | 10 |  | 15 | mV |
|  |  | $V_{D S}=15 \mathrm{~V}, \mathrm{I}_{\mathrm{D}}=200 \mu \mathrm{~A}$ |  | 5 |  | 10 |  | 15 |  |
| $\left\|\Delta\left(V_{G S 1}-V_{G S 2}\right)_{\Delta T_{A}}\right\|$ | Gate-Source-Voltage-Differential Change with Temperature | $\begin{aligned} & V_{D S}=15 \mathrm{~V}, \quad I_{D}=200 \mu \mathrm{~A}, \\ & T_{A(1)}=25^{\circ} \mathrm{C}, T_{A(2)}=-25^{\circ} \mathrm{C} \end{aligned}$ |  | 5 |  | 10 |  | 15 | mV |
|  |  | $\begin{aligned} & V_{D S}=15 \mathrm{~V}, \\ & I_{D}=200 \mu \mathrm{~A}, \\ & T_{A(1)}=25^{\circ} \mathrm{C}, \\ & T_{A(2)}=100^{\circ} \mathrm{C} \end{aligned}$ |  | 5 |  | 10 |  | 15 |  |
| $\frac{\operatorname{IDSS} 1}{\operatorname{IDSS} 2}$ | Zero-Gate-Voltage Drain Current Ratio | $\begin{array}{ll} \mathrm{V}_{\mathrm{DS}}=15 \mathrm{~V}, & \mathrm{~V}_{\mathrm{GS}}=0, \\ & \text { See Note } 3 \end{array}$ | 0.95 | 1 | 0.9 | 1 | 0.8 | 1 |  |
| $\frac{y_{f s} l_{1}}{V_{\text {fs }} l_{2}}$ | Small-Signal Common-Source Forward Transfer Admittance Ratio | $\begin{array}{ll} V_{D S}=15 \mathrm{~V}, & I_{D}=200 \mu \mathrm{~A}, \\ f=1 \mathrm{kHz}, & \text { See Note } 3 \end{array}$ | 0.95 | 1 | 0.9 | 1 | 0.8 | 1 |  |
| $\left.v_{o s}\right\|_{1}-V_{o s} l_{2}$ | Small-Signal CommonSource Output Admittance Differential | $\begin{array}{ll} V_{D S}=15 \mathrm{~V}, & I_{D}=200 \mu \mathrm{~A}, \\ f=1 \mathrm{kHz}, & \text { See Note } 3 \end{array}$ |  | 1 |  | 2 |  | 3 | $\mu \mathrm{mho}$ |

*operating characteristics at $25^{\circ} \mathrm{C}$ free-air temperature
individual triode characteristics (see note 2)

| PARAMETER |  | TEST CONDITIONS | 2N5045 | 2N5046 | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | MAX | MAX |  |
| F | Spot Noise Figure |  | $\begin{array}{lll} \mathrm{V}_{\mathrm{DS}}=15 \mathrm{~V}, & \mathrm{~V}_{\mathrm{GS}}=0, & \mathrm{f}=10 \mathrm{~Hz}, \\ \mathrm{R}_{\mathrm{G}}=1 \mathrm{M} \Omega, & \text { Noise Bandwidth }=5 \mathrm{~Hz} \\ \hline \end{array}$ | 5 | 5 | dB |
| $V_{n}$ | Equivalent Input Noise Voltage | $V_{D S}=15 \mathrm{~V}, \quad V_{G S}=0, \quad f=10 \mathrm{~Hz},$ <br> Noise Bandwidth $=5 \mathrm{~Hz}$ | 200 | 200 | $n \mathrm{~V} / \sqrt{\mathrm{Hz}}$ |

NOTES: 2. The terminals of the triode not under test are open-circuited for the measurement of these characteristics.
3. The lower of the two characteristic readings is taken as the numerator or subtrahend.
*JEDEC registered data

## HIGH-VOLTAGE 10-WATT TRANSISTORS FOR GENERAL PURPOSE AMPLIFIER APPLICATIONS IN LINE-OPERATED CIRCUITS

- Solid-State Relays
- High-Voltage Inverters
- Voltage Regulators
- TV Sweep Circuits
mechanical data

absolute maximum ratings at $\mathbf{2 5}{ }^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)


[^94]
## TYPES 2N5058, 2 N5059 <br> N-P-N SILICON TRANSISTORS

*electrical characteristics at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

| PARAMETER | TEST CONDITIONS | 2N5058 | 2N5059 | UNIT |
| :---: | :---: | :---: | :---: | :---: |
|  |  | MIN MAX | MIN MAX |  |
| V ariceo Collector-Base Breakdown Voltage | $\mathrm{I}_{C}=100 \mu \mathrm{~A}, \mathrm{I}_{\mathrm{E}}=0$ | 300 | 250 | $V$ |
| V (br)ceo Collector-Emitter Breakdown Voltage | $\mathrm{I}_{\mathrm{C}}=30 \mathrm{~mA}, \mathrm{I}_{\mathrm{g}}=0, \quad$ See Note 4 | 300 | 250 | V |
| V ERIEEO Emilter-Base Breakdown Voltage | $\mathrm{I}_{E}=100 \mu \mathrm{~A}, \mathrm{I}_{\mathrm{c}}=0$ | 7 | 6 | $V$ |
| Collector Cutoff Currenf | $V_{C B}=100 \mathrm{~V}, \mathrm{I}_{\mathrm{E}}=0$ | 50 | 50 | nA |
|  | $V_{C B}=100 \mathrm{~V}, \mathrm{I}_{\mathrm{E}}=0, \quad \mathrm{I}_{\mathrm{A}}=125^{\circ} \mathrm{C}$ | 20 | 20 | $\mu \mathrm{A}$, |
| Ieso Emitter Cutoff Current | $V_{E s}=5 \mathrm{~V}, \quad I_{C}=0$ | 10 | 10 | $n A$ |
| Static Forward Current Transfer Ratio | $V_{C E}=25 \mathrm{~V}, \mathrm{I}_{C}=5 \mathrm{~mA}$ | 10 | 10 |  |
|  | $V_{C E}=25 \mathrm{~V}, \mathrm{I}_{\mathrm{C}}=30 \mathrm{~mA}$ | $35 \quad 150$ | $30 \quad 150$ |  |
|  | $V_{C E}=25 \mathrm{~V}, \mathrm{l}_{\mathrm{C}}=100 \mathrm{~mA}$ Note | 35 | 30 |  |
|  | $\begin{aligned} V_{C E}=25 \mathrm{~V}, & \mathrm{I}_{\mathrm{C}}=30 \mathrm{~mA} \\ & \mathrm{~T}_{\mathrm{A}}=-55^{\circ} \mathrm{C} \end{aligned}$ | 10 |  |  |
| Base-Emitter Voltage | $V_{C E}=25 \mathrm{~V}, \quad \mathrm{I}_{\mathrm{C}}=30 \mathrm{~mA}$, See Note 4 | 0.82 | 0.82 | $V$ |
|  | $\mathrm{I}_{\mathrm{B}}=3 \mathrm{~mA}, \quad \mathrm{I}_{\mathrm{C}}=30 \mathrm{~mA}$, See Note 4 | 0.85 | 0.85 | $V$ |
| $\mathrm{V}_{\text {CE(eat }}$ Collector-Emitter Suturation Voltage | $I_{B}=3 \mathrm{~mA}, \quad I_{c}=30 \mathrm{~mA}$, See Note 4 | 1 | 1 | $V$ |
| \|htolSmall-Signal Common-Emitter <br> Forwasd Current Iransfor Ratio | $V_{C E}=25 \mathrm{~V}, \quad \mathrm{l}_{\mathrm{C}}=10 \mathrm{~mA}, \mathrm{f}=20 \mathrm{MHz}$ | 1.58 | 1.58 |  |
| $C_{\text {cb }} \quad$ Collector-Base Capacitance | $V_{C B}=10 \mathrm{~V}, \quad \mathrm{I}_{\mathrm{E}}=0, \quad \begin{aligned} & f=1 \mathrm{MHz}, \\ & \text { See Note } 5\end{aligned}$ | 10 | 10 | pF |
| Cobe Emitier-Base Capacitance | $\mathrm{V}_{\mathrm{EB}}=0.5 \mathrm{~V}, \mathrm{l}_{\mathrm{C}}=0, \quad \begin{aligned} & \mathrm{f}=1 \mathrm{MHz}, \\ & \text { jee Note } 5\end{aligned}$ | 75 | 75 | pF |

MOTES: 4. Thase paramotors must be measured using pulse techniques. $t_{p}=300 \mu$, duly cycle $\leq \mathbf{2 \%}$.
5. $C_{c b}$ and $\mathcal{C}_{\text {eb }}$ are massured using three-torminal measurament techniques with the third electrode (emifter or collector respectivaly) guarded.


[^95]
# HIGH-VOLTAGE SILECT ${ }^{\dagger}$ TRANSISTORS $\ddagger$ FOR GENERAL PURPOSE AMPLIFIER APPLICATIONS IN LINE-OPERATED CIRCUITS 

## - Solid-State Relays

- High-Voltage Inverters
- Voltage Regulators
- High-Voltage Indicator and Display Controls


## mechanical data

These transistors are encapsulated in a plastic compound specifically designed for this purpose, using a highly mechanized process developed by Texas Instruments. The case will withstand soldering temperatures without deformation. These devices exhibit stable characteristics under high-humidity conditions and are capable of meeting MIL-STD-202C, Method 106B. The transistors are insensitive to light.

absolute maximum ratings at $25^{\circ} \mathbf{C}$ free-air temperature (unless otherwise noted)


NOTES: 1. These values apply between 0 and 30 mA collector current when the base-emitter diode is open-circuited.
2. Derate linearly to $150^{\circ} \mathrm{C}$ free-air temperature at the rate of $6.4 \mathrm{~mW} / /^{\circ} \mathrm{C}$.
3. Derate linearly to $150^{\circ} \mathrm{C}$ lead temperature at the rate of $10 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$. Lead temperature is measured on the collector lead $\mathbf{1 / 1 6}$ inch from the case.
4. This rating applies with the entire case (including the leads) maintained at $25^{\circ} \mathrm{C}$. Derate linearly to $150^{\circ} \mathrm{C}$ case-and-lead temperature at the rete of $12.8 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$.

[^96]
## TYPES A5T5058, A5T5059 <br> N-P-N SILICON TRANSISTORS

electrical characteristics at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

| PARAMETER | TEST CONDITIONS |  | A5T5058 | A5T5059 | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  | MIN MAX | MIN MAX |  |
| $V_{\text {(BR) }}$ CBO Collector-Base Breakdown Voltage | $I_{C}=100 \mu A, \quad I_{E}=0$ |  | 300 | 250 | V |
| $\mathrm{V}_{(B R)}$ CEO Collector-Emitter Breakdown Voltage | $\mathrm{I}_{\mathrm{C}}=30 \mathrm{~mA}, \quad \mathrm{I}_{\mathrm{B}}=0$, | See Note 5 | 300 | 250 | V |
| $\mathrm{V}_{\text {(BR)EBO }}$ Emitter-Base Breakdown Voltage | $\mathrm{I}_{\mathrm{E}}=100 \mu \mathrm{~A}, \quad \mathrm{I}^{\prime}=0$ |  | 7 | 6 | V |
| ICbo Collector Cutoff Current | $V_{C B}=100 \mathrm{~V}, \mathrm{I}_{\mathrm{E}}=0$ |  | 50 | 50 | riA |
|  | $\mathrm{V}_{C B}=100 \mathrm{~V}, \mathrm{I}_{\mathrm{E}}=0$, | $\mathrm{T}_{A}=75^{\circ} \mathrm{C}$ | 2 | 2 | $\mu \mathrm{A}$ |
| IEBO Emitter Cutoff Current | $\mathrm{V}_{\mathrm{EB}}=5 \mathrm{~V}, \quad \mathrm{IC}=0$ |  | 10 | 10 | nA |
| Static Forward Current Transfer Ratio | $V_{C E}=25 \mathrm{~V}$, $\mathrm{IC}^{\prime}=5 \mathrm{~mA}$ | See Note 5 | 10 | 10 |  |
|  | $\mathrm{V}_{\text {CE }}=25 \mathrm{~V}, \mathrm{I}_{\mathrm{C}}=30 \mathrm{~mA}$ |  | $35 \quad 150$ | $30 \quad 150$ |  |
|  | $\mathrm{V}_{\text {CE }}=25 \mathrm{~V}, \mathrm{I}_{\mathrm{C}}=100 \mathrm{~mA}$ |  | 35 | 30 |  |
|  | $\begin{array}{ll} V_{C E}=25 \mathrm{~V}, & I_{C}=30 \mathrm{~mA} \\ & T_{A}=-55^{\circ} \mathrm{C} \end{array}$ |  | 10 |  |  |
| Base-Emitter Voltage | $V_{C E}=25 \mathrm{~V}, \mathrm{I}_{\mathrm{C}}=30 \mathrm{~mA}$ | See Note 5 | 0.82 | 0.82 | V |
|  | $\mathrm{I}_{\mathrm{B}}=3 \mathrm{~mA}, \quad \mathrm{I}_{\mathrm{C}}=30 \mathrm{~mA}$ |  | 0.85 | 0.85 |  |
| VCE(sat) Collector-Emitter Saturation Voltage | $\mathrm{I}_{\mathrm{B}}=3 \mathrm{~mA}, \quad I_{C}=30 \mathrm{~mA}$, | See Note 5 | 1 | 1 | V |
| $\left\|h_{\text {fel }}\right\|$ Small-Signal Common-Emitter <br> Forward Current Transfer Ratio | $V_{C E}=25 \mathrm{~V}, \mathrm{I}^{\prime}=10 \mathrm{~mA}$, | $f=\mathbf{2 0 M H z}$ | 1.58 | 1.58 |  |
| Cbb $\quad$ Collector-Base Capacitance | $\mathrm{V}_{C B}=10 \mathrm{~V}, \mathrm{I}_{\mathrm{E}}=0$, | $f=1 \mathrm{MHz},$ <br> See Note 6 | 10 | 10 | pF |
| $C_{\text {eb }} \quad$ Emitter-Base Capacitance | $V_{E B}=0.5 \mathrm{~V}, \mathrm{I}^{\prime}=0$, | $f=1 \mathrm{MHz}$ <br> See Note 6 | 75 | 75 | pF |

NOTES: 5. These parameters must be measured using pulse techniques. $t_{w}=300 \mu \mathrm{~s}$, duty cycle $\leqslant 2 \%$.
6. $\mathrm{C}_{\mathrm{cb}}$ and $\mathrm{C}_{\mathrm{eb}}$ measurements employ a three-terminal capacitance bridge incorporating a guard circuit. The third electrode (emitter or collector, respectively) is connected to the guard terminal of the bridge.

## THERMAL INFORMATION


figure 1

## SILECT ${ }^{\dagger}$ TRANSISTORS $\ddagger$

## FOR LOW-LEVEL, LOW-NOISE AUDIO AMPLIFIER APPLICATIONS

- For Complementary Use with N-P-N Types 2N5209, 2N5210, A5T5209, A5T5210
- Rugged One-Piece Construction with In-Line Leads or Standard TO-18 100-mil Pin-Circle Configuration


## mechanical data

These transistors are encapsulated in a plastic compound specifically designed for this purpose, using a highly mechanized process developed by Texas Instruments. The case will withstand soldering temperatures without deformation. These devices exhibit stable characteristics under high-humidity conditions and are capable of meeting MIL-STD-202C, Method 106B. The transistors are insensitive to light.


## TYPES 2N5086, 2N5087, A5T5086, A5T5087 <br> P-N-P SILICON TRANSISTORS

*electrical characteristics at $\mathbf{2 5}{ }^{\circ} \mathrm{C}$ free-air temperature

| PARAMETER |  | TEST CONDITIONS | 2N500\% A5T5086 | $\begin{gathered} \text { 2N6087 } \\ \text { A5T6087 } \end{gathered}$ | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | MIN MAX | MIN MAX |  |
| $V_{\text {(BR) }}$ CBO | Collector-Base Breakdown Voltage |  | $I_{C} \quad 100 \mu A, l_{E}=0$ | -50 | -50 | V |
| $V_{\text {(BR) }}$ CEO | Collector-Emitter Breakdown Voltage | $\mathrm{I}_{\mathrm{C}}=11 \mathrm{~mA}, \quad \mathrm{I}_{\mathrm{B}}=0, \quad$ See Note 3 | -50 | -50 | V |
| ICBO | Collector Cutoff Current | $V_{C B}=-35 \mathrm{~V}, \mathrm{I}_{\mathrm{E}}=0$ | -50 | -50 | nA |
| IEBO | Emitter Cutoff Current | $V_{E B}=-3 \mathrm{~V}, \mathrm{IC}=0$ | -50 | -50 | nA |
| hFE | Static Forward Current Transfer Ratio | $V_{C E}=-5 \mathrm{~V}, \quad I_{C}=-100 \mu \mathrm{~A}$ | $150 \quad 500$ | $250 \quad 800$ |  |
|  |  | $\mathrm{V}_{\text {CE }}=-5 \mathrm{~V}$, $\mathrm{I}_{\mathrm{C}}=-1 \mathrm{~mA}$ | 150 | 250 |  |
|  |  | $\mathrm{V}_{\text {CE }}=-5 \mathrm{~V}, \mathrm{I}^{\prime} \mathrm{C}=-10 \mathrm{~mA}$, See Note 3 | 150 | 250 |  |
| VBE | Base-Emitter Voltage | $\mathrm{V}_{\text {CE }}=-5 \mathrm{~V}$, $\mathrm{I}_{\mathrm{C}}=-1 \mathrm{~mA}$ | -0.85 | -0.85 | V |
| $V_{\text {CE }}$ (sat) | Collector-Emitter Saturation Voltage | $\mathrm{I}_{\mathrm{B}}=-1 \mathrm{~mA}, \quad \mathrm{I}_{\mathrm{C}}=-10 \mathrm{~mA}$, See Note 3 | -0.3 | -0.3 | V |
| $h_{\text {fe }}$ | Small-Signal Common-Emitter Forwerd Current Transfer Ratio | $V_{C E}=-5 \mathrm{~V}, \quad \mathrm{I}^{\prime}=-1 \mathrm{~mA}, \quad f=1 \mathrm{kHz}$ | 150600 | $250 \quad 900$ |  |
| ${ }_{\text {f }}$ | Transition Frequency | $\mathrm{V}_{\text {CE }}{ }^{\text {F }}-5 \mathrm{~V}$, $\mathrm{I}^{\text {c }}=-500 \mu \mathrm{~A}$, See Note 4 | 40 | 40 | MHz |
| $\mathrm{C}_{\mathbf{c b}}$ | Collector-Base Capacitance | $V_{C B}=-5 V, \quad I_{E}=0, \quad f=140 \mathrm{kHz},$ <br> Ses Note 5 | 4 | 4 | pF |

"operating characteristics at $25^{\circ} \mathrm{C}$ free-air temperature

| PARAMETER |  | TEST CONDITIONS | $\begin{gathered} \text { 2N5086 } \\ \text { A5T5086 } \end{gathered}$ |  | 2N5087 <br> A5T6087 |  | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | MIN | MAX | MIN | MAX |  |
| F | Spot Noise Figure |  | $\begin{aligned} & V_{C E}=-5 \mathrm{~V}, \quad \mathrm{I}_{\mathrm{C}}=-100 \mu \mathrm{~A}, \mathrm{R}_{\mathrm{G}}=3 \mathrm{k} \Omega \\ & \mathrm{f}=1 \mathrm{kHz} \end{aligned}$ |  | 3 |  | 2 | dB |
| $\bar{F}$ | Average Noise Figure | $V_{C E}=-5 \mathrm{~V}, \quad \mathrm{I}_{\mathrm{C}}=-20 \mu \mathrm{~A}$, $\mathrm{R}_{\mathrm{G}}=10 \mathrm{k} \Omega$, <br> Noise Bandwidth $=15.7 \mathrm{kHz}$, See Note 6 |  | 3 |  | 2 | d8 |

NOTES: 3. These parameters must be measured using pulse techniques. $t_{w}=300 \mu s$, duty eycle $<\mathbf{2 \%}$.
4. To obtain $f_{T}$, the $\mathbb{T h}_{\text {fe }} \mid$ response with frequency is extrapolated at the rate of $\mathbf{- 6} \mathbf{d 8}$ per octave from $\mathbf{f = 2 0} \mathbf{~ M H z}$ to the frequency at which $\left|h_{f e}\right|=1$.
5. $\mathrm{C}_{\mathrm{cb}}$ measurament employs a three-terminal capacitance bridge incorporating a guard circuit. The emitter is connected to the guard terminal of the bridge.
6. Average Noise Figure is measured in an amplifier with response down 3 dB at 10 Hz and 10 kHz and a high-frequency rolloff of $6 \mathrm{~dB} /$ octave.
*The asterisk identifies JEDEC registered data for the 2N5086 and 2N5087 only.

## THERMAL INFORMATION



# SILECT ${ }^{\dagger}$ TRANSISTORS $\ddagger$ <br> FOR LOW-COST, GENERAL PURPOSE AMPLIFIER APPLICATIONS <br> - Rugged One-Piece Construction with In-Line Leads or Standard TO-18 100-mil Pin-Circle Configuration <br> - A7T5172 is Plug-in Replacement for 2N5172 (TO-98 Package) 

## mechanical data

These transistors are encapsulated in a plastic compound specifically designed for this purpose, using a highly mechanized process developed by Texas Instruments. The case will withstand soldering temperatures without deformation. These devices exhibit stable characteristics under high-humidity conditions and are capable of meeting MIL-STD-202C, Method 106B. The transistors are insensitive to light.

absolute maximum ratings at $\mathbf{2 5}{ }^{\circ} \mathbf{C}$ free-air temperature (unless otherwise noted)


NOTES: 1. This value applites whon the base-emitter diode is open-circuited.
2. Derate linearly to $150^{\circ} \mathrm{C}$ free-air temperature at the rate of $5 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$.

[^97]USES CHIP N21

## TYPES A5T5172, A7T5172, A8T5172

N-P-N SILICON TRANSISTORS
electrical characteristics at $\mathbf{2 5}{ }^{\circ} \mathrm{C}$ free-air temperature

| PARAMETER | TEST CONDITIONS | MIN MAX | UNIT |
| :---: | :---: | :---: | :---: |
| V(BR)CEO Collector-Emitter Breakdown Voltage | $\mathrm{I}_{\mathrm{C}}=10 \mathrm{~mA}, \mathrm{I}_{\mathrm{B}}=0, \quad$ See Note 3 | 25 | V |
| ICBO Collector Cutoff Current | $V_{C B}=25 V, I_{E}=0$ | 100 | nA |
| JEBO Emitter Cutoff Current | $\mathrm{V}_{E B}=5 \mathrm{~V}, \mathrm{I}^{\prime}=0$ | 100 | nA |
| hFE Static Forward Current Transfer Ratio | $\mathrm{V}_{\text {CE }}=10 \mathrm{~V}, \mathrm{I}_{\mathrm{C}}=10 \mathrm{~mA}$, See Nate 3 | 100500 |  |
| $\mathrm{V}_{\text {BE }}$ Base-Emitter Voltage | $\mathrm{V}_{C E}=10 \mathrm{~V}, \mathrm{I}_{\mathrm{C}}=10 \mathrm{~mA}$, See Note 3 | 0.51 .2 | $V$ |
| $V_{\text {CE }}$ (sat) Collector-Emitter Saturation Voltage | $\mathrm{I}_{\mathrm{B}}=1 \mathrm{~mA}, \mathrm{I}^{\prime} \mathbf{C}=10 \mathrm{~mA}$, See Note 3 | 0.25 | V |
| $\mathbf{h}_{\text {fe }}$ Small-Signal Common-Emitter <br> Forward-Current Transfer Ratio | $V_{C B}=10 \mathrm{~V}, \mathrm{I} C=10 \mathrm{~mA}, \mathrm{f}=1 \mathrm{kHz}$ | 100750 |  |
| $\mathrm{C}_{\mathrm{cb}} \quad$ Collector-Base Capacitance | $V_{C B}=10 \mathrm{~V}, \mathrm{I}_{\mathrm{E}}=0, \quad f=1 \mathrm{MHz},$ <br> See Note 4 | 1.610 | pF |

NOTES: 3. These parameters must be measured using pulse techniques. $t_{w}=\mathbf{3 0 0} \mu$, duty cycle $\leq \mathbf{2 \%}$.
4. $\mathbf{C}_{\mathbf{c b}}$ measurement employs a three-terminal capacitance bridge incorporating a guard circuit. The emitter is connected to the guard terminal of the bridge.

## THERMAL INFORMATION

FREE-AIR TEMPERATURE
DISSIPATION DERATING CURVE


FIGURE 1

# TYPES 2N5209, 2N5210, A5T5209, A5T5210 <br> N-P-N SILICON TRANSISTORS 

BULLETIN NO. DL-S 7311922 , JUNE 1973

## SILECT ${ }^{\dagger}$ TRANSISTORS $\ddagger$ <br> FOR LOW-LEVEL, LOWW-NOISE AUDIO AMPLIFIER APPLICATIONS

## - For Complementary Use with P-N-P Types 2N5086, 2N5087, A5T5086, A5T5087

- Rugged One-Piece Construction with In-Line Leads or Standard TO-18 100-mil Pin-Circle Configuration


## mechanical data

These transistors are encapsulated in a plastic compound specifically designed for this purpose, using a highly mechanized process developed by Texas Instruments. The case will withstand soldering temperatures without deformation. These devices exhibit stable characteristics under high-humidity conditions and are capable of meeting MIL-STD-202C, Method 106B. The transistors are insensitive to light.

absolute maximum ratings at $\mathbf{2 5}{ }^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)


## TYPES 2N5209, 2N5210, A5T5209, A5T5210 N-P-N SILICON TRANSISTORS

"electrical characteristics at $25^{\circ} \mathrm{C}$ free-air temperature

| PARAMETER | TEST CONDITIONS | $\begin{aligned} & \text { 2NB200 } \\ & \text { ASTE200 } \end{aligned}$ | $\begin{gathered} \text { 2NB210 } \\ \text { ASTE210 } \end{gathered}$ | UNIT |
| :---: | :---: | :---: | :---: | :---: |
|  |  | MIN MAX | MIN MAX |  |
| V(BR)CBO Collector-Base Breakdown Voltage | $I_{C}=100 \mu A, I_{E}=0$ | 50 | 50 | V |
| V(BR)CEO Collector-Emitter Breakdown Voltage | $I_{C}=1 \mathrm{~mA}, \quad \mathrm{I}_{\mathrm{B}}=0, \quad$ See Note 3 | 50 | 60 | V |
| CBO Collector Cutoff Current | $V_{C B}=36 \mathrm{~V}, \mathrm{I}_{\mathrm{E}}=0$ | 50 | 50 | nA |
| IEBO Emitter Cutoff Current | $V_{E B}=3 \mathrm{~V}, \quad \mathrm{I}_{\mathrm{C}}=0$ | 50 | 50 | nA |
| Static Forward Current Transfar Ratio | $V_{C E}=5 \mathrm{~V}, \quad \mathrm{I}_{C}=100 \mu \mathrm{~A}$ | 100300 | 200600 |  |
|  | $\mathrm{V}_{\text {CE }}=5 \mathrm{~V}, \mathrm{I}_{\mathrm{C}}=1 \mathrm{~mA}$ | 160 | 250 |  |
|  | $V_{C E}=5 \mathrm{~V}, \mathrm{I}^{\prime}=10 \mathrm{~mA}$, See Note 3 | 160 | 250 |  |
| VBE Base-Emitter Voltage | $V_{C E}=5 \mathrm{~V}, \quad \mathrm{I}^{\prime}=1 \mathrm{~mA}$ | 0.85 | 0.85 | $V$ |
| VCE(sat) Collector-Emitter Saturation Voltage | $\mathrm{I}_{8}=1 \mathrm{~mA}, \quad \mathrm{I}_{\mathrm{C}}=10 \mathrm{~mA}$, See Note 3 | 0.7 | 0.7 | V |
| $h_{f e}$ Small-Signal Common-Emitter <br> Forward Current Transfer Ratio | $\mathrm{V}_{C E}=5 \mathrm{~V}, \quad \mathrm{I}^{\prime}=1 \mathrm{~mA}, \quad \mathrm{f}=1 \mathrm{kHz}$ | 150600 | 250900 |  |
| $\mathrm{f}_{\mathbf{T}} \quad$ Transition Frequency | $V_{C E}=5 \mathrm{~V}, \mathrm{I}_{\mathrm{C}}=500 \mu \mathrm{~A}$, See Note 4 | 30 | 30 | MHz |
| $\mathrm{C}_{\text {cb }} \quad$ Collector-Base Capacitance | $\begin{array}{lll} V_{C B}=5 V, & I_{E}=0, & f=100 \mathrm{kHz}, \\ \text { See Note } 5 \end{array}$ | 4 | 4 | pF |

## *operating characteristics at $25^{\circ} \mathrm{C}$ free-air temperature



NOTES: 3. These parameters must be measured using pulse techniques. $\mathrm{t}_{\mathrm{w}}=\mathbf{3 0 0} \mu \mathrm{s}$, duty cycle $<\mathbf{2 \%}$.
4. To obtain $f_{T}$, the $h_{f e} \mid$ response with frequency is extrapolated at the rate of -6 dB per octave from $\mathrm{f}=\mathbf{2 0} \mathbf{~ M H z}$ to the frequency at which $\left|h_{\text {fe }}\right|=1$.
5. C $C_{c b}$ measurement employs a three-terminal capacitance bridge incorporating a guard eircuit. The emitter is connected to the guard terminal of the bridge.
6. Average Noise figure is measured in an amplifier with response down 3 dB at 10 Hz and $\mathbf{1 0} \mathbf{k H z}$ and a high-frequency rolloff of $6 \mathrm{~dB} /$ octave.
*The eaterisk identifies JEDEC registered data for the 2N5209 and 2NE210 only.
THERMAL INFORMATION


BULLETIN NO. DL-8 7811929, MABCH 1979

## SILECT ${ }^{\dagger}$ TRANSISTORS $\ddagger$

## - For Low-Level, Small-Signal, General Purpose Amplifier and Oscillator Applications <br> - Rugged One-Piece Construction with In-Line Leads or Standard TO-18 100-mil Pin-Circie Configuration

## mechanical data

These transistors are encapsulated in a plastic compound specifically designed for this purpose, using a highly mechanized process developed by Texas Instruments. The case will withstand soldering temperatures without deformation. These devices exhibit stable characteristics under high-humidity conditions and are capable of meeting MIL-STD-202C, Method 106B. The transistors are insensitive to light.

absolute maximum ratings at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)


NOTES: 1. This value applles when the base-amitter diode is open-circuited.
2. Derate the $625-\mathrm{mW}$ rating linearly to $150^{\circ} \mathrm{C}$ free-alr temperatura at the rate of $6 \mathrm{~mW}{ }^{\circ} \mathrm{C}$. Derate the $310-\mathrm{mW}$ (JEDEC reglatered) rating linearly to $135^{\circ} \mathrm{C}$ free-air temperature at the rate of $2.82 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$.
*The asteriak ldentifiea JEDEC regietered date for the $\mathbf{2 N E} 219$ only. This data sheet contains all apolicable registered dsta in offect at the time of publication.
${ }^{\dagger}$ Trademark of Texas Instruments.
$\ddagger$ U.S. Patent No. 3,439,238.
8 Texas Instruments guarantees these values in addition to the JEDEC registered values which are also shown.
USES CHIP N21
*electrical characteristics at $25^{\circ} \mathrm{C}$ free-air temperature

| PARAMETER | TEST CONDITIONS |  |  | MIN | MAX | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| $V_{\text {(BR) }}$ CBO Collector-Base Breakdown Voltege | $I^{\prime} \mathrm{C}=100 \mu \mathrm{~A}$, | $\mathrm{I}_{\mathrm{E}}=0$ |  | 20 |  | $V$ |
| $V_{\text {(BR)CEO }}$ Collector-Emitter Breakdown Voltage | $\mathrm{I}_{\mathrm{C}}=1 \mathrm{~mA}$, | $\mathrm{I}_{\mathrm{B}}=0$, | See Note 3 | 15 |  | V |
| $\mathrm{V}_{\text {(BR) }}$ (BO Emitter-Base Breakdown Vol tage | $\mathrm{I}_{\mathrm{E}}=100 \mu \mathrm{~A}$, | ${ }^{\prime} \mathrm{C}=0$ |  | 3 |  | $V$ |
| 1 CBO Collector Cutoff Current | $V_{C B}=10 \mathrm{~V}$, | $\mathrm{I}_{\mathrm{E}}=0$ |  |  | 100 | nA |
| IEBO Emitter Cutoff Current | $\mathrm{VEB}^{\text {e }}=2 \mathrm{~V}$, | $I_{C}=0$ |  |  | 600 | nA |
| heE Static Forward Current Transfer Ratio | $V_{C E}=10 \mathrm{~V}$, | $I_{C}=2 \mathrm{~mA}$ |  | 35 | 600 |  |
| $\mathrm{V}_{\text {BE }}$ Base-Emitter Voltage | $\mathrm{I}_{\mathrm{B}}=1 \mathrm{~mA}$, | $I_{C}=10 \mathrm{~mA}$, | See Note 3 |  | 1 | V |
| $\mathrm{V}_{\text {CE }}$ (gat) Collector-Emittar Saturation Voltage | $\mathrm{I}_{\mathrm{B}}=1 \mathrm{~mA}$, | $1 \mathrm{C}=10 \mathrm{~mA}$ | See Note 3 |  | 0.4 | V |
| $h_{f e}$ Small-Signal Common-Emitter <br> Forward Current Transfer Ratio | $V_{C E}=10 \mathrm{~V}$, | $I_{C}=2 \mathrm{~mA}$, | $\mathrm{f}=1 \mathrm{kHz}$ | 35 | 1500 |  |
| $\mathrm{f}_{\boldsymbol{T}} \quad$ Transition Frequency | $V_{C E}=10 \mathrm{~V}$, | $I^{\prime}=10 \mathrm{~mA}$, | See Note 4 | 150 |  | MHz |
| Cbb $\quad$ Coltector-Base Capacitance | $V_{C B}=10 \mathrm{~V}$ <br> See Note 5 | $I_{E}=0,$ | $f=1 \mathrm{MHz}$ |  | 4 | pF |

NOTES: 3. These parameters must be measured using pulse techniques. $t_{w}=\mathbf{3 0 0} \mu$, duty cycle $<\mathbf{2 \%}$.
4. To obteln $f_{T}$, the $M_{\text {fe }} \mid$ response with frequency is extrapolated at the rate of $-6 \mathbf{d B}$ per octave from $f=40 \mathrm{MHz}$ to the frequency at which $\left|h_{\mathrm{fe}}\right|=1$.
5. $\mathrm{C}_{\mathrm{cb}}$ measurement emplovs a three-terminal capacitance bridge incorporating a guard circuit. The emitter is connected to the guard terminal of the bridge.
*The asterisk identifies JEDEC registered date for the 2 N5219 only.

THERMAL INFORMATION


BULLETIN NO. DL-S 7311920, MARCH 1973

## SILECT ${ }^{\dagger}$ TRANSISTORS $\ddagger$

FOR GENERAL PURPOSE AMPLIFIER AND LOW-POWER AUDIO APPLICATIONS

- For Complementary Use with P-N-P Types 2N5221, A5T5221
- Rugged One-Piece Construction with In-Line Leads or Standard TO-18 100-mil Pin-Circle Configuration


## mechanical data

These transistors are encapsulated in a plastic compound specifically designed for this purpose, using a highly mechanized process developed by Texas Instruments. The case will withstand soldering temperatures without deformation. These devices exhibit stable characteristics under high-humidity conditions and are capable of meeting MIL-STD-202C, Method 106B. The transistors are insensitive to light.

absolute maximum ratings at $25^{\circ} \mathbf{C}$ free-air temperature (unless otherwise noted)


## TYPES 2N5220, A5T5220

N-P-N SILICON TRANSISTORS
*electrical characteristics at $\mathbf{2 5}^{\circ} \mathrm{C}$ free-air temperature

| PARAMETER | TEST CONDITIONS |  |  | MIN | MAX | $\begin{array}{\|c} \hline \text { UNIT } \\ \hline V \end{array}$ |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| $V_{(B R)}$ CBO Collector-Base Breakdown Voltage | $I_{C}=100 \mu A$, | $l_{E}=0$ |  | 15 |  |  |
| $\mathrm{V}_{(B R)}$ CEO Collector-Emitter Breakdown Voltage | $\mathrm{I}^{\prime} \mathrm{C}=10 \mathrm{~mA}$, | $\mathrm{I}_{\mathrm{B}}=0$, | See Note 3 | 15 |  | V |
| $\mathrm{V}_{\text {(BR)EBO }}$ Emitter-Base Breakdown Voltage | $I_{E}=100 \mu A$, | $\mathrm{l}_{\mathrm{C}}=0$ |  | 3 |  | $V$ |
| 1 CBO Collector Cutoff Current | $V_{C B}=10 \mathrm{~V}$, | $I_{E}=0$ |  |  | 100 | nA |
| IEBO Emitter Cutoff Current | $V_{E B}=3 \mathrm{~V}$, | $1 \mathrm{C}=0$ |  |  | 100 | nA |
| Static Forward Current Transfer Ratio | $\mathrm{V}_{\text {CE }}=10 \mathrm{~V}$, | $I^{\prime}=10 \mathrm{~mA}$ | See Note 3 | 25 |  |  |
|  | $V_{C E}=10 \mathrm{~V}$, | ${ }^{1} \mathrm{C}=50 \mathrm{~mA}$ |  | 30 | 600 |  |
| VBE Base-Emitter Voltage | $\mathrm{I}_{\mathrm{B}}=15 \mathrm{~mA}$, | ${ }^{1} \mathrm{C}=150 \mathrm{~mA}$, | See Note 3 |  | 1.1 | V |
| $\mathrm{V}_{\text {CE }}$ (sat) Collector-Emitter Saturation Voltage | $I_{B}=15 \mathrm{~mA}$, | $\mathrm{I}_{\mathrm{C}}=150 \mathrm{~mA}$, | See Note 3 |  | 0.5 | V |
| $\mathbf{h}_{\mathbf{f e}}$ Small-Signal Common-Emitter <br> Forward Current Transfer Ratio | $V_{C E}=10 \mathrm{~V}$, | ${ }^{1} \mathrm{C}=50 \mathrm{~mA}$, | $\mathrm{f}=1 \mathrm{kHz}$ | 30 | 1800 |  |
| $\mathrm{f}_{\mathbf{T}} \quad$ Transition Frequency | $V_{C E}=10 \mathrm{~V}$, | $\mathrm{I}_{\mathrm{C}}=20 \mathrm{~mA}$, | See Note 4 | 100 |  | MHz |
| Cbb Collector-Basa Capacitance | $\begin{aligned} & V_{C B}=5 \mathrm{~V} \\ & \text { See Note } 5 \end{aligned}$ | $I_{E}=0,$ | $f=1 \mathrm{MHz},$ |  | 10 | pF |

NOTES: 3. These parameters must be measured using pulse techniques. $t_{w}=300 \mu \mathrm{~s}$, duty cycle $\leqslant 2 \%$.
4. To obtain $f_{T}$, the $h_{f e} \mid$ response with frequency is extrapolated at the rate of -6 dB per octave from $f=20 \mathrm{MHz}$ to the frequency at which $\left|h_{f e}\right|=1$.
5. $\mathrm{C}_{\boldsymbol{c b}}$ measurement employs a three-terminal capacitance bridge incorporating a guard circuit. The emitter is connected to the guard terminal of the bridge.

[^98]THERMAL INFORMATION


# TYPES 2N5221, A5T5221 P-N-P SILICON TRANSISTORS 

BULLETIN NO. DL-S 7311924, MARCH 1973

## SILECT ${ }^{\dagger}$ TRANSISTORS $\ddagger$ FOR GENERAL PURPOSE AMPLIFIER AND LOW-POWER AUDIO APPLICATIONS

- For Complementary Use with N-P-N Types 2N5220, A5T5220
- Rugged One-Piece Construction with In-Line Leads or Standard TO-18 100-mil Pin-Circle Configuration


## mechanical data

These transistors are encapsulated in a plastic compound specifically designed for this purpose, using a highly mechanized process developed by Texas Instruments. The case will withstand soldering temperatures without deformation. These devices exhibit stable characteristics under high-humidity conditions and are capable of meeting MIL-STD-202C, Method 106B. The transistors are insensitive to light.



NOTES: 1. This value applies when the base-emitter diode is open-circuited.
2. Derate the $625-\mathrm{mW}$ rating linearly to $160^{\circ} \mathrm{C}$ free-air temperature at the rate of $5 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$. Derate the $310-\mathrm{mW}$ (JEDEC registered) rating linearly to $135^{\circ} \mathrm{C}$ free-air temperature at the rate of $2.82 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$.
§Texas instruments guarantees these values in addition to the JEDEC registered values which are also shown.
*electrical characteristics at $\mathbf{2 5}{ }^{\circ} \mathrm{C}$ free-air temperature


NOTES: 3. These parameters must be measured using pulse techniques. $t_{w}=\mathbf{3 0 0} \mu \mathrm{s}$, duty cycle $\leqslant 2 \%$.
4. To obtain $f_{T}$, the $\left.\right|_{h_{f e}} \mid$ response with frequency is extrapolated at the rate of -6 dB per octave from $\mathrm{f}=\mathbf{2 0} \mathrm{MHz}$ to the frequency at which $\left|h_{f e}\right|=1$.
5. $\mathrm{C}_{\mathrm{cb}}$ measurement employs a three-terminal capacitance bridge incorporating a guard circuit. The emitter is connected to the guard terminal of the bridge.
*The asterisk identifies JEDEC registered data for the 2N5221 only.

THERMAL INFORMATION


# TYPES 2N5222, AGT5222 N-P-N SILICON TRANSISTORS 

BULLETIN NO. DL-S 731 1929, MARCH 1973

## SILEECT ${ }^{\dagger}$ TRANSISTORS $\ddagger$

- For RF Amplifier, Mixer, and Video IF Applications in Radio and Television Receivers
- Rugged One-Piece Construction with In-Line Leads or Standard TO-18 100-mil Pin-Circle Configuration


## mechanical data

These transistors are encapsulated in a plastic compound specifically designed for this purpose, using a highly mechanized process developed by Texas Instruments. The case will withstand soldering temperatures without deformation. These devices exhibit stable characteristics under high-humidity conditions and are capable of meeting MIL-STD-202C, Method 106B. The transistors are insensitive to light.

| NOTES: A. Lead diameter is not controlled in this area. <br> B. All dimensions are in inches. <br> - ALL JEDEC TO-92 DIMENSIONS AND NOTES ARE APPLICABLE |  |
| :---: | :---: |
| A6T6222 <br> NOTES: A. Lead diameter is not controlled in this area. <br> 8. Leads having maximum diemeter ( 0.019 ) shall be within 0.007 of their true positions measured In the gaging plane 0.054 below the seating plane of the device relative to a maximumdiameter packega. <br> C. All dimensions are in inches. | S |

absolute maximum ratings at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)


## TYPES 2N5222, A6T5222 <br> N-P-N SILICON TRANSISTORS

## *electrical characteristics at $\mathbf{2 5}{ }^{\circ} \mathrm{C}$ free-air temperature

| PARAMETER | TEST CONDITIONS |  |  | MIN | MAX | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| V(BR)CBO Collector-Base Breakdown Voltage | $1 C=100 \mu A$, | IE -0 |  | 20 |  | $V$ |
| $V_{\text {(BR) }}$ CEO Collector-Emitter Breakdown Voitage | $1 \mathrm{C}=1 \mathrm{~mA}$. | $I_{B}=0$, | See Note 3 | 15 |  | V |
| V(BR)EBO Emitter-Base Breakdown Voltage | $l_{E}=100 \mu A$, | IC $=0$ |  | 2 |  | V |
| ICBO Collector Cutoff Current | $V_{C B}=10 \mathrm{~V}$, | 1E=0 |  |  | 100 | nA |
| IEBO Emitter Cutoff Current | $\mathrm{VEB}^{\text {a }}=2 \mathrm{~V}$, | $1 \mathrm{C}=0$ |  |  | 100 | nA |
| hFE Static F orward Current Transfor Ratio | $V_{C E}=10 \mathrm{~V}$, | $1 \mathrm{c}=4 \mathrm{~mA}$, | See Note 3 |  | 1500 |  |
| VBE Base-Emitter Voitage | $\mathrm{I}_{\mathrm{B}}=0.4 \mathrm{~mA}$, | $\mathrm{I}_{\mathrm{C}}=4 \mathrm{~mA}$ |  |  | 1.2 | V |
| $V_{C E}$ (sat) Collector-Emitter Saturation Voitage | $\mathrm{I}_{\mathrm{B}}=0.4 \mathrm{~mA}$, | $\mathrm{IC}_{\mathrm{C}}=4 \mathrm{~mA}$ |  |  | 1 | V |
| $\mathrm{h}_{\mathrm{fe}}$ Small-Signal Common-Emittar <br> Forward Current Transfer Ratio | $V_{C E}=10 \mathrm{~V}$, | $\mathrm{IC}=4 \mathrm{~mA}$, | $\mathrm{f}=1 \mathrm{kHz}$ |  | 3000 |  |
| $\mathrm{f}_{\mathbf{T}} \quad$ Transition Frequency | $V_{C E}=10 \mathrm{~V}$, | $l^{\prime} \mathrm{C}=4 \mathrm{~mA}$, | See Note 4 | 460 |  | MHz |
| $\mathrm{C}_{\mathrm{cb}} \quad$ Collector-Basa Capacitance | $\begin{aligned} & V_{C B}=10 \mathrm{~V}, \\ & \text { See Note } 5 \\ & \hline \end{aligned}$ | $T_{E}=0$ | $f=1 M H z$ |  | 1.3 | pF |

NOTES: 3. Thece parameters must be measured using pulee techniques. $t_{w}=\mathbf{3 0 0} \mu$, duty cycte $<\mathbf{2 \%}$.
4. To obtain $\mathrm{f}_{\mathrm{T}} \mathrm{t}$, the h fol response with frequency is extrapolated at the rete of -6 dB per octave from $\mathrm{f}=100 \mathrm{MHz}$ to the frequency at which $h_{\text {fol }}=1$.
5. $\mathrm{C}_{\mathrm{cb}}$ measurement employs a three-terminal capacitence bridge incorporsting agard circult. The emitter is connected to the guard terminal of the bridge.

- The asterisk identifien JEDEC registered data for the 2 N5222 only.

THERMAL INFORMATION

DISSIPATION DERATING CURVE


## SILECT ${ }^{\dagger}$ TRANSISTORS ${ }^{\ddagger}$

- For Low-Level, Small-Signal, General Purpose Amplifier and Oscillator Applications
- Rugged One-Piece Construction with In-Line Leads or Standard TO-18 100-mil Pin-Circle Configuration


## mechanical data

These transistors are encapsulated in a plastic compound specifically designed for this purpose, using a highly mechanized process developed by Texas Instruments. The case will withstand soldering temperatures without deformation. These devices exhibit stable characteristics under high-humidity conditions and are capable of meeting MIL-STD-202C, Method 106B. The transistors are insensitive to light.

absolute maximum ratings at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)


## TYPES 2N5223, A5T5223 <br> N-P-N SILICON TRANSISTORS

## *electrical characteristics at $\mathbf{2 5}{ }^{\circ} \mathbf{C}$ free-air temperature

| PARAMETER | TEST CONDITIONS |  |  | MIN | MAX | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| V(BR)CBO Collector-Base Breakdown Voltage | $I_{C}=100 \mu A$, | $\mathrm{I}_{\mathrm{E}}=0$ |  | 25 |  | V |
| $V_{\text {(BR) }}$ CEO Collector-Emitter Breakdown Voltage | $I^{\prime} \mathrm{C}=1 \mathrm{~mA}$, | $I_{B}=0$, | See Note 3 | 20 |  | $V$ |
| $V_{\text {(BR)EBO }}$ Emitter-Base Breakdown Voltage | $I_{E}=100 \mu A$, | $\mathrm{I}_{\mathrm{C}}=0$ |  | 3 |  | V |
| ICBO Collector Cutoff Current | $V_{C B}=10 \mathrm{~V}$, | $I_{E}=0$ |  |  | 100 | nA |
| EBO Emitter Cutoff Current | $V_{E B}=3 \mathrm{~V}$, | $\mathrm{l}_{\mathrm{C}}=0$ |  |  | 500 | nA |
| hFE Static Forward Current Transfer Ratio | $V_{C E}=10 \mathrm{~V}$, | $\mathrm{I}_{\mathrm{c}}=2 \mathrm{~mA}$, | See Note 3 | 50 | 800 |  |
| $V_{\text {BE }}$ Base-Emitter Voltage | $\mathrm{I}_{\mathrm{B}}=1 \mathrm{~mA}$, | $\mathrm{I}_{\mathrm{c}} \mathrm{C}=10 \mathrm{~mA}$, | See Note 3 |  | 1.2 | V |
| VCE(sat) Collector-Emitter Saturation Vol tage | $\mathrm{I}_{\mathrm{B}}=1 \mathrm{~mA}$, | $I_{C}=10 \mathrm{~mA}$, | See Note 3 |  | 0.7 | $V$ |
| $h_{f e}$ Small-Signal Common-Emitter <br> Forward Current Transfer Ratio | $V_{C E}=10 \mathrm{~V}$, | $I^{\prime} \mathrm{C}=2 \mathrm{~mA}$, | $f=1 \mathrm{kHz}$ | 50 | 1600 |  |
| $\mathrm{fT}_{\mathbf{T}} \quad$ Transition Frequency | $V_{C E}=10 \mathrm{~V}$, | $I_{C}=10 \mathrm{~mA}$, | See Note 4 | 150 |  | MHz |
| $\mathrm{C}_{\mathrm{cb}} \quad$ Collector-Base Capacitance | $V_{C B}=10 \mathrm{~V}$ <br> See Note 5 | $I_{E}=0,$ | $\mathrm{f}=1 \mathrm{MHz}$ |  | 4 | pF |

NOTES: 3. These parameters must be measured using pulse techniques. $\mathbf{t}_{w}=\mathbf{3 0 0} \mu \mathrm{s}$, duty cycle $<\mathbf{2 \%}$.
4. To obtain $f_{T}$, the $M_{f} \mid$ response with frequency is extrapoleted at the rate of -6 dB per octave from $f=40 \mathrm{MHz}$ to the frequency at which $h_{\text {fol }}=1$.
5. $\mathrm{C}_{\text {eb }}$ massurement employs a three-terminal capacitance bridge incorporating aguard circuit. The emitter is connected to the guard terminal of the bridge.
*The asterisk identifies JE DEC registered date for the 2N6223 only.

## THERMAL INFORMATION

## DISSIPATION DEHATING CURVE



## TYPES 2N5225, A5T5225 N-P-N SILICON TRANSISTORS

## SILECT ${ }^{\dagger}$ TRANSISTORS $\ddagger$ FOR MEDIUM-CURRENT AUDIO AMPLIFIER APPLICATIONS

- For Complementary Use with P-N-P Types 2N5226, A5T5226
- Rugged One-Piece Construction with In-Line Leads or Standard TO-18 100-mil Pin-Circle Configuration


## mechanical data

These transistors are encapsulated in a plastic compound specifically designed for this purpose, using a highly mechanized process developed by Texas Instruments. The case will withstand soldering temperatures without deformation. These devices exhibit stable characteristics under high-humidity conditions and are capable of meeting MIL-STD-202C, Method 106B. The transistors are insensitive to light.

absolute maximum ratings at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)


NOTES: 1. This value applies when the base-emitter diode is open-circuited.
2. Derate the $625-\mathrm{mW}$ rating linearly to $150^{\circ} \mathrm{C}$ free-air temperature at the rate of $5 \mathrm{~mW} / \mathrm{C}$. Derate the $310-\mathrm{mW}$ (JEDEC registered) rating lineariy to $135^{\circ} \mathrm{C}$ free-air temperature at the rate of $2.82 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$.
*The asterisk identifies JEDEC registered data for the 2 N 5225 only. This data sheet contains all applicable registered data in effect at the time of publication.
Tradernark of Texas Instruments.
¥u.S. Patent No. 3,439,238.
\& Texas Instruments guarantees these values in addition to the JEDEC registered values which are also shown.
USES CHIP N24

N-P-N SILICON TRANSISTORS

## *electrical characteristics at $\mathbf{2 5}{ }^{\circ} \mathrm{C}$ free-air temperature

| PARAMETER | TEST CONDITIONS |  |  | MIN | MAX | $\begin{array}{\|c\|} \hline \text { UNIT } \\ \hline V \\ \hline \end{array}$ |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| $V_{\text {(BR)CBO }}$ Collector-Base Breakdown Voltage | $I_{C}=100 \mu A$, | $\mathrm{I}_{\mathrm{E}}=0$ |  | 25 |  |  |
| $V_{\text {(BR) }}$ CEO Collector-Emitter Breakdown Voltage | $\mathrm{IC}^{*}=10 \mathrm{~mA}$, | $\mathrm{I}_{\mathrm{B}}=0$, | See Note 3 | 25 |  | V |
| $V_{\text {(BR)EBO }}$ Emitter-Base Breakdown Voltage | $I_{E}=100 \mu A$, | $I_{C}=0$ |  | 4 |  | V |
| ICBO Collector Cutoff Current | $V_{C B}=15 \mathrm{~V}$, | $I_{E}=0$ |  |  | 300 | nA |
| IEBO Emitter Cutoff Current | $V_{E B}=4 \mathrm{~V}$, | $\mathrm{I}_{\mathrm{C}}=0$ |  |  | 500 | nA |
| Static Forward Current Transfer Ratio | $V_{C E}=10 \mathrm{~V}$, | $I_{C}=10 \mathrm{~mA}$ | See Note 3 | 25 |  |  |
|  | $V_{C E}=10 \mathrm{~V}$, | $I_{C}=50 \mathrm{~mA}$ |  | 30 | 600 |  |
| VBE Base-Emitter Voltage | $\mathrm{I}_{B}=10 \mathrm{~mA}$, | $I C=100 \mathrm{~mA}$, | See Note 3 |  | 1 | V |
| $\mathrm{V}_{\text {CE }}$ (sat) Collector-Emitter Saturation Voltage | $I_{B}=10 \mathrm{~mA}$, | $l_{C}=100 \mathrm{~mA}$, | See Note 3 |  | 0.8 | V |
| $\mathbf{h}_{\text {fe }}$ Small-Signal Common-Emitter <br>  Forward Current Transfer Ratio | $V_{C E}=10 \mathrm{~V}$, | ${ }^{\prime} \mathrm{C}=501.1 \mathrm{~A}$, | $\mathrm{f}=1 \mathrm{kHz}$ | 30 | 1800 |  |
| $\mathbf{f}_{\mathbf{T}} \quad$ Transition Frequency | $\mathrm{V}_{C E}=10 \mathrm{~V}$, | $I_{C}=20 \mathrm{~mA}$, | See Note 4 | 50 |  | MHz |
| $\mathrm{C}_{\mathbf{c b}} \quad$ Collector-Base Capacitance | $V_{C B}=5 \mathrm{~V},$ <br> See Note 5 | $I_{E}=0,$ | $f=1 \mathrm{MHz},$ |  | 20 | pF |

NOTES: 3. These parameters must be measured using pulse techniques. $t_{w}=300 \mu s$, duty cycle $\leqslant 2 \%$.
4. To obtain $f^{T} T$, the $\boldsymbol{h}_{\text {fe }} \mid$ response with frequency is extrapolated at the rate of -6 dB per octave from $f=20 \mathrm{MHz}$ to the frequency at which $h_{f a}=1$
5. $C_{c b}$ measurement employs a three-terminal capacitance bridge incorporating a guard circuit. The emitter is connected to the guard terminal of the bridge.
*The asterisk identifies JEDEC registered data for the 2N5225 only.

## THERMAL INFORMATION

DISSIPATION DERATING CURVE


## TYPES 2N5226, A5T5226 <br> P-N-P SILICON TRANSISTORS

BULLETIN NO. DL-S 7311923, MARCH 1973

## SILECT $\dagger$ TRANSISTORS $\ddagger$ FOR MEDIUM-CURRENT, AUDIO AMPLIFIER APPLICATIONS

## - For Complementary Use with N-P-N Types 2N5225, A5T5225

- Rugged One-Piece Construction with In-Line Leads or Standard TO-18 100-mil Pin-Circle Configuration


## mechanical data

These transistors are encapsulated in a plastic compound specifically designed for this purpose, using a highly mechanized process developed by Texas Instruments. The case will withstand soldering temperatures without deformation. These devices exhibit stable characteristics under high humidity conditions and are capable of meeting MIL-STD-202C, Method 106B. The transistors are insensitive to light.

absolute maximum ratings at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

| Collector-Base Voltage |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: |
| Collector-Emitter Voltage (See Note 1). Emitter-Base Voltage |  |  |  |  |
|  |  |  |  |  |
| Continuous Collector Current . . . . . . . . . . . . . . . . . . . . . . . . . . . . . $500 \mathrm{~mA}{ }^{*}$ |  |  |  |  |
| Continuous Device Dissipation at (or below) $\mathbf{2 5}^{\circ} \mathrm{C}$ Free-Air Temperature (See Note 2) . . . . . . . $\left\{\begin{array}{l}625 \mathrm{~mW} \\ 310 \mathrm{~mW}\end{array}\right.$ |  |  |  |  |
| Storage Temperature Range . . . . . . . . . . . . . . . . . . . . . . . . . . ${ }^{-1}-55^{\circ} \mathrm{C}$ to $135^{\circ} \mathrm{C}^{*}$ |  |  |  |  |
| Lead Temperature 1/16 Inch from Case for $\mathbf{6 0}$ Seconds . . . . . . . . . . . . . . . . . . . $\left\{^{2600^{\circ} \mathrm{C}^{*}}\right.$ |  |  |  |  |
|  |  |  |  |  |

NOTES: 1. This value applies when the baso-emitter diode is open-circuited.
2. Derate the $625-\mathrm{mW}$ rating linearly to $150^{\circ} \mathrm{C}$ free-air temperature at the rate of $5 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$. Derate the $310-\mathrm{mW}$ (JEDEC registered) rating linearly to $135^{\circ} \mathrm{C}$ free-air temperature at the rate of $2.82 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$.
*The astarisk identifies JEDEC registered data for the 2 N5226 only. This data street contains all applicable registered date in effect at the time of publication.
${ }^{\dagger}$ Trademark of Texas Instruments.
$\ddagger$ U.S. Patent No. 3,439,238.
§ Texas Instruments guarantees these values in addition to the JEDEC registered values which are also shown.
USES CHIP P20

## TYPES 2N5226, A5T5226

P-N-P SILICON TRANSISTORS

## *electrical characteristics at $25^{\circ} \mathrm{C}$ free-air temperature

| PARAMETER | TEST CONDITIONS | MIN MAX | UNIT |
| :---: | :---: | :---: | :---: |
| V(BR)CBO Colfector-Base Breakdown Voltage | $\mathrm{I}^{\prime}=-100 \mu \mathrm{~A}, \mathrm{I}_{\mathrm{E}}=0$ | -25 | $V$ |
| $\mathrm{V}_{\text {(BR) }}$ CEO Collector-Emitter Breakdown Voitage | $I_{C}=-10 \mathrm{~mA}, \mathrm{I}_{\mathrm{B}}=0, \quad$ See Note 3 | -25 | V |
| $\mathbf{V}_{\text {(BR)EBO }}$ Emitter-Base Breakdown Voitage | $\mathrm{I}_{\mathrm{E}}=-100 \mu \mathrm{~A}, \quad \mathrm{I}_{\mathrm{C}}=0$ | -4 | V |
| ICBO Collector Cutoff Current | $V_{C B}=-15 V, I_{E}=0$ | -300 | nA |
| IE8O Emitter Cutoff Current | $V_{E B}=-4 \mathrm{~V}, \quad \mathrm{I}_{\mathrm{C}}=0$ | -500 | nA |
| Static Forward Current Transfer Ratio | $\mathrm{V}_{\text {CE }}=-10 \mathrm{~V}, \mathrm{I}^{\prime}=-10 \mathrm{~mA}$, | 25 |  |
|  | $\mathrm{V}_{\mathbf{C E}}=-10 \mathrm{~V}, \mathrm{I}_{\mathbf{C}}=-50 \mathrm{~mA}$ See Note 3 | $30 \quad 600$ |  |
| VBE Base-Emitter Voltage | $\mathrm{I}_{\mathrm{B}}=-10 \mathrm{~mA}, \quad \mathrm{I}_{\mathrm{C}}=-100 \mathrm{~mA}$, See Note 3 | -1 | V |
| VCE(sat) Collector-Emitter Saturation Voltage | $\mathrm{I}_{\mathrm{B}}=-10 \mathrm{~mA}, \mathrm{I}_{\mathrm{C}}=-100 \mathrm{~mA}$, See Note 3 | -0.8 | V |
| $\mathbf{h}_{\mathrm{fe}}$ Small-Signal Common-Emitter <br> Forward Current Transfer Ratio | $V_{C E}=-10 \mathrm{~V}, \mathrm{I}^{\prime} \mathrm{C}=-50 \mathrm{~mA}, \quad f=1 \mathrm{kHz}$ | 301800 |  |
| $\mathrm{f}_{\mathbf{T}} \quad$ Transition Frequency | $V_{C E}=-10 \mathrm{~V}, \mathrm{I}_{\mathrm{C}}=-20 \mathrm{~mA}$, See Note 4 | 50 | MHz |
| Cbb $\quad$ Collector-Base Capacitance | $V_{C B}=-5 \bar{V}, \quad T_{E}=0, \quad f=1 \mathrm{kHz},$ <br> See Note 5 | 20 | pF |

NOTES: 3. These parameters must be measured using pulse techniques. $t_{w}=\mathbf{3 0 0} \mu \mathrm{s}$, duty cycle $\leqslant \mathbf{2 \%}$.
4. To obtain ${ }^{f} T$, the $\boldsymbol{H}_{f} \mid$ response with frequency is extrapolated at the rate of -6 dB per octave from $\mathrm{f}=20 \mathrm{MHz}$ to the frequency at which $\left|h_{f e}\right|=1$.
5. $\mathrm{C}_{\mathrm{cb}}$ measurement employs a three-terminal capacitance bridge incorporating a guard circuit. The emitter is connected to the guard terminal of the bridge.

- The asterisk identifies JEDEC registered data for the 2N5226 only.


## THERMAL INFORMATION

DISSIPATION DERATING CURVE


## SILECT ${ }^{\dagger}$ TRANSISTORS $\ddagger$

## - For Low-Level, Small-Signal, General Purpose Amplifier and Oscillator Applications

- Rugged One-Piece Construction with In-Line Leads or Standard TO-18 100-mil Pin-Circle Configuration


## mechanical data

These transistors are encapsulated in a plastic compound specifically designed for this purpose, using a highly mechanized process developed by Texas Instruments. The case will withstand soldering temperatures without deformation. These devices exhibit stable characteristics under high-humidity conditions and are capable of meeting MIL-STD-202C, Method 106B. The transistors are insensitive to light.

absolute maximum ratings at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)


NOTES: 1. This value applies when the base-mitter diode is open-circuited.
2. Derate the $625-\mathrm{mW}$ rating linearly to $150^{\circ} \mathrm{C}$ frac-alr temperature at the rete of $5 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$. Derate the $310-\mathrm{mW}$ (JEDEC registered) rating Innearly to $135^{\circ} \mathrm{C}$ freo-air temperature at the rate of $2.82 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$.
-The asteriak identifies JEDEC registered dath for the $\mathbf{2 N B} 227$ only. This datt atheet contains all appliemble registered date in offect at the time of publication.
t Trademark of Texes Instruments.
$\ddagger$ U.S. Patent No. 3,439,238.
8i Toxas inatruments quarantees these values in eddition to the JEDEC regiscersd values which are also thown.
USES CHIP P18
"electrical characteristics at $\mathbf{2 5}{ }^{\circ} \mathrm{C}$ free-air temperature


NOTES: 3. These parameters must be measured using pulse technlques. $t_{w}=\mathbf{3 0 0} \mu \mathrm{s}$, duty cycle $<\mathbf{2 \%}$.
4. To obtain $f_{T}$, the $h_{f+1} \mid$ response with frequency is extrapolated at the rate of -6 dB per octave from $\mathrm{f}=20 \mathrm{MHz}$ to the frequency at which $\left|h_{\text {fe }}\right|=1$.
6. $\mathrm{C}_{\mathrm{cb}}$ measurement employs a three-terminal capaeitance bridge incorporating a guard circult. The emitter is connected to the guard terminal of the bridge.

- The asterisk identifies JEDEC reglatered data for the 2N5227 only.

THERMAL INFORMATION


# N-CHANNEL SLLECT $\dagger$ FIELD-EFFECT TRANSISTORS $\ddagger$ FOR VHF AMPLIFIER AND MIXER APPLICATIONS 

- High Power Gain . . 10 dB Min at 400 MHz
- High Transconductance . . . $4000 \mu \mathrm{mho}$ Min at 400 MHz (2N5245, 2N5247)
- Low Cro... 1 pF Max
- High $\left|\boldsymbol{y}_{\boldsymbol{s}}\right| / \mathrm{C}_{\mathrm{lat}}$ Ratio (High-Frequency Figure-of-Merit)
- Drgin and Gate Leads Separated for High Maximum Stable Gain
- Cross-Modulation Minimized by Square-Law Transiar Characteristic
- For Use in VHF Amplifiers in FM, TV, and Mobile Communications Equipment


## mechanical data

These transistors are encapsulated in a plastic compound specifically designed for this purpose, using a highly mechanized process developed by Texas Instruments. The case will withstand soldering temperatures without deformation. These devices exhibit stable characteristics under high-humidity conditions and are capable of meeting MIL-STD-202C, Method 1068. The transistors are insensitive to light.

*absolute maximum ratings at $25^{\circ} \mathrm{C}$ free-alr temperature (unless otherwise noted)

$$
\text { Drain-Gate Voltage . . . . . . . . . . . . . . . . . . . . . . . . . } 30 \text { V }
$$

Reverse Gate-Source Voltage ..... $-30 \mathrm{~V}$
Continuous Forward Gate Current ..... 50 mA
Continuous Device Dissipation at (or below) $25^{\circ} \mathrm{C}$ Free-Air Temperature (See Note 1). ..... 360 mW
Continuous Device Dissipation at (or below) $25^{\circ} \mathrm{C}$ Lead Temperature (See Note 2) . ..... 500 mW
Storage Temperature Range ..... $-65^{\circ} \mathrm{C}$ to $150^{\circ} \mathrm{C}$
Lead Temperature Kı Inch from Case for 10 Seconds ..... $260^{\circ} \mathrm{C}$



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## TYPES 2N5245 THRU 2N5247

## N-CHANNEL SILICON JUNCTION FIELD-EFFECT TRANSISTORS

*electrical characteristics at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)


HOTE 3: This poremeter must be meosured exing pulso techniques. $\mathbf{I}_{\mathrm{p}}=100 \mathrm{~ms}$, duly cycle $\leq 10 \%$.
*operating characteristics at $25^{\circ} \mathrm{C}$ free-air temperature

| PARAMETER |  | TEST CONDITIONS |  | 2N5245 |  | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| $\mathbf{G}_{\boldsymbol{p} \boldsymbol{r}}$ | Small-Signal Common-Source Neutralized Insertion Power Gain | $\begin{aligned} & V_{D S}=15 \mathrm{~V}, \quad I_{0}=5 \mathrm{~mA}, \\ & R_{G}^{\prime}=1 \mathrm{k} \Omega_{,} \\ & \hline \end{aligned}$ | $f=100 \mathrm{mHz},$ <br> See Figure 1 | MIN | MAX | $d B$ |
|  |  | $\begin{aligned} & V_{D S}=15 \mathrm{~V}, \quad I_{D}=5 \mathrm{~mA}, \\ & R_{G}^{\prime}=1 \mathrm{k}, \end{aligned}$ | $I=400 \mathrm{mHz},$ <br> Soe Figure 1 | 10 |  |  |
| WF | Spot Noise Figure | $\begin{array}{\|l} \hline \mathrm{VSS}_{\mathrm{DS}}=15 \mathrm{~V}, \quad \mathrm{I}_{\mathrm{D}}=5 \mathrm{~mA}, \\ \mathrm{R}_{\mathrm{G}}^{\prime}=1 \mathrm{k} \mathrm{\Omega}, \\ \hline \end{array}$ | $f=100 \mathrm{MHz},$ <br> See Figure 1 |  | 2 | dB |
|  |  | $\begin{aligned} & V_{D S}=15 \mathrm{~V}, \quad \mathrm{I}_{\mathrm{D}}=5 \mathrm{~mA}, \\ & \mathrm{R}_{\mathrm{G}}^{\prime}=1 \mathrm{k} \Omega_{,} \end{aligned}$ | $t=400 \mathrm{MHz}_{1}$ <br> See Figure 1 |  | 4 |  |

[^99]
## TYPES 2N5245 THRU 2N5247 N-CHANNEL SILICON JUNCTION FIELD-EFFECT TRANSISTORS

## *PARAMETER MEASUREMENT INFORMATION



FIGURE 1 - SCHEMATIC AND COMPONENT INFORMATION FOR $100-\mathrm{MHz}$ AND $400-\mathrm{MHz}$ NEUTRALIZED INSERTION POWER GAIN AND SPOT NOISE FIGURE TEST CIRCUITS
*Indicates JEDEC registorad data

## TYPICAL CHARACTERISTICS

## 2N5245

CORRELATION OF SMALL-SIGNAL COMMON-SOURCE FORWARD TRANSFER ADMITTANCE and GATE-SOURCE CUTOFF VOLTAGE
with
INDIVIDUAL DEVICE ZERO-GATE-VOLTAGE DRAIN CURRENT


## SILECT ${ }^{\dagger}$ FIELD-EFFECT TRANSISTOR $\ddagger$ FOR VHF AMPLIFIER AND MIXER APPLICATIONS

- Low Crss: $\leqslant 2$ pF
- High Yfs/Ciss Ratio (High-Frequency Figure-of-Merit)
- Formerly TIS34


## mechanical deta

This transistor is encapsulated in a plastic compound specifically designed for this purpose, using a highly mechanized process developed by Texas Instruments. The case will withstand soldering temperatures without deformation. This device exhibits stable characteristics under high-humidity conditions and is capable of meeting MIL-STD-202C, Method 106B. The transistor is insensitive to light.

*absolute maximum ratings at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)
Drain-Gate Voltage . . . . . . . . . . . . . . . . . . . . . . . . . . . 30 V
Reverse Gate-Source Voltage . . . . . . . . . . . . . . . . . . . . . . . -30 V
Continuous Forward Gate Current . . . . . . . . . . . . . . . . . . . . . 10 mA
Continuous Device Dissipation at (or below) $25^{\circ} \mathrm{C}$ Free-Air Temperature (See Note 1) . . . 360 mW
Storage Temperature Range . . . . . . . . . . . . . . . . . . . $-65^{\circ} \mathrm{C}$ to $150^{\circ} \mathrm{C}$
Lead Temperature $1 / 10$ Inch from Case for 10 Seconds . . . . . . . . . . . . . . . $260^{\circ} \mathrm{C}$
*electrical characteristics at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

| PARAMETER |  | TEST CONDITIONS |  |  | MIN MAX | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| $V_{\text {(ma) }}$ gss | Gate-Sourre Breakdown Voltage | $\mathrm{I}_{6}=-1 \mu \mathrm{~A}, \quad V_{D S}=0$ |  |  | -30 | V |
| Isss | Gate Cutoff Current | $V_{G S}=-20 \mathrm{~V}, V_{\text {DS }}=0$ |  |  | -5 | nA |
|  |  | $V_{G S}=-20 \mathrm{~V}, V_{D S}=0, \quad T_{A}=100^{\circ} \mathrm{C}$ |  |  | -1.5 | $\mu \mathrm{A}$ |
| $V_{\text {csioff }}$ | Gate-Sourca Cutoff Voltage | $V_{D S}=15 \mathrm{~V}, \quad \mathrm{I}_{\mathrm{D}}=10 \mathrm{nA}$ |  |  | -1 -8 | $v$ |
| $V_{\text {GS }}$ | Gate-Source Voltage | $V_{D S}=15 \mathrm{~V}, \quad \mathrm{I}_{\mathrm{D}}=400 \mu \mathrm{~A}$ |  |  | $\begin{array}{lll}-1 & -7.5\end{array}$ | $V$ |
| loss | Zero-Gato-Voltage Drain Current | $V_{D S}=15 \mathrm{~V}, \quad V_{G S}=0, \quad$ See Mote 2 |  |  | 420 | mA |
| $\left\|\mathrm{r}_{\mathrm{ts}}\right\|$ | Small-Signal Common-Source Forward Tronsfer Admittance | $\mathrm{V}_{\mathrm{DS}}=15 \mathrm{~V}, \quad \mathrm{~V}_{\text {GS }}=0, \quad f=1 \mathrm{kHz}$ |  |  | 3.56 .5 | mmho |
| \|Yos| | small-Signol Common-Source Output Admittance | $V_{\text {OS }}=15 \mathrm{~V}, \quad \mathrm{~V}_{\text {es }}=0, \quad f=1 \mathrm{kHz}$ |  |  | 50 | $\mu \mathrm{mho}$ |
| Css | Common-Source Shorr-Gircuit Input Capacitance | $V_{\text {DS }}=15 \mathrm{~V}$, | $\mathbf{V}_{\mathbf{G S}}=\mathbf{0}$, | $f=1 \mathrm{MHz}$ | 6 | pF |
| $C_{r s}$ | Common-Source Short-Giruit Reverse Iransfer Capacitance |  |  |  | 2 | pf |
| Re( $y_{i s}$ ) | small-Signal Common-Source Input Conductance | $v_{\text {DS }}=15 \mathrm{~V}$, | $V_{\text {cs }}=0$, | $t=200 \mathrm{MHz}$ | 0.8 | mmho |
| Re( $\mathrm{y}_{6}$ ) | small-Signal Common-Source Forward Iransfer Conductance |  |  |  | 3 | mmho |
| Re(Yos) | Small-Signol Common-Source Output Conductance |  |  |  | 0.2 | mmho |

NOTES: 1. Derate linearly to $150^{\circ} \mathrm{C}$ free-air temperature at the rate of $2.88 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$.
2. These parameters must be measured using pulse techniques. $t_{w}=100 \mathrm{~ms}$, duty cycle $\leqslant 10 \%$.

- indicates JEDEC registered data
${ }^{\text {T}}$ Trademark of Texas Instruments
$\ddagger$ U.S. Patent No. 3,439,238


# RADIATION-TOLERANT TRANSISTOR FOR SWITCHING AND GENERAL PURPOSE VHF-UHF AMPLIFIER APPLICATIONS 

- Guaranfeed $I_{\text {csor }} h_{\text {fE, }}$ and $V_{\text {CE(zat) }}$ after $\mathbf{I x 1 0}{ }^{15}$ Fast Neutrons $/ \mathrm{cm}^{2}$
- Complement to N-P-N type 2N5399


## description

The 2N5332 transistor offers a significant advance in radiation-tolerant-device technology. Unique construction techniques produce transistors which maintain useful characteristics after fast-neutron radiation fluences through $10^{15} \mathrm{n} / \mathrm{cm}^{2}$.

## *mochanical data


*absolute maximum ratings at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)
Collector-Base Voltage ..... $-20 \mathrm{~V}$
Collector-Emitter Voltage (See Note 1) ..... $-12 \mathrm{~V}$
Emitter-Base Voltage ..... $-2 \mathrm{~V}$
Continuous Collector Current ..... $-100 \mathrm{~mA}$
Continuous Device Dissipation at (or below) $25^{\circ} \mathrm{C}$ Free-Air Temperature (See Note 2) ..... 360 mW
Continuous Device Dissipation at (or below) $25^{\circ} \mathrm{C}$ Case Temperature (See Note 3) ..... 1.2 W
Storage Temperature Range ..... $-65^{\circ} \mathrm{C}$ to $200^{\circ} \mathrm{C}$
Lead Temperature $\mathrm{K}_{6}$ Inch from Case for 10 Seconds . ..... $300^{\circ} \mathrm{C}$

MOTES: 1 . This value applios between 0 and 100 mA cellecter currout when the beso-milter diode is open-circvited.
2. Derate linearly to $175^{\circ} \mathrm{C}$ froo-air temperature at the rate of $2.4 \mathrm{mw} / \mathrm{deg}$.
3. Derate linearly to $175^{\circ} \mathrm{C}$ cesse tamperature at the reta of $8 \mathrm{mw} / \mathrm{deg}$.

- Iadicutes JEDEC ragisterod data


## TYPE 2N5332

P-N-P SILICON TRANSISTOR
*electrical characteristics at $25^{\circ} \mathbf{C}$ free-air temperature (unless otherwise noted)

| PARAMETER |  | TEST CONDITIONS |  |  |  | MIN | MAX | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| $V_{\text {(Ba) }}$ Cso Collector-Base Breakdown Voltage |  | $\mathrm{I}_{\mathrm{C}}=-10 \mu \mathrm{~A}, \quad \mathrm{I}_{\mathrm{E}}=0$ |  |  |  | -20 |  | $V$ |
| $V_{\text {(Bap) }}$ CEE Collector-Emitter Breakdown Voltage |  | $\mathrm{I}_{\mathrm{C}}=-10 \mathrm{~mA}, \quad \mathrm{I}_{\mathrm{B}}=0$, |  |  | See Note 4 | -12 |  | $V$ |
|  | Emitter-Base Breakdown Voltage | $\mathrm{I}_{\mathrm{E}}=-10 \mu \mathrm{~A}, \quad \mathrm{I}_{\mathrm{C}}=0$, |  |  | See Note 5 | -2 |  | V |
|  | Collector Cutoff Current | $V_{C B}=-15 \mathrm{~V}, \quad I_{E}=0$ |  |  |  |  | $-10$ | nA |
|  |  | $\mathrm{V}_{\text {CB }}=-15 \mathrm{~V}, \quad \mathrm{I}_{\mathrm{E}}=0, \quad \mathrm{~T}_{\mathrm{A}}=125^{\circ} \mathrm{C}$ |  |  |  |  | -10 | $\mu \mathrm{A}$ |
| $\mathrm{I}_{\text {EIO }}$ | Emitter Cuteff Current | $V_{E B}=-1.5 \mathrm{~V}, \quad \mathrm{I}_{\mathrm{C}}=0$ |  |  |  |  | -1 | $\mu \mathrm{A}$ |
| $h_{\text {fes }}$ | Static Forword Current Transfer Ratio | $V_{C E}=-1 \mathrm{~V}$, | $\mathrm{I}_{\mathrm{C}}=-1$ |  |  | 20 | 80 |  |
|  |  | $V_{C E}=-1 V_{1}, \quad I_{C}=-10 \mathrm{~mA}$ |  |  | $\begin{gathered} \text { See } \\ \text { Note } \\ 4 \end{gathered}$ | 20 | 80 |  |
|  |  | $V_{C E}=-1 V_{1} \quad \mathrm{I}_{\mathrm{C}}=-20 \mathrm{~mA}$ |  |  |  | 20 | 80 |  |
|  |  | $\mathrm{V}_{\text {CE }}=-1 \mathrm{~V}, \quad \mathrm{I}_{\mathrm{C}}=-20 \mathrm{~mA}, \quad \mathrm{~T}_{\mathrm{A}}=-55^{\circ} \mathrm{C}$ |  |  |  | 10 |  |  |
|  |  | $V_{C E}=-5 \mathrm{~V}, \quad \mathrm{I}_{\mathrm{C}}=-50 \mathrm{~mA}$ |  |  |  | 20 | 80 |  |
| $V_{\text {BE }}$ | Base-Emittar Voltage | $\mathrm{I}_{\mathrm{B}}=-4 \mathrm{~mA}$, | $\mathrm{I}_{\mathrm{c}}=-2$ |  | See Note 4 | -0.7 | -1 | V |
| $\mathrm{V}_{\text {CEIatl }}$ | Collector-Emitter Saturation Voltage | $\mathrm{I}_{\mathrm{B}}=-4 \mathrm{~mA}$, | $\mathrm{I}_{\mathrm{c}}=-2$ |  | See Note 4 |  | -0.2 | $V$ |
| $\left\|h_{\text {fol }}\right\|$ | Small-Signal Common-Emitter Forward Current Transfer Ratio | $V_{\mathrm{CE}}=-5 \mathrm{~V}, \quad \mathrm{I}_{\mathrm{C}}=-10 \mathrm{~mA}, \quad f=100 \mathrm{MHz}$ |  |  |  | 6 |  |  |
|  |  | $\mathrm{V}_{\text {CE }}=-5 \mathrm{~V}, \quad \mathrm{I}_{\mathrm{C}}=-50 \mathrm{~mA}, \quad f=100 \mathrm{mHz}$ |  |  |  | 8 |  |  |
| $\mathrm{C}_{\mathrm{cb}}$ | Collector-Base Capacitance | $V_{C B}=-5 \mathrm{~V}$, | $\mathrm{T}_{\mathrm{E}}=0$, | $\mathrm{f}=1 \mathrm{MHz}$, | See Note 6 |  | 3.5 | pF |
| $C_{0}$ | Emitter-Base Capacitance | $\mathrm{V}_{\mathrm{EB}}=-0.5 \mathrm{~V}$, | $\mathrm{I}_{\mathrm{c}}=0$, | $f=1 \mathrm{MHz}$, | See Note 6 |  | 8 | pF |

*post-irradiation electrical characteristics at $\mathbf{2 5}{ }^{\circ} \mathbf{C}$ free-air temperature

| PARAMETER | TEST CONDITIONS | RADIATION FLUENCE $\dagger$ | MIN MAX | UNIT |
| :---: | :---: | :---: | :---: | :---: |
| ICBO Collector Cutoff Current | $\mathrm{V}_{\text {Ci }}=-15 \mathrm{~V}, \quad \mathrm{I}_{\mathrm{E}}=0$ | $1 \times 10^{15} \mathrm{n} / \mathrm{cm}^{2}$ | -10 | $\mu \mathrm{A}$ |
| $\mathrm{h}_{\text {fe }} \quad$ Static Forward Current Transfer Ratio | $V_{C E}=-2 \mathrm{~V}, \quad \mathrm{l}_{\mathrm{c}}=-20 \mathrm{~mA}$, See Note 4 |  | 10 |  |
| $\mathrm{V}_{\text {CE(sat) }}$ Collector-Emittar Saturation Voltage | $\mathrm{T}_{\mathrm{B}}=-4 \mathrm{~mA}, \quad \mathrm{C}_{C}=-20 \mathrm{~mA}, \quad$ See Note 4 |  | -0.6 | V |

MOTES: 4. Thess paramelerss must be measured using pulsa techniquos. $\mathrm{I}_{\mathrm{p}}=300 \mu \mathrm{~s}$, duty cycle $\leq 2 \%$.
5. The applicable test methods of mIL-STD-750A are recommended for lesting all poramefers; however, due to the unusual construction of this device, it is particulariy impertant to obsorve the test procedures detailed in Method 3026.1 for testing $\mathbf{V}_{(B R) \in E O}$. The voltage shall be grodually increased from zere until either the 2-V limit or the $10-\mu \mathrm{h}$ test current is reached. The device is acceptable if $\mathbf{2} \mathbf{Y}$ is reached before the fest curfent exceeds $10 \mu \mathrm{~A}$.
6. $C_{c b}$ and $C_{a b}$ measurements amplay a three-ierminal capacitance bridge incorporating a guard sircuif. The third electrode (emitter or coliactor, respectively) is connected to the guard tominal of the bridge.
$\dagger$ Rediation is fast neutrons ( n ) of $\mathrm{E} \geq 10 \mathrm{keV}$ (reactor spectrum).
*switching characteristics at $\mathbf{2 5}{ }^{\boldsymbol{\circ}} \mathbf{C}$ free-air femperature

| PARAMETER |  | TEST CONDITIONS $\ddagger$ |  |  | MIN MAX | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| $t_{\text {d }}$ | Delay Time | $V_{\text {cc }}=-3 \mathbf{V}$, | $\mathrm{I}_{C}=-20 \mathrm{~mA}$, | $\mathrm{I}_{\mathrm{B}(1)}=-4 \mathrm{~mA}$, | 12 | ns |
| $t_{r}$ | Rise Time | $V_{\text {BE }[\text { off }]}=0.7 \mathrm{~V}$, |  | See Figure 1 | 8 | ns |
| $t_{5}$ | Storage Time | $\mathrm{V}_{\mathrm{cc}}=-3 \mathrm{~V}$, | $I C S^{\prime}=-20 \mathrm{~mA}$, | $\mathrm{I}_{\mathrm{B}(1)}=-4 \mathrm{~mA}$, | 70 | ns |
| $t_{f}$ | Fall Time | $\mathrm{I}_{\mathrm{t}(2)}=4 \mathrm{~mA}$, |  | See Figure 1 | 16 | ns |

[^100]
## TYPE 2N5332 <br> P-N-P SILICON TRANSISTOR

*PARAMETER MEASUREMENT INFORMATION


b. Woviforms are monitored on an oxcillescepe with the fellewiag chorocieristles $\mathrm{t}_{\mathrm{r}} \leq 1 \mathrm{~ms}, \mathrm{~m}_{\mathrm{m}} \geq 100 \mathrm{kM}, \mathrm{G}_{\mathrm{in}} \leq 10 \mathrm{pF}$.
*Indicates JEDEC registorad data
TYPICAL CHARACTERISTICS, POST IRRADIATION


# TYPES 2N5358 THRU 2N5364 N-CHANNEL SILICON JUNCTION FIELD-EFFECT TRANSISTORS 

## FOR SMALL-SIGNAL APPLICATIONS

- Narrow IDSS and VGS(off) Ranges
- For Low-Noise Audio-Frequency Amplifier Applications
- For RF Amplifier Applications Thru $100 \mathbf{M H z}$
- For Chopper and Switching Applications
*mechanical data

*absolute maximum ratings at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)
Drain-Source Voltage . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 40 V
Reverse Gate-Source Voltage . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .
Continuous Forward Gate Current

NOTE 1: Derate linearly to $178^{\circ} \mathrm{C}$ free-air temparature at the rate of $\mathbf{2 m W} /{ }^{\circ} \mathrm{C}$.
*JEDEC registered data. This data sheet contains all applicable registered data in effect at the time of publication.

# TYPES 2N5358 THRU 2N5364 N-CHANNEL SILICON JUNCTION FIELD-EFFECT TRANSISTORS 

*electrical characteristics at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

*electrical characteristics at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)


NOTES: 2. This parameter must be measured using pulse techniques. $t_{w}=300 \mu$, duty cycle $<\mathbf{2 \%}$.
3. These parameters must be measured with bias conditions applied for less than $\overline{5}$ seconds to avold overheating.
*JE DE C reglstered date
The fourth lead (cese) is connected to the source for all measurements.

## TYPES 2N5358 THRU 2N5364 N-CHANNEL SILICON JUNCTION FIELD-EFFECT TRANSISTORS

*electrical characteristics at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

| PARAMETER | TEST CONDITIONSt | 2N5362 | 2N5363 | 2N6384 | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | MIN MAX | MIN MAX | MIN MAX |  |
| V(BR)GSS Gate-Source Breakdown Voltage | $I_{G}=-10 \mu A, V_{D S}=0$ | -40 | -40 | -40 | $\checkmark$ |
|  | $V_{G S}=-20 \mathrm{~V}, V_{\text {DS }}=0$ | -0.1 | -0.1 | -0.1 | nA |
| IGSS Gate Reverse Current | $\begin{aligned} & V_{G S}=-20 \mathrm{~V}, V_{D S}=0, \\ & T_{A}=150^{\circ} \mathrm{C} \end{aligned}$ | -0.1 | -0.1 | -0.1 | $\mu \mathrm{A}$ |
| VGS(off) Gate-Source Cutoff Voltage | $V_{D S}=15 \mathrm{~V}, \quad 1 \mathrm{D}=100 \mathrm{nA}$ | -2 -7 | -2.5 -8 | -2.5 -8 | V |
| Gate-Source Voltage | $V_{D S}=15 \mathrm{~V}, 10=0.4 \mathrm{~mA}$ | -1.3 $\quad-5$ |  |  | $V$ |
|  | $V_{D S}=15 \mathrm{~V}, \quad 10=0.7 \mathrm{~mA}$ |  | -2 -6 |  |  |
|  | $V_{D S}=15 \mathrm{~V}, \mathrm{I}_{0}=0.9 \mathrm{~mA}$ |  |  | -2 -6 |  |
| IDSS Zero-Gate-Voltage Drain Current | $V_{D S}=15 V, \quad V_{G S}=0,$ <br> See Note 2 | 48 | $7 \quad 14$ | $9 \quad 18$ | mA |
| $\|$Sis  <br> Forward Transfer Admittance  | $\begin{array}{ll} V_{D S}=15 \mathrm{~V}, & V_{G S}=0, \\ f=1 \mathrm{kHz}, & \text { See Note } 3 \end{array}$ | 25.5 | 2.56 | 2.76 .5 | mmho |
| $\|$Sos $\mid$ Small-Signal Common-Source <br> Output Admittance |  | 40 | 40 | 60 | $\mu \mathrm{mho}$ |
| $C_{\text {iss }}$ Common-Source Short-Circuit <br> Input Capacitance | $\begin{array}{ll} V_{\text {DS }}=15 \mathrm{~V}, & V_{G S}=0, \\ f=1 \mathrm{MHz}, & \text { See Note } 3 \end{array}$ | 6 | 6 | 6 | pF |
| Crss Common-Source Short-Circuit <br> Reverse Transfer Capacitance |  | 2 | 2 | 2 | pF |
| Gfs Small-Signal Common-Source <br>  Forward Transfer Conductance | $\begin{array}{ll} V_{D S}=15 \mathrm{~V}, & V_{G S}=0, \\ f=100 \mathrm{MHz}, & \text { See Note } 3 \end{array}$ | 1.9 | 2.1 | 2.2 | mmho |

*operating characteristics at $25^{\circ} \mathrm{C}$ free-air temperature

| PARAMETER | TEST CONDITIONS ${ }^{+}$ | ALL TYPES | UNIT |
| :---: | :---: | :---: | :---: |
|  |  | MIN MAX | UNIT |
| NF Common-Source <br>  Spot Noise Figure | $\begin{array}{lll} V_{D S}=15 \mathrm{~V}, & V_{G S}=0, & f=100 \mathrm{~Hz}, \\ R_{G}=1 \mathrm{M} \Omega, & \text { See Note } 3 & \end{array}$ | 2.5 | dB |

NOTES: 2. This parameter must be messured using pulse techniques. $\mathbf{t}_{w}=\mathbf{3 0 0} \mu \mathrm{s}$, duty cycle $<\mathbf{2 \%}$.
3. These parameters must be measured with bias conditions applied for less than $\mathbf{5}$ seconds to avoid overheating.
*JEDEC registered data
${ }^{t}$ The fourth lesd (cese) is connected to the source for all mesarements.

## TYPICAL CHARACTERISTICS



# TYPE 2N5397 <br> N-CHANNEL SILICON JUNCTION FIELD-EFFECT TRANSISTOR 

## FOR VHF AMPLIFIER AND MIXER APPLICATIONS

- High Power Gain . . . 15 dB Min at $\mathbf{4 5 0} \mathbf{~ M H z}$
- Low Noise Figure . . . 3.5 dB Max at 450 MHz
- High Transconductance . . . $\mathbf{5 5 0 0} \mu \mathrm{mho}$ Min at $\mathbf{4 5 0} \mathbf{~ M H z}$
- Low Crss ... 1.2 pF Max
*mechanical data

*absolute maximum ratings at $\mathbf{2 5}{ }^{\circ} \mathbf{C}$ free-air temperature (unless otherwise noted)
Drain-Gate Voltage ..... 25 V
Drain-Source Voltage ..... 25 V
Reverse Gate-Source Voltage ..... -25 V
Continuous Forward Gate Current ..... 10 mA
Continuous Device Dissipation at (or below) $25^{\circ} \mathrm{C}$ Free-Air Temperature (See Note 1) ..... 300 mW
Storage Temperature Range ..... $-65^{\circ} \mathrm{C}$ to $200^{\circ} \mathrm{C}$
Lead Temperature 1/16 Inch from Case for 10 Seconds ..... $300^{\circ} \mathrm{C}$

NOTE 1: Derate linearly to $200^{\circ} \mathrm{C}$ free-air temperature at the rate of $1.7 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$.
-JEDEC registered diato. This data sheet contains all applicable registered data in effect at the time of publication.

## TYPE 2N5397

N-CHANNEL SILICON JUNCTION FIELD-EFFECT TRANSISTOR
*electrical characteristics at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

| PARAMETER |  | TEST CONDITIONS ${ }^{\dagger}$ |  |  | MIN | MAX | $\begin{gathered} \hline \text { UNIT } \\ \hline v \\ \hline \end{gathered}$ |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| $V_{\text {(BR) GSS }}$ | Gate-Source Breakdown Voltage | ${ }^{\prime} \mathrm{G}^{\prime}=-1 \mu \mathrm{~A}$, | $V_{\text {DS }}=0$ |  | -25 |  |  |
| $V_{\text {GSF }}$ | Gate-Source Forward Voltage | $\mathrm{I}_{\mathrm{G}}=1 \mathrm{~mA}$, | $V_{\text {DS }}=0$ |  |  | 1 | $V$ |
| 'GSS | Gate Revarse Current | $\mathrm{V}_{\text {GS }}=-15 \mathrm{~V}$ | $V_{\text {DS }}=0$ |  |  | -0.1 | nA |
|  |  | $\mathrm{V}_{\mathrm{GS}}=-15 \mathrm{~V}$ | $V_{D S}=0$, | $\mathrm{T}_{\mathrm{A}}=150^{\circ} \mathrm{C}$ |  | -0.1 | $\mu \mathrm{A}$ |
| $V_{\text {GS (otf) }}$ | Gate-Source Cutoff Voltage | $\mathrm{V}_{\mathrm{DS}}=10 \mathrm{~V}$, | $I_{D}=1 \mathrm{nA}$ |  | -1 | -6 | V |
| IDSS | Zero-Gate-Voltage Drain Current | $\mathrm{V}_{\text {DS }}=10 \mathrm{~V}$, | $V_{\text {GS }}=0$, | See Note 3 | 10 | 30 | mA |
| $\left\|\mathrm{ffs}_{\mathrm{f}}\right\|$ | Small-Signal Common-Source Forward Transfer Admittance | $V_{D S}=10 \mathrm{~V}, I_{D}=10 \mathrm{~mA}, f=1 \mathrm{kHz}$ |  |  | 6 | 10 | mmho |
| Hos\| | Small-Signal Common-Source Output Admittance |  |  |  |  | 0.2 | mmho |
| $\mathrm{C}_{\text {iss }}$ | Common-Source Short-Circuit Input Capacitance | $V_{\text {DG }}=10 \mathrm{~V}, I_{\text {d }}=10 \mathrm{~mA}, f=1 \mathrm{MHz}$ |  |  |  | 5 | pF |
| Crss | Common-Source Short-Circuit Reverse Transfer Capacitance |  |  |  |  | 1.2 | pF |
| 9is | Small-Signal Common-Source Input Conductance | $V_{D G}=10 \mathrm{~V}, i^{\prime}=10 \mathrm{~mA}, f=450 \mathrm{MHz}$ |  |  |  | 2 | mmho |
| 9fs | Small-Signal Common-Source Forward Transfer Conductance |  |  |  | 5.5 | 9 | mmho |
| gos | Small-Signal Common-Source Output Conductance |  |  |  |  | 0.4 | mmho |

NOTE 3: This parameter must be measured using pulse techniques. $t_{w}=300 \mu s$, duty cycle $\leqslant 1 \%$.
*operating characteristics at $25^{\circ} \mathrm{C}$ free-air temperature

|  | PARAMETER | TEST CONDITIONS ${ }^{\dagger}$ | MIN MAX | UNIT |
| :---: | :---: | :---: | :---: | :---: |
| $\mathrm{G}_{\mathrm{ps}}$ | Small-Signal Common-Source Neutralized Insertion Power Gain | $\begin{array}{ll} V_{D G}=10 \mathrm{~V}, & \mathrm{I}_{\mathrm{D}}=10 \mathrm{~mA}, \quad \mathrm{f}=450 \mathrm{MHz}, \\ R_{G}=1 \mathrm{k} \Omega, & Y_{G}=1.1 \mathrm{mmho}-\mathrm{j} 4 \mathrm{mmho}, \end{array}$ | 15 | dB |
| NF | Spot Noise Figure | See Figure 1 | 3.5 | dB |

*JEDEC registered data. ${ }^{\text {T The fourth lead (case) is connected to the source for all measurements. }}$


## FOR VHF AMPLIFIER AND MIXER APPLICATIONS

- High Transconductance . . . $\mathbf{5 0 0 0} \mu \mathrm{mho}$ Min at $\mathbf{4 5 0} \mathbf{~ M H z}$
- Low Crss... 1.3 pF Max


## *mechanical data


*absolute maximum ratings at $\mathbf{2 5}{ }^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)


[^101]- JEDEC registered data. This data sheet contains all applicable registered data in effect at the time of publication.
*electrical characteristics at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

| PARAMETER |  | TEST CONDITIONS ${ }^{\text {t }}$ |  |  | MIN | MAX | $\frac{\text { UNIT }}{V}$ |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| $V_{\text {(BR) }}$ GSS | Gate-Source Breakdown Voltage | $\mathrm{I}_{\mathrm{G}}=-1 \mu \mathrm{~A}$, | $V_{D S}=0$ |  | -25. |  |  |
| $V_{\text {GSF }}$ | Gate-Source Forward Voltage | $\mathrm{I}_{G}=1 \mathrm{~mA}$, | $V_{\text {DS }}=0$ |  |  | 1 | V |
| 'GSS | Gate Reverse Current | $\mathrm{V}_{\mathbf{G S}}=-15 \mathrm{~V}$. | $V_{D S}=0$ |  |  | -0.1 | nA |
|  |  | $\mathrm{V}_{\mathrm{GS}}=-15 \mathrm{~V}$. | $V_{\text {DS }}=0$. | $\mathrm{T}_{A}=150^{\circ} \mathrm{C}$ |  | -0.1 | $\mu \mathrm{A}$ |
| $V_{\text {GS }}$ (off) | Gate-Source Cutoff Voltage | $\mathrm{V}_{\text {DS }}=10 \mathrm{~V}$. | ${ }^{1} \mathrm{D}=1 \mathrm{nA}$ |  | -1 | -6 | V |
| IDSS | Zero-Gate-Voltage Drain Current | $\mathrm{V}_{\mathrm{DS}}=10 \mathrm{~V}$. | $\mathrm{V}_{\mathrm{GS}}=0$. | See Note 2 | 5 | 40 | mA |
| $\|\mathrm{Vfs}\|$ | Small-Signal Common-Source Forward Transfer Admittance | $V_{D S}=10 \mathrm{~V}$, | $V_{\text {GS }}=0$, | $f=1 \mathrm{kHz}$ | 5.5 | 10 | mmho |
| \|ros| | SmallSignal Common-Source Output Admittance |  |  |  |  | 0.4 | mmho |
| $\mathrm{C}_{\text {iss }}$ | Common-Source Short-Circuit Input Capacitance | $\mathrm{VDS}=10 \mathrm{~V}$ | $V_{G S}=0$, | $f=1 \mathrm{MHz}$ |  | 5.5 | pF |
| $\mathrm{C}_{\text {rss }}$ | Common-Source Short-Circuit <br> Reverse Transfer Capacitance |  |  |  |  | 1.3 | pF |
| $\mathrm{gis}_{\text {is }}$ | Small-Signal Common-Source Input Conductance | $V_{D S}=10 \mathrm{~V}$, | $V_{G S}=0$, | $f=450 \mathrm{MHz}$ |  | 3 | mmho |
| $\mathrm{g}_{\mathrm{fs}}$ | Small-Signal Common-Source Forward Transfer Conductance |  |  |  | 5 | 10 | mmho |
| gos | Small-Signal Common-Source Output Conductance |  |  |  |  | 0.5 | mmho |

NOTE 2: This parameter must be measured using pulse techniquas. $\mathrm{t}_{\mathbf{w}}=\mathbf{3 0 0} \mu \mathrm{s}$, duty cycle $\leqslant \mathbf{1 \%}$.

- JEDEC registered data
${ }^{t}$ The fourth lead (case) is connected to the source for all mesurements.


# RADIATION-TOLERANT TRANSISTOR FOR LOW-POWER GENERAL PURPOSE VHF - UHF AMPLIFIER AND SATURATED-SWITCHING APPLICATIONS 

\author{

- Guaranteed $I_{\text {cto, }} h_{\text {fe }}$ and $V_{\text {cE(sat) }}$ after $1 \times 10^{15}$ Fast Neutrons $/ \mathrm{cm}^{2}$ <br> - Complement to P-N-P Type 2N5332
}


## description

The 2N5399 transistor offers a significant advance in radiation-tolerant-device technology. Unique construction techniques produce transistors which maintain useful characteristics after fast-neutron radiation fluences through $10^{15} \mathrm{n} / \mathrm{cm}^{2}$.

## *mechanical data


$\dagger$ II guaranteed minimum. The JEOEC registered minimum lead diamater for the r0.46 is $\mathbf{0 . 0 1 2}$.


NOTES: 1 . This value applies between 0 and 100 mA colitecter current when the bose-emitter diode is open-circuited.
2. Derate linearly to $175^{\circ} \mathrm{C}$ fres-air temperature at the rate of $2.4 \mathrm{~mW} / \mathrm{dog}$.
3. Derate linearly to $175^{\circ} \mathrm{C}$ case temperature at the rate of $8 \mathrm{~mW} / \mathrm{deg}$.
*Indicates JEDEC registored data

## N-P-N SILICON TRANSISTOR

*electrical characteristics at $25^{\circ} \mathrm{C}$ free-air temporature (unless otherwise noted)

*post-Irradiation olectrical charactoristics at $\mathbf{2 5}{ }^{\circ} \mathrm{C}$ free-alr temperature

| PARAMETER |  | test conditions |  |  | RADIATION FLUENCE $\dagger$ | MIN |  | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Ieso | Collector Cutoff Current | $\mathrm{V}_{\mathrm{ct}}=15 \mathrm{~V}$, | $\mathrm{I}_{\mathrm{E}}=0$ |  |  |  | 10 | $\mu \mathrm{A}$ |
| $h_{\text {He }}$ | Static Forward Current Tronster Ratio | $V_{C B}=2 V_{\text {, }}$ | $\mathrm{I}_{\mathrm{c}}=20 \mathrm{~mA}$, | See Note 4 | $1 \times 10^{15} \mathrm{n} / \mathrm{cm}^{2}$ | 12 |  |  |
| $\mathrm{V}_{\text {clint }}$ | Collector-Emitter Saturallon Voltage | $\mathrm{I}_{\mathrm{B}}=4 \mathrm{~mA}$, | $\mathrm{I}_{\mathrm{c}}=20 \mathrm{~mA}$, | Soe Noto 4 |  |  | 0.5 | V |

NOTES: 4. Thuse paramators must be meosured using pula techniques. $t_{p}=300 \mu$, duly cyele $\leq \mathbf{2 \%}$.
5. The applicable test mathods of MIL-STD-750A are recommended for testing all paramaters; howovir, due to the unusual construction of this device, it is patitcularly
 of the $10-\mu \mathrm{A}$ test current is reached. Tha dovice is accaplable if 2 V is reached betore the test current exeseds $10 \mu \mathrm{~A}$.
6. Cob and $C_{00}$ measurements amploy a thres-terminal capactiance bridge incorporating a guard circuit. The third aloctrede (emitter or collactor, respectivaly) is connected to the guard terminal of the bridge.
$\dagger$ Rodiation is fast noutrons ( n ) at $\mathbf{E} \geq 10 \mathrm{koV}$ (reactor spectrum).
*switching characteristics at $\mathbf{2 5}{ }^{\circ} \mathrm{C}$ free-air temperature

| PARAMETER |  | TEST CONDITIONS $\ddagger$ |  | MIN MAX | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: |
| $\$_{d}$ | Delay Time | $\begin{array}{ll} \hline V_{c C}=3 \mathrm{~V}, \quad I_{C}=20 \mathrm{~mA}, & I_{B(1)}=4 \mathrm{~mA}, \\ V_{B E[\text { off }]}=-0.7 \mathrm{~V}, & \text { SeB Figure } 1 \end{array}$ |  | 12 | ns |
| $t_{r}$ | Rise Time |  |  | 8 | ns |
| $t_{8}$ | Storoge Time | $\begin{array}{ll} \begin{array}{ll} V_{c c}=3 \mathrm{~V}, \quad I_{\mathrm{C}}=20 \mathrm{~mA}, & I_{\mathrm{B}\|1\|}=4 \mathrm{~mA}, \\ I_{\mathrm{B}[2]}=-4 \mathrm{~mA}, & S_{\theta \theta} \text { Figure } 1 \end{array} \end{array}$ |  | 70 | ns |
| $t_{1}$ | Fall Time |  |  | 16 | ns |

¥Voltage and current valuas shown ore nominal; exact values vary sightly with transistor and diode parameters.

* JEDEC registered data


# TYPE 2N5399 <br> N-P-N SILICON TRANSISTOR 

PARAMETER MEASUREMENT INFORMATION


FIOURE 1
NOTES: a. The input wevelorms are suppliad by a generator with the fellewing eharcctaristits: $z_{\text {out }}=50 \Omega, t_{p} \geq 300$ ns, duty eycle $\leq \mathbf{2 \%}$
b. Waveforms are menitored on an oscillostope with the following characteristics: $\mathrm{t}_{\mathrm{r}} \leq 1 \mathrm{~ns}, \mathrm{k}_{\mathrm{in}} \geq 100 \mathrm{k} \Omega, \mathrm{c}_{\mathrm{in}} \leq 10 \mathrm{pF}$.

- JEDEC registerred data


## TYPICAL CHARACTERISTICS, POST IRRADIATION


ficunt 2

STATIC FORWARD CURRENT TRANSFER RATIO


FIGURE 3

NOTE 5: These poramelers must be measured using puise techniques. $\mathrm{t}_{\mathrm{p}}=\mathbf{3 0 0} \mu \mathrm{s}$, duty cycle $\leq \mathbf{2 \%}$.
$\dagger$ This curve indicates typlial behavior of a dwice havias the limill value of $\mathrm{h}_{\mathrm{fE}}=30$ at $\mathrm{V}_{\mathrm{CE}}=1 \mathrm{~V}, \boldsymbol{\Phi}=0$.

TYPICAL CHARACTERISTICS, POST IRRADIATION


NOTE 4: Theso paramaters must be measured wsing puiss lochniques. $t_{p}=\mathbf{3 0 0} \mu$ s, duty cycie $\leq \mathbf{2 \%}$.

# TYPE 2N5398 N-P-N SILICON TRANSISTOR 

## TYPICAL CHARACTERISTICS



WOTE 4: These paramelers must be measurad asing palse techniques. $t_{p}=300 \mu$, duly cycie $\leq \mathbf{2 \%}$.

## TYPE 2N5399 <br> N-P-N SILICON TRANSISTOR

## TYPICAL CHARACTERISTICS



# TYPE 2N5399 <br> N-P-N SILICON TRANSISTOR 

## TYPICAL CHARACTERISTICS




NOTES: 7. To obtain $\mathrm{f}_{\mathrm{T}}$, the $\left|\mathrm{h}_{\mathrm{f}}\right|$ response with frequency is extropolated of the rate of -6 dB per octave from $\mathbf{i}=100$ MHz to the frequency at which $\left|\mathrm{h}_{\mathrm{fa}}\right|=1$.
8. $C_{c b}$ and $C_{s b}$ measurements employ a three-ferminal capacitance bridge incorporaling a guard circuit. The third electrode (emitior or collector, respectivaly) is cennected to the guard terminol of the bridge. $C_{\text {obo }}$ and $\boldsymbol{C}_{\text {ibo }}$ are measured with the third electrode floating.

## SILECT ${ }^{\dagger}$ TRANSISTORS $\ddagger$

## FOR GENERAL PURPOSE, HIGH-VOLTAGE AMPLIFIER APPLICATIONS

## - 120 V or 150 V Min V(BR)CEO

## - Rugged One-Piece Construction with In-Line Leads or Standard TO-18 100-mil Pin-Circle Configuration

## mechanical data

These transistors are encapsulated in a plastic compound specifically designed for this purpose, using a highly mechanized process developed by Texas Instruments. The case will withstand soldering temperatures without deformation. These devices exhibit stable characteristics under high-humidity conditions and are capable of meeting MIL-STD-202C, Method 106B. The transistors are insensitive to light.

absolute maximum ratings at $\mathbf{2 5}{ }^{\circ} \mathbf{C}$ free-air temperature (unless otherwise noted)


NOTES: 1. These values apply when the base-emitter diode is open-circuited.
2. Derate the $625-\mathrm{mW}$ ratings lineariy to $150^{\circ} \mathrm{C}$ free-air temperature at the rate of $5 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$. Derate the $310-\mathrm{mW}$ (JEDEC registered) rating linearly to $135^{\circ} \mathrm{C}$ free-air temperature at the rate of $2.81 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$.
*The asterisk identifies JEDEC registered deta for the $2 N 5400$ and $2 N 5401$ only. This date sheet contains all applicable registered data in effect at the time of publication.
${ }^{\dagger}$ Trademark of Texas instruments
$\ddagger$ U.S. Patent No. 3,439,238
§ Texas Instruments guarsntees these values in addition to the JEDEC registered values which are also shown.
USES CHIP P22

## TYPES 2N5400, 2N5401, A5T5400, A5T5401 P-N-P SILICON TRANSISTORS

## *electrical characteristics at $\mathbf{2 5}{ }^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

| PARAMETER | TEST CONDITIONS |  | $\begin{aligned} & \hline \text { 2N5400 } \\ & \text { A5T5400 } \\ & \hline \end{aligned}$ | 2N5401 <br> A5T5401 | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  | MIN MAX | MIN MAX |  |
| V(BR)CBO Collector-Base Breakdown Voltage | $I_{C}=-100 \mu A, I_{E}=0$ |  | -130 | -160 | V |
| $V_{\text {(BR)CEO }}$ Collector-Emitter Breakdown Voltage | $\mathrm{I}_{C}=-1 \mathrm{~mA}, \quad \mathrm{I}_{B}=0$, | See Note 3 | -120 | -150 | V |
| V(BR)E80 Emitter-Base Breakdown Voltage | $\mathrm{I}_{\mathrm{E}}=-10 \mu \mathrm{~A}, \quad \mathrm{I}^{\prime}=0$ |  | -5 | -5 | V |
| ICBO Collector Cutoff Current | $V_{C B}=-100 \mathrm{~V}, \mathrm{I}_{\mathrm{E}}=0$ |  | -100 |  | nA |
|  | $V_{C B}=-100 \mathrm{~V}, \mathrm{I}_{\mathrm{E}}=0, \quad \mathrm{~T}_{A}=100^{\circ} \mathrm{C}$ |  | -100 |  | $\mu \mathrm{A}$ |
|  | $V_{C B}=-120 \mathrm{~V}, \mathrm{I}_{\mathrm{E}}=0$ |  |  | -50 | $n A$ |
|  | $V_{E B}=-3 V, \quad I_{C}=0$ |  |  | -50 | $\mu A$ |
| IEBO Emitter Cutoff Current |  |  | -50 | -50 | nA |
| Static Forward Current Transfer Ratio | $V_{C E}=-5 \mathrm{~V}, \quad \mathrm{I}_{C}=-1 \mathrm{~mA}$ | See Note 3 | 30 | 50 |  |
|  | $V_{C E}=-5 \mathrm{~V}, 1 C^{=}=-10 \mathrm{~mA}$ |  | $40 \quad 180$ | $60 \quad 240$ |  |
|  | $\mathrm{V}_{C E}=-5 \mathrm{~V}, \quad \mathrm{I}^{\prime}=-50 \mathrm{~mA}$ |  | 40 | 50 |  |
| Base-Emitter Voltage | $\mathrm{I}_{\mathrm{B}}=-1 \mathrm{~mA}, \quad \mathrm{I}_{C}=-10 \mathrm{~mA}$ | See Note 3 | -1 | -1 | $V$ |
|  | $I_{B}=-5 \mathrm{~mA}, \quad I_{C}=-60 \mathrm{~mA}$ |  | -1 | -1 |  |
| Collector-Emitter Saturation Voltage | $\mathrm{I}_{B}=-1 \mathrm{~mA}, \quad I_{C}=-10 \mathrm{~mA}$ | See Note 3 | -0.2 | -0.2 | $V$ |
|  | $\mathrm{I}_{\mathrm{B}}=-5 \mathrm{~mA}, \quad 1 \mathrm{C}=-50 \mathrm{~mA}$ |  | -0.5 | -0.5 |  |
| $\mathrm{h}_{\mathrm{fo}}$ Small-Signal Common-Emitter <br>  Forward Current Transfer Ratio | $V_{C E}=-10 \mathrm{~V}, \mathrm{IC}=-1 \mathrm{~mA}$, | $f=1 \mathrm{kHz}$ | $30 \quad 200$ | $40 \quad 200$ |  |
| $\mathrm{f}_{\mathrm{T}}$ Transition Frequency | $V_{C E}=-10 \mathrm{~V}, \mathrm{I}^{\prime} \mathrm{C}=-10 \mathrm{~mA}$, | See Note 4 | 100400 | 100300 | MHz |
| Cobo Common-Base Open-Circuit Output Cepacitance | $V_{C B}=-10 \mathrm{~V}, \mathrm{I}_{\mathrm{E}}=0$, | $f=1 \mathrm{MHz}$ | 6 | 6 | pF |

*operating characteristics at $25^{\circ} \mathrm{C}$ free-air temperature

| PARAMETER |  | TEST CONDITIONS | $\begin{aligned} & \hline \text { 2N5400 } \\ & \text { A5T5400 } \\ & \hline \end{aligned}$ | 2N5401 <br> A5T5401 | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | MIN MAX | MIN MAX |  |
| F | Averege Noise Figure |  | $\begin{aligned} & V_{C E}=-5 \mathrm{~V}, \quad I_{C}=-250 \mu A, \\ & R_{G}=1 \mathrm{k} \Omega, \\ & \text { Noise bandwidth }=15.7 \mathrm{kHz}, \end{aligned} \text { See Note } 5$ | 8 | 8 | dB |

NOTES: 3. These paramaters must be measured using pulse techniques, $t_{w}=300 \mu \mathrm{~s}$, duty cycle $<\mathbf{2 \%}$.
4. To obtain $\mathrm{i}_{\mathrm{T}}$, the $\mathrm{h}_{\mathrm{f}}$ i response is extrapolated at the rate of $-\mathbf{6} \mathrm{dB}$ per oetave from $\mathrm{f}=100 \mathrm{MHz}$ to the frequency at which $h_{\text {fo }} \mid=1$.
5. Average Noise Figure is messured in an amplifier with response down 3 dB at 10 Hz and 10 kHz and a high-frequency rolloff of BdB/octave.
*The asterisk indientifies JEDEC registered data for the 2N5400 and 2N5401 only.

## SLLECI ${ }^{\dagger}$ TRANSISTORS $\ddagger$

- For Medium-Power Amplifiers, Class B Audio Outputs, Hi-Fi Drivers
- Also Available in TO-92 Versions . . . 2N3702, 2N3703
- For Complementary Use with 2N5449, 2N5450, and 2N5461


## mechanical data

These transistors are encapsulated in a plastic compound specifically designed for this purpose, using a highly mechanized process developed by Texas Instruments. The case will withstand soldering temperatures without deformation. These devices exhibit stable characteriatics under high-humidity conditions and are capable of meating MIL-STD-202C, Method 108B. The transistors are insensitive to light.

absolute maximum ratings at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)


# TYPES 2N5447, 2N5448 P-N-P SILICON TRANSISTORS 

"electrical characteristics at $\mathbf{2 5}{ }^{\circ} \mathrm{C}$ free-air temperature

| Parameter |  | TEST CONDITIONS | 2N6447 |  | 2N5448 |  | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | MIN | max | MIN | MAX |  |
| $V_{\text {(bR) }}$ CBO | Collector-Bme Breakdown Voltage |  | ${ }^{\prime} \mathrm{C}=-100 \mu \mathrm{~A}, \quad \mathrm{l} E=0$ | -40 |  | -50 |  | $v$ |
| $V_{\text {(bR)CEO }}$ | Colloctor-Emitter Breakdown Voltage | $I_{C}=-10 \mathrm{~mA}, \quad \mathrm{I}_{\mathbf{B}}=0, \quad$ See Note 4 | -25 |  | $-30$ |  | $\checkmark$ |
| $V_{\text {(br)ebo }}$ | Emitter-Bate <br> Breakdown Voltepe | $\mathrm{I}_{\mathrm{E}}=-100 \mu \mathrm{~A}, \mathrm{IC}=0$ | -5 |  | -5 |  | $\checkmark$ |
| Iceo | Collector Cutoff Current | $\mathrm{V}_{\mathrm{CB}}=-20 \mathrm{~V}, \mathrm{IE}=0$ | -100 |  | -100 |  | nA |
| TEBO | Emifter Cutolf Current | $V_{E B}=-3 V_{1} I_{C}=0$ | -100 |  | -100 |  | nA |
| hFE | Static Forwerd Current Tranafer Ratlo | $\mathrm{V}_{\text {CE }}=-5 \mathrm{~V}, \mathrm{IC}^{\text {c }}=-50 \mathrm{~mA}$, See Note 4 | $60 \quad 300$ |  | $30 \quad 150$ |  |  |
| $V_{B E}$ | Baco-Emitter Voltage | $V_{C E}=-5 \mathrm{~V}, 1 \mathrm{l}=-50 \mathrm{~mA}$, Soe Note 4 | $-0.6-1$ |  | -0.6 -1 |  | V |
| VcEsart) | Colloctor-Emitter Eeturation Voltere | $\mathrm{I}_{\mathrm{B}}=\mathbf{- 5} \mathrm{mA}, \quad \mathrm{IC}=-60 \mathrm{~mA}, \mathrm{See}$ Note 4 | -0.25 |  | -0.25 |  | $v$ |
| T | Transition Frequency | $V_{C E}=-5 \mathrm{~V}, 1 \mathrm{IC}=-60 \mathrm{~mA}$, Soe Note 5 | 100 |  | 100 |  | MHz |
| $\mathrm{C}_{\mathrm{cb}}$ | Collector-Base Capacitance | $\begin{aligned} & \text { VCB }=-10 \mathrm{~V}, \mathrm{I}_{\mathrm{E}}=0, \quad \mathrm{f}=1 \mathrm{MHz}, \\ & \text { See Note } 6 \end{aligned}$ |  | 12 |  | 12 | pF |


E. To obtein if, the hfelreeponse with frequeney is extrapoleted at the rate of -6 de per octave from $f=20 \mathrm{MHz}$ to the frequency

THERMAL INFORMATION

FREE-AIR TEMPERATURE DISSIPATION DERATING CURVE

figure 1

## LEAD TEMPERATURE DISSIPATION DERATING CURVE


figure 2

## SILECT ${ }^{\dagger}$ TRANSISTORS $\ddagger$

## - For Medium-Power Amplifiers, Class B Audio Outputs, Hi-Fi Drivers

- Also Available in TO-92 Versions . . . 2N3704 thru 2N3706
- For Complementary Use with 2N5447 and 2N5448
mechanical data
These transistors are encapsulated in a plastic compound specifically designed for this purpose, using a highly mechanized process developed by Texas instruments. The case will withstand soldering temperatures without deformation. These devices exhibit stable characteristics under high-humidity conditions and are capable of meeting MIL-STD-202C, Method 106B. The transistors are insensitive to light.

absolute maximum ratings at $25^{\circ} \mathbf{C}$ free-air temperature (unless otherwise noted)


NOTES: 1. These values apply when the base-emitter diode is open-circuited.
2. Darate the $625-\mathrm{mW}$ rating linearly to $150^{\circ} \mathrm{C}$ free-air temperature at the rate of $5 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$. Derate the $360-\mathrm{mW}$ (JEDEC ragistered) rating linearly to $150^{\circ} \mathrm{C}$ free-air temperature at the rate of $2.88 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$.
3. Derate the $1.25-\mathrm{W}$ rating linearly to $150^{\circ} \mathrm{C}$ lead temperature at the rate of $10 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$. Derate the $500-\mathrm{mW}$ (JEDEC registered) rating linearly to $150^{\circ} \mathrm{C}$ lead temperature at the rate of $4 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$. Lesd temperature is measured on the collector lead $1 / 16$ inch from the case.

- JEDEC registared data. This data sheet contains all applicable registered data in affect at the time of publication.
${ }^{\dagger}$ Trademark of Texas Instruments
$\ddagger$ U.s. Patent No. 3,439,238
§ Texas Instruments guarantees these values in addition to the JEDEC registered values which are also shown.


# TYPES 2N5449, 2N5450, 2N5451 <br> N-P-N SILICON TRANSISTORS 

*electrical characteristics at $25^{\circ} \mathrm{C}$ free-air temperature

| PARAMETER | TEST CONDITIONS | 2N5449 | 2N5450 | 2N5451 | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | MIN MAX | MiN MAX | MIN MAX |  |
| $V_{\text {(BR)CBO }}$Collector-Base <br> Breakdown Voltage | $I_{C}=100 \mu A, \quad I_{E}=0$ | 50 | 50 | 40 | $V$ |
| V(BR)CEOCollector-Emitter <br> Breakdown Voltage | $\begin{array}{ll} \mathrm{I}_{\mathrm{C}}=10 \mathrm{~mA}, & \mathrm{I}_{\mathrm{B}}=0, \\ \text { See Note } 4 \end{array}$ | 30 | 30 | 20 | V |
| $V_{\text {(BR)EBO }} \begin{aligned} & \text { Emitter-Base } \\ & \text { Breakdown Voltage } \end{aligned}$ | $I_{E}=100 \mu A, \quad I^{\prime} C=0$ | 5 | 5 | 5 | $V$ |
| ICBO Collector Cutoff Current | $V_{C B}=20 \mathrm{~V}, \mathrm{I}_{\mathrm{E}}=0$ | 100 | 100 | 100 | nA |
| IEBO Emitter Cutoff Current | $V_{E B}=3 \mathrm{~V}, \quad I_{C}=0$ | 100 | 100 | 100 | nA |
| hFE Static Forward Current <br>  Transfer Ratio | $\begin{aligned} & V_{C E}=2 \mathrm{~V}, \quad I^{\prime} \mathrm{C}=50 \mathrm{~mA}, \\ & \text { See Note } 4 \end{aligned}$ | 100300 | 50150 | 30600 |  |
| VBE Base-Emitter Voltage | $\begin{aligned} & V_{C E}=2 \mathrm{~V}, \quad \mathrm{IC}=100 \mathrm{~mA}, \\ & \text { See Note } 4 \end{aligned}$ | 0.51 | 0.51 | 0.51 | V |
| VCE(sat) $\begin{aligned} & \text { Collector-Emitter } \\ & \text { Saturation Voltage }\end{aligned}$ | $\begin{aligned} & I_{B}=5 \mathrm{~mA}, \quad I_{C}=100 \mathrm{~mA}, \\ & \text { See Note } 4 \end{aligned}$ | 0.6 | 0.8 | 1 | V |
| fT Transition Frequency | $\begin{aligned} & V_{C E}=2 \mathrm{~V}, \quad I^{\prime}=50 \mathrm{~mA}, \\ & \text { See Note } 5 \end{aligned}$ | 100 | 100 | 100 | MHz |
| $\mathrm{C}_{c b} \quad$ Collector-Base Capacitance | $\begin{array}{ll} V_{C B}=10 \mathrm{~V}, & \mathrm{I}_{\mathrm{E}}=0, \\ \mathrm{f}=1 \mathrm{MHz}, & \text { See Note } 6 \end{array}$ | 12 | 12 | 12 | pF |

NOTES: 4. These parameters must be measured using pulse techniques. $t_{w}=300 \mu s$, duty eycle $\leqslant 2 \%$.
5. To obrain $f^{T}$, the $\left.\mathrm{h}_{\mathrm{fe}}\right|_{\text {response }}$ with frequency is extrapolated at the rate of -6 dB per octave from $\mathrm{f}=\mathbf{2 0 \mathrm { MHz } \text { to the frequency }}$ at which $\left|\mathrm{m}_{\mathrm{fe}}\right|=1$.
6. $\mathrm{C}_{\mathrm{cb}}$ measurement employs athree-terminal capacitance bridge incorporating a guard circuit. The emitter is connacted to the guard terminal of the bridge.

- JEDEC registered data

TYPICAL CHARACTERISTICS


## SILECT ${ }^{\dagger}$ FIELD-EFFECT TRANSISTORS $\ddagger$

 FOR INDUSTRIAL AND CONSUMER SMALL-SIGNAL APPLICATIONS- Rugged One-Piece Construction with In-Line Leads or Standard TO-18 100-mil Pin-Circle Configuration


## mechanical data

These transistors are encapsulated in a plastic compound specifically designed for this purpose, using a highly mechanized process developed by Texas Instruments. The case will withstand soldering temperatures without deformation. These devices exhibit stable characteristics under high-humidity conditions and are capable of meeting MIL-STD-202C, Method 106B. The transistors are insensitive to light.

*absolute maximum ratings at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

[^102]
## TYPES 2N5460, 2N5461, 2N5462, A5T5460, A5T5461, A5T5462 P-CHANNEL SILICON JUNCTION FIELD-EFFECT TRANSISTORS

electrical characteristics at $\mathbf{2 5}{ }^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

*operating characteristics at $\mathbf{2 5}{ }^{\circ} \mathrm{C}$ free-air temperature

| PARAMETER |  | TEST CONDITIONS |  | $\begin{array}{r} \text { 2N5460 } \\ \text { A5T5460 } \\ \hline \end{array}$ |  | 2N5461 <br> A5T5461 |  | $\begin{gathered} \hline \text { 2N5462 } \\ \text { A5T5462 } \\ \hline \end{gathered}$ |  | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | MIN | MAX | MIN | MAX | MIN | MAX |  |
| F | Spot Noise Figure |  |  | $\begin{array}{ll} V_{D S}=-15 V, & V_{G S}=0, \\ f=100 \mathrm{~Hz}, & B W=1 \mathrm{~Hz} \end{array}$ | $R_{G}=1 \mathrm{M} \Omega$ |  | 2.5 |  | 2.5 |  | 2.5 | dB |
| $V_{n}$ | Equivalent Input Noise Voltage | $\begin{aligned} & \mathrm{V}_{\mathrm{DS}}=-15 \mathrm{~V}, \mathrm{~V}_{\mathrm{GS}}=0, \\ & \mathrm{BW}=1 \mathrm{~Hz} \end{aligned}$ | $f=100 \mathrm{~Hz}$ |  | 115 |  | 115 |  | 115 | $\mathrm{nV} / \sqrt{1{ }^{\text {z }}}$ |

[^103]
## TYPES 2N5525, 2N5526 N-P-N DARLINGTON-CONNECTED SILICON TRANSISTORS

## SILECT† TRANSISTORS $\ddagger$ <br> TWO N-P.N TRIODES INTERNALLY CONNECTED IN DARLINGTON CONFIGURATION mechanical data

These transistors are encapsulated in a plastic compound specifically designed for this purpose, using a highly mechanized process developed by Texas Instruments. The case will withstand soldering temperatures without deformation. These devices exhibit stable characteristics under high-humidity conditions and are capable of meeting MIL-STD-202C, Method 1068. The transistors are insensitive to light.

*absolute maximum ratings at $\mathbf{2 5}{ }^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)
Collector-Base Voltage ..... 40 V
Collector-Emitter Voltage (See Note 1) ..... 30 V
Emitter-Base Voltage ..... 9 V
Continuous Collector Current ..... 200 mA
Continuous Device Dissipation at (or below) $25^{\circ} \mathrm{C}$ Free-Air Temperature (See Note 2) ..... 360 mW
Continuous Device Dissipation at (or below) $\mathbf{2 5}{ }^{\circ} \mathrm{C}$ Lead Temperature (See Note 3) ..... 500 mW
Storage Temperature Range ..... $-65^{\circ} \mathrm{C}$ to $150^{\circ} \mathrm{C}$
Lead Temperature 1/16 Inch from Case for 10 Seconds ..... $260^{\circ} \mathrm{C}$
*electrical characteristics at $25^{\circ} \mathrm{C}$ free-air temperature

| PARAMETER |  | TEST CONDITIONS |  | 2N5525 |  | 2N5526 |  | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | MIN | MAX | MIN | MAX |  |
| $V_{\text {(BR) }}$ CBO | Collector-Base Breakdown Voltage |  |  | $I_{C}=100 \mu A, I_{E}=0$ |  | 40 |  | 40 |  | V |
| $V_{\text {(BR) }}{ }^{\text {(BEO }}$ | Collector-Emitter Breakdown Voltage | $I_{C}=10 \mathrm{~mA}, \quad I_{B}=0$, | See Note 4 | 30 |  | 30 |  | V |
| $V_{\text {(BR)EBO }}$ | Emitter-Base Breakdown Voltage | $\mathrm{I}_{\mathrm{E}}=100 \mu \mathrm{~A}, \mathrm{I}_{\mathrm{C}}=0$ |  | 9 |  | 9 |  | V |
| ${ }^{\text {I CBO }}$ | Collector Cutoff Current | $V_{C B}=20 \mathrm{~V}, \mathrm{I}_{\mathrm{E}}=0$ |  |  | 100 |  | 100 | nA |
| IEBO | Emitter Cutoff Current | $V_{E B}=5 \mathrm{~V}, \quad \mathrm{I}^{\prime}=0$ |  |  | 100 |  | 100 | nA |
| hFE | Static Forward Current Transfer Ratio | $V_{C E}=10 \mathrm{~V}$, $\mathrm{I}_{\mathrm{C}}=10 \mathrm{~mA}$, | See Note 4 | 5000 |  | 1000 |  |  |
| $V_{\text {BE }}$ | Base-Emitter Voltage | $V_{C E}=10 \mathrm{~V}, \mathrm{I}_{\mathrm{C}}=100 \mathrm{~mA}$, | See Note 4 | 0.9 | 1.8 | 0.9 | 1.8 | V |
| $V_{\text {CE }}$ (sat) | Collector-Emitter Saturation Voltage | $\mathrm{I}_{\mathrm{B}}=0.5 \mathrm{~mA}, \mathrm{I}^{\prime}=50 \mathrm{~mA}$, | See Note 4 |  | 1 |  | 1 | V |
| $h_{f e}$ | Small-Signal Common-Emitter Forward Current Transfer Ratio | $V_{C E}=10 \mathrm{~V}, I_{C}=10 \mathrm{~mA}$, | $f=1 \mathrm{kHz}$ | 5000 |  | 1000 |  |  |
| \|hel | Small-Signal Common-Emitter Forward Current Transfer Ratio | $V_{C E}=10 \mathrm{~V},{ }^{1} \mathrm{C}=20 \mathrm{~mA}$, | $f=100 \mathrm{MHz}$ | 2 |  | 2 |  |  |
| Cobo | Common-Base Open-Circuit Output Capacitance | $V_{C B}=10 \mathrm{~V}, \mathrm{I}^{\prime}=0$, | $f=1 \mathrm{MHz}$ |  | 10 |  | 10 | pF |

NOTES: 1. This value applies when the base-amitter diode is open-circuited.
2. Derate linearly to $150^{\circ} \mathrm{C}$ free-air temperature at the rate of $2.88 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$.
3. Deraty linearly to $150^{\circ} \mathrm{C}$ lead temperature at the rate of $4 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$. Lead temperature is measured on the collector lead $1 / 16$ inch from the case.
4. These parameters must be measured using pulse techniques. $\mathbf{t}_{\mathbf{w}}=\mathbf{3 0 0} \mu \mathrm{s}$, duty cycle $\leqslant 2 \%$.
*JEDEC registered data. This data sheet contains all applicable registered data in effect at the time of publication
${ }^{\dagger}$ Trademark of Texas Instruments.
+U.S. Patant No. 3,439,238.

## MATCHED FIELD-EFFECT TRANSISTORS

- High lyfs $/ \mathrm{C}_{\text {iss }}$ Ratio (High-Frequency Figure-of-Merit)
- Low Input Capacitance Ciss . . . 6 pF Max
- Low Gate-Current Differential . . . 5 nA Max at $\mathrm{T}_{\mathrm{A}}=125^{\circ} \mathrm{C}$
- Recommended for Low-Level D-C Amplifiers, Sample-Hold Circuits, and Series-Shunt Choppers
- Improved Matching and Tracking Characteristics
*mechanical data

*absolute maximum ratings at $\mathbf{2 5}{ }^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)


NOTE 1: Derate linearly to $175^{\circ} \mathrm{C}$ free-air temperature at the rates of $1.67 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$ for each triode and $2.67 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$ for the total device.
*JEDEC registered data. This data sheat conrains all epplicable registered data in effect at the time of publication.

## TYPES 2N5545, 2N5546, 2N5547 <br> DUAL N-CHANNEL SILICON JUNCTION FIELD-EFFECT TRANSISTORS

*electrical characteristics at $\mathbf{2 5}{ }^{\circ} \mathbf{C}$ free-air temperature (unless otherwise noted)
individual triode characteristics (see note 2)

| PARAMETER | TEST CONDITIONS | MIN MAX | UNIT |
| :---: | :---: | :---: | :---: |
| Gate Reverse Current | $V_{G S}=-50 \mathrm{~V}, \mathrm{~V}_{\mathrm{DS}}=0$ | -1 | $\mu \mathrm{A}$ |
|  | $\mathrm{V}_{\mathrm{GS}}=-30 \mathrm{~V}, \mathrm{~V}_{\mathrm{DS}}=0$ | -0.1 | nA |
|  | $V_{G S}=-30 \mathrm{~V}, \mathrm{~V}_{\mathrm{DS}}=0, \quad \mathrm{TA}_{\text {A }}=150^{\circ} \mathrm{C}$ | -150 | nA |
| VGS(off) Gate-Source Cutoff Voltage | $V_{D S}=15 \mathrm{~V}, \mathrm{I}_{\mathrm{D}}=0.6 \mathrm{nA}$ | $\begin{array}{ll}-0.5 & -4.5\end{array}$ | V |
| IG Gate Current | $V_{D G}=15 \mathrm{~V}, I_{D}=200 \mu \mathrm{~A}$ | -50 | pA |
| Ipss Zero-Gate-Voltege Drain Current | $V_{D S}=15 \mathrm{~V}, \mathrm{~V}_{G S}=0$ | $0.5 \quad 8$ | mA |
| Vfe Small-Signal Common-Source Forward Tranafer Admittance | $V_{D S}=15 \mathrm{~V}, V_{G S}=0, \quad f=1 \mathrm{kHz}$ | 1.56 | mmho |
| Vos Small-Signal Common-Source Output Admittance | $V_{D S}=15 \mathrm{~V}, V_{G S}=0, \quad f=1 \mathrm{kHz}$ | 25 | $\mu \mathrm{mho}$ |
| $\mathrm{C}_{\text {ifs }}$ Small-Signal Common-Source Input Capacitance | $\mathrm{V}_{\text {DS }}=16 \mathrm{~V}_{1} \mathrm{~V}_{\text {GS }}=0, \quad \pm=1 \mathrm{MHz}$ | 6 | pF |
| $\mathrm{Cran}_{\text {rater }}$ Small-Signal Common-Source Reverse Transfor Capacitance | $V_{\text {DS }}=16 \mathrm{~V}, \mathrm{~V}_{\mathrm{GS}}=0, \quad f=1 \mathrm{MHz}$ | 2 | pF |
| Yte. Small-Signal Common-Source Forward Tranafer Admittance | $V_{D S}=15 \mathrm{~V}, \quad V_{G S}=0, \quad f=100 \mathrm{MHz}$ | 7.6 | mmho |

triode matching characteriatica

| PARAMETER |  | TE8T CONDITIONS | 2N6646 |  | 2N6E48 |  | 2NEE47 |  | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | MIN | MAX | MIN | MAX | MIN | MAX |  |
| \|G1-IG2| | Gate-Current Differential |  | $\begin{aligned} & \hline V_{D G}=16 \mathrm{~V}, I_{D}=200 \mu \mathrm{~A}, \\ & T_{A}=126^{\circ} \mathrm{C} \\ & \hline \end{aligned}$ |  | 5 |  | 6 |  | 5 | nA |
| \| $\mathbf{G s 1}^{\text {-VGs2 }}$ \| | Gate-Source-Voltage Differential | $V_{D G}=15 \mathrm{~V}, 10=50 \mu \mathrm{~A}$ |  | 5 |  | 10 |  | 15 | mV |
|  |  | $V_{\text {DG }}=15 V_{1} I_{D}=200 \mu A$ |  | 5 |  | 10 |  | 15 |  |
| $\left.\mid \operatorname{AIV}_{\mathbf{G S 1}}-V_{\mathbf{G S 2}}\right)_{\Delta T_{A}} \mid$ | Gate-Source-Voltage-Differential Change with Temperature | $\begin{aligned} & V_{D G}=16 \mathrm{~V}, \quad I_{D}=200 \mu \mathrm{~A}, \\ & T_{A(1)}=25^{\circ} \mathrm{C}, T_{A(2)}=-65^{\circ} \mathrm{C} \end{aligned}$ |  | 0.8 |  | 1.6 |  | 3.2 | mV |
|  |  | $\begin{aligned} & V_{D G}=15 V, I_{D}=200 \mu \mathrm{~A}, \\ & T_{A(1)}=25^{\circ} \mathrm{C}, T_{A(2)}=125^{\circ} \mathrm{C} \end{aligned}$ |  | 1 |  | 2 | 4 |  |  |
| $\frac{\text { IDss1 }}{\text { IDss2 }}$ | Zero-Gate-Voltage Drain Currant Ratio | $\begin{array}{ll} V_{D S}=15 \mathrm{~V}, & V_{G S}=0 \\ & \text { See Note }^{2} \end{array}$ | 0.95 | 1 | 0.9 | 1 | 0.9 | 1 |  |
| $\frac{\mid V_{f f} l_{1}}{\mid V_{f s}{ }_{2}}$ | Small-Signal Common-Source Forward Transfer Admittance Ratio | $\begin{array}{ll} V_{D G}=15 \mathrm{~V}, & I_{D}=200 \mu \mathrm{~A}, \\ f=1 \mathrm{kHz}, & \text { See Note } 3 \end{array}$ | 0.97 | 1 | 0.96 | 1 | 0.9 | 1 |  |
| $\mathrm{V}_{0} \mathrm{l}_{1}$ - $\left.\mathrm{V}_{\mathrm{os}}\right\|_{2}$ | Small-Signal Common-Saurce Output Admittance Differential | $\begin{array}{ll} \hline V_{D G}=15 \mathrm{~V}, & \mathrm{I}_{\mathrm{D}}=200 \mu \mathrm{~A}, \\ \mathrm{f}=1 \mathrm{kHz}, & \text { See Nate } 3 \end{array}$ |  | 1 |  | 2 |  | 3 | $\mu \mathrm{mho}$ |

## *operating characteristics at $25^{\circ} \mathrm{C}$ free-air temperature

 individual triode characteristics (see note 2)| PARAMETER |  | TEST CONDITIONS | 2N5645 | 2N5546 | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | MAX | MAX |  |
| F | Spot Noise Figure |  | $\begin{array}{ll} V_{D G}=15 \mathrm{~V}, & I_{D}=200 \mu \mathrm{~A}, \quad f=10 \mathrm{~Hz}, \\ R_{G}=1 \mathrm{M} \Omega, & \text { Noise Bandwidth }=5 \mathrm{~Hz} \end{array}$ | 3.5 | 5 | dB |
| $V_{n}$ | Equivalent Input Noise Voltage | $\begin{aligned} & V_{D G}=15 \mathrm{~V}, \quad I_{D}=200 \mu \mathrm{~A}, \quad f=10 \mathrm{~Hz}, \\ & \text { Noise Bandwidth }=5 \mathrm{~Hz} \end{aligned}$ | 180 | 200 | $\mathrm{nV} / \sqrt{\mathrm{Hz}}$ |

NOTES: 2. The terminals of the triode not under test are grounded for the measurement of these characteristics.
3. The lower of the two characteristic readings is taken is the numerator or subtrahend.
*JEDEC registerad data

# FOR LOW-LEVEL CHOPPERS, LOGIC SWITCHES, MULTIPLEXERS, AND RF AND VHF AMPLIFIERS 

- High $\mid \mathrm{yfs}_{s} / \mathrm{C}_{\mathrm{iss}}$ Ratio (High-Frequency Figure-of-Merit)
- Low Feedback Capacitance Crss . . . 2 pF Max
- Low On-State Resistance rds(on) ... $100 \Omega$ Max
"mechanical data

*absolute maximum ratings at $\mathbf{2 5}{ }^{\circ} \mathbf{C}$ free-air temparature (unless otherwise noted)


NOTE 9: Derate linearly to $175^{\circ} \mathrm{C}$ free-air temperature at the rate of $2.4 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$.
-JEDEC registered data. This data sheet contains all applicable registered data in effect at the time of publication.

## TYPE 2N5549 <br> N-CHANNEL SILICON JUNCTION FIELD-EFFECT TRANSISTOR

*electrical characteristics at $\mathbf{2 5}^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)


NOTE 2: These parameters must be measured using pulse techniques, $t_{w} \approx 100 \mathrm{~ms}$, duty cycla $\leqslant 10 \%$. -JEDEC registered dets

## THERMAL INFORMATION

DISSIPATION DERATING CURVE


## SILECT ${ }^{\dagger}$ TRANSISTORS $\ddagger$ <br> FOR GENERAL PURPOSE, HIGH-VOLTAGE AMPLIFIER APPLICATIONS

- High V(BR)CEO . . 140 V (2N5550, A5T5550) or 160 V (2N5551, A5T5551)
- Suitable for Controlling Gas-Discharge Indicator Tubes and Other High-Voltage Applications
- Rugged One-Piece Construction with In-Line Leads or Standard TO-18 100-mil Pin-Circle Configuration


## machanical data

These transistors are encapsulated in a plastic compound specifically designed for this purpose, using a highly mechanized process developed by Texas Instruments. The case will withstand soldering temperatures without deformation. These devices exhibit stable characteristics under high-humidity conditions and are capable of meeting MIL-STD-202C, Method 106B. The transistors are insensitive to light.

absolute maximum ratings at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)


NOTES: 1. These values apply when the base-emitter diode is open-circuited.
2. Derate the $625-\mathrm{mW}$ rating linearly to $150^{\circ} \mathrm{C}$ free-air temperature at the rate of $5 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$. Derate the $310-\mathrm{mW}$ (JEDEC registared) rating linearly to $135^{\circ} \mathrm{C}$ free-air temperature at the rate of $2.82 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$.
*The asterisk identifies JEDEC registered data for the $2 N 5550$ and $2 N 5551$ only. This data sheet contains all applicable registered data in effect at the time of publication.
${ }^{\dagger}$ Trademark of Texas Instruments
$\ddagger$ U.S. Patent No. 3,439,238
§ Texas Instruments guarantees these values in addition to the JEDEC registered values which are also shown.

## TYPES 2N5550, 2N5551, A5T5550, A5T5551 <br> N-P-N SILICON TRANSISTORS

*electrical characteristics at $\mathbf{2 5}{ }^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

| PARAMETER |  | TEST CONDITIONS |  | $\begin{gathered} \text { 2N6550 } \\ \text { A5T5550 } \end{gathered}$ |  | 2N6551A5T5551 |  | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | MIN | MAX | MIN | MAX |  |
| $V_{\text {(BR) }}$ CBO | Collector-Base Breakdown Voltage |  |  | $I_{C}=100 \mu A, \quad l_{E}=0$ |  | 160 |  | 180 |  | V |
| $V_{\text {(BR)CEO }}$ | Collector-Emitter Breakdown Voltage | $\mathrm{I}_{C}=1 \mathrm{~mA}, \quad \mathrm{I}_{B}=0$, | See Note 3 | 140 |  | 160 |  | V |
| $V_{\text {(BR)EBO }}$ | Emitter-Base Breakdown Voltage | $\mathrm{I}_{\mathrm{E}}=10 \mu A, \quad \mathrm{I}^{\prime}=0$ |  | 6 |  | 6 |  | V |
| ${ }^{\text {C CBO }}$ | Collector Cutoff Current | $\mathrm{V}_{C B}=100 \mathrm{~V}$, $\mathrm{IE}=0$ |  |  | 100 |  |  | nA |
|  |  | $\mathrm{V}_{C B}=120 \mathrm{~V}, \mathrm{IE}=0$ |  |  |  |  | 50 |  |
|  |  | $V_{C B}=100 \mathrm{~V}, \mathrm{I}_{\mathrm{E}}=0$, | $T_{A}=100^{\circ} \mathrm{C}$ |  | 100 |  |  | $\mu \mathrm{A}$ |
|  |  | $V_{C B}=120 \mathrm{~V}, \mathrm{I}_{\mathrm{E}}=0$, | $T_{A}=100^{\circ} \mathrm{C}$ |  |  |  | 50 |  |
| IEBO | Emitter Cutoff Current | $V_{E B}=4 \mathrm{~V}$, $\mathrm{I}_{\mathrm{C}}=0$ |  |  | 50 |  | 50 | nA |
| hFE | Static Forward Current Transfer Ratio | $\mathrm{V}_{\text {CE }}=5 \mathrm{~V}, \quad \mathrm{I}_{\mathrm{C}}=1 \mathrm{~mA}$ |  | 60 |  | 80 |  |  |
|  |  | $\mathrm{V}_{C E}=5 \mathrm{~V}, \quad \mathrm{I}_{\mathrm{C}}=10 \mathrm{~mA}$ | See Note 3 | 60 | 250 | 80 | 250 |  |
|  |  | $V_{C E}=5 \mathrm{~V}, \quad I^{\prime} \mathrm{C}=50 \mathrm{~mA}$ |  | 20 |  | 30 |  |  |
| $V_{\text {be }}$ | Base-Emitter Voltage | $\mathrm{I}_{\mathrm{B}}=1 \mathrm{~mA}, \quad \mathrm{I}^{\prime}=10 \mathrm{~mA}$ | See Note 3 |  | 1 |  | 1 | V |
|  |  | $I_{B}=5 \mathrm{~mA}, \quad 1 C=50 \mathrm{~mA}$ |  |  | 1.2 |  | 1 |  |
| $V_{\text {CE }}$ (sat) | Collector-Emitter Saturation Vol tage | $I_{B}=1 \mathrm{~mA}, \quad I_{C}=10 \mathrm{~mA}$ | See Note 3 |  | 0.15 |  | 0.15 | V |
|  |  | $\mathrm{I}_{\mathrm{B}}=5 \mathrm{~mA}, \quad \mathrm{I}^{\prime} \mathrm{C}=50 \mathrm{~mA}$ |  |  | 0.25 |  | 0.2 |  |
| $h_{\text {fe }}$ | Small-Signal Common-Emitter Forward Current Transfer Ratio | $V_{C E}=10 \mathrm{~V}, \quad 1 \mathrm{C}=1 \mathrm{~mA}$, | $\mathrm{f}=1 \mathrm{kHz}$ | 50 | 200 |  | 200 |  |
| \|hfel | Small-Signal Common-Emitter Forward Current Transfer Ratio | $V_{C E}=10 \mathrm{~V}, \quad 1 \mathrm{C}=10 \mathrm{~mA}$, | $\mathrm{f}=100 \mathrm{MHz}$ | 1 | 3 | 1 | 3 |  |
| Cobo | Common-Base Open-Circuit Output Capacitance | $V_{C B}=10 \mathrm{~V}, \quad \mathrm{I}_{\mathrm{E}}=0$, | $\mathrm{f}=1 \mathrm{MHz}$ |  | 6 |  | 6 | pF |
| $\mathrm{C}_{\text {ibo }}$ | Common-Base Open-Circuit Input Capacitance | $V_{E B}=0.5 \mathrm{~V}, \quad \mathrm{l} C=0$, | $f=1 \mathrm{MHz}$ |  | 30 |  | 20 | pF |

*operating characteristics at $25^{\circ} \mathrm{C}$ free-air temperature

| PARAMETER |  | TEST CONDITIONS | $\begin{gathered} \text { 2N5560 } \\ \text { A5T5560 } \end{gathered}$ |  | $\begin{aligned} & \text { 2NE551 } \\ & \text { AST5561 } \end{aligned}$ |  | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | MIN | MaX | MIN | MAX |  |
| $\overline{\mathbf{F}}$ | Average Noise Figure |  | $V_{C E}=5 \mathrm{~V}, \quad I_{C}=250 \mu \mathrm{~A}, \mathrm{R}_{\mathrm{G}}=1 \mathrm{k} \Omega$ <br> Noise Bandwidth $=15.7 \mathbf{k H z}$, See Note 4 |  | 10 |  | 8 | dB |

NOTES: 3. These parameters must be measured using pulse techniques. $t_{w}=300 \mu \mathrm{~s}$, duty cycle $\leq \mathbf{2 \%}$.
4. Average Noise Figure is messured in an amplifier with response down 3 dB at 10 Hz and 10 kHz and a high-frequency rolloff of $6 \mathrm{~dB} / \mathrm{octave}$.
-JEDEC registered data

# SILECT ${ }^{\dagger}$ FIELD-EFFECT TRANSISTORS $\ddagger$ 

## - Narrow IDSS and VGS(off) Ranges

- For Low-Noise Audio-Frequency Amplifier Applications
- For RF Amplifier Applications Thru $100 \mathbf{~ M H z}$
- Low rds(on) for Chopper and Switching Applications


## mechanical data

These transistors are encapsulated in a plastic compound specifically designed for this purpose, using a highly mechanized process developed by Texas Instruments. The case will withstand soldering temperatures without deformation. These devices exhibit stable characteristics under high-humidity conditions and are capable of meeting MIL-STD-202C Method 1068. The transistors are insensitive to light.
*CASE OUTLINE


NOTES: A. Lead diameter is not controlied in this area.
 sured in the gaging plane 0.054 below the seating plane of the device relative to a maximum diameter package.
C. All dimensions are in inches.

## *absolute maximum ratings at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

Drain-Gate Voltage ..... 30 V
Reverse Gate-Source Voltage ..... $-30 \mathrm{~V}$
Continuous Forward Gate Current ..... 10 mA
Continuous Device Dissipation at (or below) $25^{\circ} \mathrm{C}$ Free-Air Temperature (See Note 1) ..... 360 mW
Continuous Device Dissipation at (or below) $25^{\circ} \mathrm{C}$ Lead Temperature (See Note 2) ..... 500 mW
Storage Temperature Range ..... $-65^{\circ} \mathrm{C}$ to $150^{\circ} \mathrm{C}$
Lead Temperature 1/16 Inch from Case for 10 Seconds ..... $260^{\circ} \mathrm{C}$

NOTES: 1. Derate linearly to $150^{\circ} \mathrm{C}$ free-air temperature at the rate of $2.88 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$.
2. Derate linearly to $150^{\circ} \mathrm{C}$ lead tempersture at the rate of $4 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$. Lead temperature is measured on the gate lead $1 / 16$ inch from the case.

[^104]
## TYPES 2N5949 THRU 2N5953

N-CHANNEL SILICON JUNCTION FIELD-EFFECT TRANSISTORS


## *operating characteristics at $25^{\circ} \mathrm{C}$ free-air temperature

| PARAMETER |  | TEST CONDITIONS |  |  |  | ALL TYPES |  | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | MIN | MAX |  |
| F | Common-Source Spot Noise Figure |  |  |  |  | $V_{D S}=15 \mathrm{~V}$ <br> See Note 4 | $V_{G S}=0,$ | $f=100 \mathrm{Mr}$ | $\mathbf{R}_{\mathbf{G}}=\mathbf{1} \mathrm{k} \Omega_{\text {d }}$ |  | 5 | dB |
|  |  | $V_{D S}=15 \mathrm{~V}$ <br> See Note 4 | $V_{G S}=0,$ | $f=1 \mathrm{kHz},$ | $\mathrm{R}_{\mathrm{G}}=1 \mathrm{M} \Omega$, |  | 2 |  |  |
| $V_{n}$ | Equivalent Input Noise Voltage | VDS $=15 \mathrm{~V}$. | $V_{G S}=0$, | $f=1 \mathrm{kHz}$, | See Note 4 |  | 100 | $n \mathrm{~K} / \mathrm{Hz}$ |  |

NOTES: 3. This parameter must be measured using pulse techniques. $\mathbf{t w}_{\mathbf{w}} \mathbf{= 3 0 0} \boldsymbol{\mu}$, dutv cycle $\leqslant \mathbf{2 \%}$.
4. These parameters must be measured with bias conditions applied for less than 5 seconds to avoid overheating.
*JEDEC registered data
P-

## SILECT ${ }^{\dagger}$ TRANSISTORS $\ddagger$ FOR USE IN PULSE, TIMING, SWEEP, TRIGGER, AND OSCILLATOR CIRCUITS

- Plug-in Replacements for 2N6027, 2N6028 (TO-98 Package)
- Low Peak-Point Current and Low Forward Voltage
- Programmable $\eta$, rBB, Ip, and IV
mechanical data
These transistors are encapsulated in a plastic compound specifically designed for this purpose, using a highly mechanized process developed by Texas Instruments. The case will withstand soldering temperatures without deformation. These devices exhibit stable characteristics under high-humidity conditions and are capable of meeting MIL-STD-202C, Method 106B. The transistors are insensitive to light.

THE GATE IS CONNECTED TO AN N REGION
ALL JEDEC TO-92 DIMENSIONS AND NOTES ARE APPLICABLE


NOTES: A. Lead diameter is not controlled In this area.
B. All dimensions are in inches.
absolute maximum ratings at $\mathbf{2 5}{ }^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)
Anode-Cathode Voltage . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . $\pm 40 \mathrm{~V}$
Gate-Anode Voltage . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 40 V
Gate-Cathode Voltage: (Positive Limit) . . . . . . . . . . . . . . . . . . . . . . . . . . . . 40 V
(Negative Limit) . . . . . . . . . . . . . . . . . . . . . . . . . . . -5 V
Continuous Anode Current . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 150 mA
Repetitive Peak Anode Current: ( $\mathbf{t}_{\mathbf{w}}=\mathbf{1 0 0} \mu \mathrm{s}$, Duty Cycle $\leqslant 1 \%$ ) . . . . . . . . . . . . . . . . . . 1 A
( $t_{w}=20 \mu$, Duty Cycle $\leqslant \mathbf{1 \%}$ ) . . . . . . . . . . . . . . . . . . 2 A
Nonrepetitive Peak Anode Current: $\left(t_{w}=10 \mu \mathrm{~s}, \mathrm{Duty}\right.$ Cycle $\left.=0\right)$. . . . . . . . . . . . . . . . . . 5 A
Continuous Gate Current . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . $\pm 50 \mathrm{~mA}$
Continuous Device Dissipation at (or below) $\mathbf{2 5}^{\circ} \mathrm{C}$ Free-Air Temperature (See Note 1) . . . . . . . 300 mW
Storage Temperature Range . . . . . . . . . . . . . . . . . . . . . . . . . . . $-65^{\circ} \mathrm{C}$ to $150^{\circ} \mathrm{C}$
Lead Temperature 1/16 Inch from Case for 60 Seconds
$260^{\circ} \mathrm{C}$
electrical characteristics at $25^{\circ} \mathrm{C}$ free-air temperature

| PARAMETER | TEST CONDITIONS | A7T6027 | A7T6028 | UNIT |
| :---: | :---: | :---: | :---: | :---: |
|  |  | MIN MAX | MIN MAX |  |
| IGAO Gate Reverse Current | $\mathrm{V}_{\mathrm{GA}}=40 \mathrm{~V}, \mathrm{I}_{\mathrm{K}}=0$ | 10 | 10 | nA |
|  | $V_{G A}=40 \mathrm{~V}, \mathrm{I}_{\mathrm{K}}=0, \quad \mathrm{~T}_{A}=75^{\circ} \mathrm{C}$ | 100 | 100 |  |
| IGKS Gate Reverse Current | $V_{\text {GK }}=40 \mathrm{~V}, \mathrm{~V}_{\text {AK }}=0$ | 100 | 100 | nA |
| $\mathrm{V}_{\mathrm{P}}-\mathrm{V}_{\mathbf{S}}$ Offset Voltege | $\mathrm{V}_{\mathrm{S}}=10 \mathrm{~V}, \quad \mathrm{R}_{\mathrm{G}}=10 \mathrm{k} \Omega$ | 0.20 .6 | 0.20 .6 | V |
|  | $\mathrm{V}_{\mathrm{S}}=10 \mathrm{~V}, \quad \mathrm{R}_{\mathrm{G}}=1 \mathrm{M} \Omega$ | 0.21 .6 | 0.20 .6 |  |
| Peak-Point Current | $\mathrm{V}_{\mathrm{S}}=10 \mathrm{~V}, \quad \mathrm{R}_{\mathrm{G}}=10 \mathrm{k} \Omega$ | 5 | 1 | $\mu \mathrm{A}$ |
|  | $\mathrm{V}_{S}=10 \mathrm{~V}, \quad \mathrm{R}_{\mathrm{G}}=1 \mathrm{M} \Omega$ | 2 | 0.15 |  |
| IV Valley-Point Current | $\mathrm{V}_{S}=10 \mathrm{~V}, \quad \mathrm{R}_{\mathrm{G}}=200 \Omega$ | 1500 | 1000 | $\mu \mathrm{A}$ |
|  | $\mathrm{V}_{S}=10 \mathrm{~V}, \quad \mathrm{R}_{\mathrm{G}}=10 \mathrm{k} \Omega$ | 70 | 25 |  |
|  | $\mathrm{V}_{S}=10 \mathrm{~V}, \quad \mathrm{R}_{\mathrm{G}}=1 \mathrm{M} \Omega$ | 50 | 25 |  |
| VF Anode-Cathode On-State Voltage | $V_{S}=10 \mathrm{~V}, \quad \mathrm{R}_{\mathrm{G}}=10 \mathrm{k} \Omega, I_{F}=50 \mathrm{~mA}$ | 1.5 | 1.5 | V |

[^105]$\ddagger$ U.S. Patent No. 3,439,238

## TYPES A7T6027, A7T6028

P-N-P-N SILICON PROGRAMMABLE UNIJUNCTION TRANSISTORS

## operating characteristics at $25^{\circ} \mathrm{C}$ free-air temperature

| PARAMETER |  | TEST CONDITIONS | A7T6027 |  |  | ATT8028 |  |  | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | MIN | TYP | MAX | MIN | TYP | MAX |  |
| Vom | Pask Output Voltage |  | $V_{A A}=20 \mathrm{~V}, \quad C 1=0.2 \mu F$ <br> See Figure 4 | 6 |  |  | 6 |  |  | V |
| $t_{r}$ | Output Pulso Rise Time |  |  | 65 | 80 |  | 66 | 80 | n |

## PARAMETER MEASUREMENT INFORMATION

FIGURE 1-PROGRAMMABLE UNIJUNCTION CIRCUIT


$$
\begin{aligned}
& V_{\mathrm{S}}=\frac{\mathrm{R} 1 \cdot \mathrm{~V}_{\mathrm{B} 2 \mathrm{~B} 1}}{R_{1}+R_{2}} \\
& R_{\mathrm{G}}=\frac{R_{1} \cdot \mathrm{R}_{2}}{R_{1}+R_{2}}
\end{aligned}
$$

FIGURE 2-EQUIVALENT CIRCUIT USED FOR TESTING


FIOURE 3-QENERAL ANODE CHARACTERIBTICS


FIGURE 4-TESTING OPERATING CHARACTERISTICS

# TYPES 2N6116, 2N6117, 2N6118 P-N-P-N SILICON PROGRAMMABLE UNIJUNCTION TRANSISTORS <br> BULLETIN NO. DL-S 7211778, DECEMBER 1972 

- For Use in Pulse, Timing, Sweep, Trigger, and Oscillator Circuits
- Features Low Peak-Point Current and L.ow Forward Voltage
- Programmable $\eta$, rBB, IP, and IV
mechanical data



## "absolute maximum ratings at $\mathbf{2 5}^{\circ} \mathbf{C}$ free-air temperature (unless otherwise noted)


"electrical characteristics at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

| PARAMETER | TEST CONDITIONS | 2N6116 |  | 2N8117 |  | 2N6118 |  | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | MIN | MAX | MIN | MAX | MIN | MAX |  |
| IGAO Gate Reverse Current | $V_{G A}=40 \mathrm{~V}, I_{K}=0$ |  | 5 |  | 5 |  | 5 | $n \mathrm{~A}$ |
|  | $\begin{aligned} & V_{G A}=40 \mathrm{~V}, I_{K}=0, \\ & T_{A}=75^{\circ} \mathrm{C} \end{aligned}$ |  | 76 |  | 75 |  | 75 |  |
| IGKS Gate Reverse Current | $V_{G K}=40 \mathrm{~V}, V_{A K}=0$ |  | 50 |  | 60 |  | 60 | nA |
| VP-VS Offset Voltage | $V_{S}=10 \mathrm{~V}, \mathrm{R}_{\mathrm{G}}=10 \mathrm{k} \Omega$ | 0.2 | 0.6 | 0.2 | 0.6 | 0.2 | 0.6 | V |
|  | $\mathrm{V}_{\mathbf{S}}=10 \mathrm{~V}, \mathrm{R}_{\mathrm{G}}=1 \mathrm{M} \Omega$ | 0.2 | 1.6 | 0.2 | 0.6 | 0.2 | 0.6 |  |
| Peak-Point Current | $V_{S}=10 \mathrm{~V}, \mathrm{R}_{\mathrm{G}}=10 \mathrm{k} \Omega$ |  | 5 |  | 2 |  | 1 | $\mu \mathrm{A}$ |
|  | $\mathrm{V}_{\mathrm{S}}=10 \mathrm{~V}, \mathrm{R}_{\mathrm{G}}=1 \mathrm{M} \Omega$ |  | 2 |  | 0.3 |  | 0.15 |  |
| Valley-Point Current | $\mathrm{V}_{\mathrm{S}}=10 \mathrm{~V}, \mathrm{R}_{\mathrm{G}}=10 \mathrm{k} \Omega$ | 70 |  | 50 |  | 50 |  | $\mu \mathrm{A}$ |
|  | $\mathrm{V}_{\mathrm{S}}=10 \mathrm{~V}, \mathrm{R}_{\mathrm{G}}=1 \mathrm{M} \Omega$ |  | 50 |  | 50 |  | 25 |  |
| VF Anode-Cathode On-State Voltage | $\begin{aligned} & V_{S}=10 \mathrm{~V}, \quad R_{G}=10 \mathrm{k} \Omega, \\ & I_{F}=50 \mathrm{~mA} \end{aligned}$ |  | 1.5 |  | 1.5 |  | 1.5 | $V$ |

NOTES: 1. Derate Finearly to $125^{\circ} \mathrm{C}$ free-air temperature at the rate of $2 \mathrm{~mA} /{ }^{\circ} \mathrm{C}$
2. Derate linearly to $125^{\circ} \mathrm{C}$ free-sir temperature at the rate of $2.5 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$.
*JEDEC registered data. This data sheet contains all applicable registered data in effect at the time of publication.

## TYPES 2N6116, 2N6177, 2N6118 <br> P-N-P-N SILICON PROGRAMMABLE UNIJUNCTION TRANSISTORS

## "operating characteristics at $25^{\circ} \mathrm{C}$ free-air temperature

| PARAMETER |  | TEST CONDITIONS | 2N6116 |  | 2N6117 |  | 2N6118 |  | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | MIN | MAX | MIN | MAX | MIN | MAX |  |
| Vom | Peak Output Voltage |  | $\mathrm{V}_{\mathrm{AA}}=20 \mathrm{~V}, \mathrm{C} 1=0.2 \mu \mathrm{~F},$ <br> See Figure 4 | 6 |  | 6 |  | 6 |  | $v$ |
| ${ }_{\text {t }}^{\text {r }}$ | Output Puise Rise Time |  |  | 80 |  | 80 |  | 80 | ns |

*PARAMETER MEASUREMENT INFORMATION


FIGURE 1-PROGRAMMABLE UNIJUNCTION CIRCUIT

$V_{S}=\frac{A_{1} \cdot V_{B 2 B 1}}{R 1+R_{2}}$
$R_{G}=\frac{R_{1} \cdot R_{2}}{R_{1}+R_{2}}$
FIGURE 2-EQUIVALENT CIRCUIT USED FOR TESTING


FIGURE 3-GENERAL ANODE CHARACTERISTICS


[^106]
# TYPES A5T6116, A5T6117, A5T6118 P-N-P-N SILICON PROGRAMMABLE UNLJUNCTION TRANSISTORS 

BULLETIN NO DL-S 731 1984, MARCH 1973

## SILECT $^{\dagger}$ TRANSISTORS $\ddagger$ FOR USE IN PULSE, TIMING, SWEEP, TRIGGER, AND OSCILLATOR CIRCUITS

- Rugged One-Piece Construction with Standard TO-18 100-mil Pin-Circle Configuration
- Low Peak-Point Current and Low Forward Voltage - Programmable $\eta$, rBB, IP, and IV mechanical data

These transistors are encapsulated in a plastic compound specifically designed for this purpose, using a highly mechanized process developed by Texas Instruments. The case will withstand soldering temperatures without deformation. These devices exhibit stable characteristics under high-humidity conditions and are capable of meeting MIL-STD-202C, Method 106B. The transistors are insensitive to light.
THE GATE IS CONNECTED TO AN N REGION
absolute maximum ratings at $\mathbf{2 5}{ }^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)
Anode-Cathode Voltage ..... $\pm 40 \mathrm{~V}$
Gate-Anode Voltage ..... 40 V
Gate-Cathode Voltage: (Positive Limit) ..... 40 V
(Negative Limit) ..... $-5 \mathrm{~V}$
Continuous Anode Current ..... 200 mA
Repetitive Peak Anode Current: ( $\mathbf{t}_{\mathbf{w}}=\mathbf{1 0 0} \boldsymbol{\mu}$ s, Duty Cycle $\leqslant 1 \%$ ) ..... 1 A
 ..... 2 A
Nonrepetitive Peak Anode Current: ( $\mathbf{t}_{\mathbf{w}}=\mathbf{1 0} \mu \mathrm{s}$, Duty Cycle $\left.=0\right)$ ..... 5 A
Continuous Gate Current ..... $\pm 20 \mathrm{~mA}$
Continuous Device Dissipation at (or below) $25^{\circ} \mathrm{C}$ Free-Air Temperature (See Note 1) ..... 300 mW

Storage Temperature Range $260^{\circ} \mathrm{C}$
electrical characteristics at $\mathbf{2 5}{ }^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

| PARAMETER | TEST CONDITIONS | A5T6116 |  | A5T6117 |  | A5T6118 |  | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | MIN | MAX | MIN | MAX | MIN | MAX |  |
| IGAO Gate Reverse Current | $V_{G A}=40 \mathrm{~V}, I_{K}=0$ |  | 5 |  | 5 |  | 5 | nA |
|  | $\begin{aligned} & V_{G A}=40 \mathrm{~V}, I_{\mathrm{K}}=0, \\ & T_{A}=75^{\circ} \mathrm{C} \end{aligned}$ |  | 75 |  | 75 |  | 75 |  |
| IGKS Gate Reverse Current | $\mathrm{V}_{\text {GK }}=40 \mathrm{~V}, \mathrm{~V}_{\text {AK }}=0$ |  | 50 |  | 50 |  | 50 | nA |
| $V_{P}-V_{S}$ Offset Voltage | $\mathrm{V}_{\mathrm{S}}=10 \mathrm{~V}, \quad \mathrm{R}_{\mathrm{G}}=10 \mathrm{k} \Omega$ | 0.2 | 0.6 | 0.2 | 0.6 | 0.2 | 0.6 | V |
|  | $\mathrm{V}_{\mathrm{S}}=10 \mathrm{~V}, \quad \mathrm{R}_{\mathrm{G}}=1 \mathrm{M} \Omega$ | 0.2 | 1.6 | 0.2 | 0.6 | 0.2 | 0.6 |  |
| IP Peak-Point Current | $V_{S}=10 \mathrm{~V}, \quad R_{G}=10 \mathrm{k} \Omega$ |  | 5 |  | 2 |  | 1 | $\mu \mathrm{A}$ |
|  | $\mathrm{V}_{\mathrm{S}}=10 \mathrm{~V}, \quad \mathrm{R}_{\mathrm{G}}=1 \mathrm{M} \Omega$ |  | 2 |  | 0.3 |  | 0.15 |  |
| IV Valley-Point Current | $\mathrm{V}_{S}=10 \mathrm{~V}, \quad \mathrm{R}_{\mathrm{G}}=10 \mathrm{k} \Omega$ | 70 |  | 50 |  | 50 |  | $\mu \mathrm{A}$ |
|  | $\mathrm{V}_{\mathrm{S}}=10 \mathrm{~V}, \quad \mathrm{R}_{\mathrm{G}}=1 \mathrm{M} \Omega$ |  | 50 |  | 50 |  | 25 |  |
| VF Anode-Cathode On-State Voltage | $\begin{array}{ll} V_{S}=10 \mathrm{~V}, & R_{G}=10 \mathrm{k} \Omega, \\ I_{F}=50 \mathrm{~mA} \end{array}$ |  | 1.5 |  | 1.5 |  | 1.5 | $\checkmark$ |

[^107]USES CHIP U41

TYPES A5T6116, A5T6117, A5T6118
P-N-P-N SILICON PROGRAMMABLE UNLUUNCTION TRANSISTORS
operating characteristics at $25^{\circ} \mathrm{C}$ free-air temperature

| PARAMETER |  | TEST CONDITIONS | A5T6116 |  | A5T6117 |  | A5T6118 |  | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | MIN | MAX | MIN | MAX | MIN | MAX |  |
| $\mathrm{V}_{\text {OM }}$ | Peak Output Voltage |  | $V_{A A}=20 \mathrm{~V}, \mathrm{C}_{1}=0.2 \mu \mathrm{~F}$ <br> See Figure 4 | 6 |  | 6 |  | 6 |  | V |
| $\mathrm{t}_{\mathrm{r}}$ | Output Pulse Rise Time |  |  | 80 |  | 80 |  | 80 | ns |

PARAMETER MEASUREMENT INFORMATION

FIGURE 1-PROGRAMMABLE UNIJUNCTION CIRCUIT


FIGURE 2-EQUIVALENT CIRCUIT USED FOR TESTING


FIGURE 3-GENERAL ANODE CHARACTERISTICS


## HIGH-VOLTAGE FIELD-EFFECT TRANSISTORS

- High V(BR)GSS . . . 300 V Min (2N6449)
- High Dissipation Capability . . 5 W


## *mechanical data


*absolute maximum ratings at $\mathbf{2 5}{ }^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)


NOTES: 1. Derate linearly to $175^{\circ} \mathrm{C}$ free-air temperature at the rate of $5.33 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$.
2. Derate linearly to $175^{\circ} \mathrm{C}$ case temperature at the rate of $33.3 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$.

[^108]
## TYPES 2N6449, 2N6450 <br> N-CHANNEL SILICON JUNCTION FIELD-EFFECT TRANSISTORS

*electrical characteristics at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

| PARAMETER |  | TEST CONDITIONS |  | 2N6449 |  | 2N6450 |  | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | MIN | MAX | MIN | MAX |  |
| $V_{\text {(BR) }}$ GSS | Gate-Source Breakdown Voltage |  |  | $\mathrm{I}_{\mathrm{G}}=-10 \mu \mathrm{~A}$, | $V_{D S}=0$ | -300 |  | -200 |  | V |
| ${ }^{\text {I GSS }}$ | Gate Roverse Current | $\mathrm{V}_{\mathbf{G S}}=-150 \mathrm{~V}$ | $V_{D S}=0$ |  | -100 |  |  | nA |
|  |  | $V_{G S}=-100 \mathrm{~V}$ | $V_{D S}=0$ |  |  |  | -100 |  |
|  |  | $\mathrm{V}_{\mathbf{G S}}=-150 \mathrm{~V}$ | $V_{D S}=0, T_{A}=150^{\circ} \mathrm{C}$ |  | $-100$ |  |  | $\mu \mathrm{A}$ |
|  |  | $V_{G S}=-100 \mathrm{~V}$ | $V_{D S}=0, T_{A}=150^{\circ} \mathrm{C}$ |  |  |  | -100 |  |
| VGS (off) | Gate-Source Cutoff Voltage | $V_{\text {DS }}=30 \mathrm{~V}$, | $I_{D}=4 \mathrm{nA}$ | -2 | -15 | -2 | -15 | V |
| IDSS | Zero-Gate-Voltage Drain Current | $V_{D S}=30 \mathrm{~V}$, | $\mathrm{V}_{\mathrm{GS}}=0$, See Note 3 | 2 | 10 | 2 | 10 | mA |
| \| $\mathrm{ff}_{\text {f }}$ ] | Small-Signal Common-Source Forward Transfer Admittance | $V_{D S}=30 \mathrm{~V}, \quad V_{G S}=0, f=1 \mathrm{kHz},$ <br> See Note 4 |  | 0.5 | 3 | 0.5 | 3 | mmho |
| \|Vosi | Smali-Signal Common-Source Output Admittance |  |  |  | 100 |  | 100 | $\mu \mathrm{mho}$ |
| $C_{\text {iss }}$ | Common-Source Short-Circuit Input Capacitance | $V_{D S}=30 \mathrm{~V} . \quad V_{G S}=0, f=1 \mathrm{MHz},$ <br> See Note 4 |  |  | 20 |  | 20 | pF |
| $\mathrm{C}_{\text {rss }}$ | Common-Source Short-Circuit Reverse Transfer Capacitance |  |  |  | 2.5 |  | 2.5 | pF |

NOTES: 3. This parameter must be messured using pulse techniques. $t_{w}=\mathbf{3 0 0} \mu \mathrm{s}$, dutv cycle $\leqslant \mathbf{2 \%}$.
4. To obtain repeatable results, these parameters must be messured with bias conditions applied for less than 5 seconds.
*JEDEC registered data

## THERMAL INFORMATION

FREE-AIR TEMPERATURE DISSIPATION DERATING CURVE


FIGURE 1

CASE TEMPERATURE DISSIPATION DERATING CURVE

figure' 2

TYPES A5T6449, A5T6450, A8T6449, A8T6450 N-CHANNEL SILICON JUNCTION FIELD-EFFECT TRANSISTORS

## SILECTI HIGH-VOLTAGE FIELD-EFFECT TRANSISTORS

- High V(BR) GSS . . . 300 V Min (A5T6449, A8T6449)
- High Dissipation Capability . . . $\mathbf{1 . 6} \mathbf{W}$ at $\mathbf{2 5}{ }^{\circ} \mathrm{C}$ Case Temperature


## mechanical data


absolute maximum ratings at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

|  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  |  |
|  |  |  |  |  |  |
|  | Reverse Gate-Source VoltageContinuous Forward Gate Cur |  |  |  |  |
|  |  |  |  |  |  |
|  | Continuous Device Dissipation |  |  |  |  |
|  | Continuous Device Dissipation |  |  |  |  |
|  |  |  |  |  |  |
|  | Continuous Device Dissipation Storage Temperature Range |  |  |  |  |
|  | Storage Temperature RangeLead Temperature $1 / 16$ Inch |  |  |  |  |

NOTES: 1. Derate linearly to $150^{\circ} \mathrm{C}$ free-air temperature at the rate of $5 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$.
2. Derate linearly to $150^{\circ} \mathrm{C}$ lead temperature at the rate of $10 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$. Lead temperature is measured on the collector lead $\mathbf{1 / 1 6}$ inch from the case.
3. This rating applies with the entire case (including the leads) maintained at $25^{\circ} \mathrm{C}$. Derate linearly to $150^{\circ} \mathrm{C}$ case-and-lead tempersture at the rate of $12.8 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$.

[^109]†U.S. Patent No. 3,439,238
electrical characteristics at $\mathbf{2 5}{ }^{\circ} \mathbf{C}$ free-air temperature (unless otherwise notad)

| PARAMETER |  | TEET CONDITIONS |  | A5T6449 A8T6449 |  | A5T6460 <br> A8T6450 |  | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | MIN | MAX | MIN | MAX |  |
| $V$ (BR) ${ }^{\text {GSS }}$ | Gate-Source Breakdown Voltage |  |  | $1 \mathrm{~g}=-10 \mu \mathrm{~A}$, | $V_{D S}=0$ | -300 |  | -200 |  | V |
| IGSS | Gate Reverse Current | $V_{G S}=-160 \mathrm{~V}$ | $V_{D S}=0$ |  | -100 |  |  | nA |
|  |  | $\mathrm{V}_{\mathrm{GS}}=-100 \mathrm{~V}$ | $V_{0 S}=0$ |  |  |  | -100 |  |
|  |  | $V_{G S}=-150 \mathrm{~V}$ | $V_{D S}=0, T_{A}=100^{\circ} \mathrm{C}$ |  | -10 |  |  | $\mu \mathrm{A}$ |
|  |  | $V_{G S}=-100 \mathrm{~V}$ | $V_{D S}=0, T_{A}=100^{\circ} \mathrm{C}$ |  |  |  | -10 |  |
| VGS(off) | Gate-Source Cutoff Voltage | $\mathrm{V}_{\mathrm{DS}}=30 \mathrm{~V}$. | $I_{D}=4 \mathrm{nA}$ | -2 | -15 | -2 | -15 | $V$ |
| IDSs | Zero-Gate-Voltage Drain Current | $\mathrm{V}_{\mathrm{DS}}=30 \mathrm{~V}$, | $V_{\text {GS }}=0$, See Note 4 | 2 | 10 | 2 | 10 | mA |
| \|Yfs ${ }^{\text {a }}$ | Small-Signal Common-Source Forward Transfer Admittance | $\begin{aligned} & V_{D S}=30 \mathrm{~V}, \quad V_{G S}=0, f=1 \mathrm{kHz}, \\ & \text { See Note } 5 \end{aligned}$ |  | 0.5 | 3 | 0.5 | 3 | mmho |
| \|Yos| | Small-Signal Common-Source Output Admittance |  |  |  | 100 |  | 100 | $\mu \mathrm{mho}$ |
| $\mathrm{C}_{\text {iss }}$ | Common-Source Short-Circuit Input Capacitance | $V_{D S}=30 \mathrm{~V}, \quad V_{G S}=0, f=1 \mathrm{MHz}$ <br> See Note 5 |  |  | 20 |  | 20 | pF |
| $\mathrm{C}_{\text {rss }}$ | Common-Source Short-Circuit Reverse Transfer Capacitance |  |  |  | 2.5 |  | 2.6 | pF |

NOTES: 4. This parameter must be masured using pulse techniques, $t_{w}=300 \mu s$, duty cycle $\leqslant 2 \%$.
5. To obtain repeatable results, these parameters must be measured with bias conditions applled for less than $\mathbf{E}$ eeconds.

## THERMAL INFORMATION



FIGURE 1

## TYPES 2N6451 THRU 2N6454 N-CHANNEL SILICON JUNCTION FIELD-EFFECT TRANSISTORS

## DESIGNED FOR LOW-NOISE PREAMPLIFIER APPLICATIONS ESPECIALLY HYDROPHONES, IR SENSORS, AND PARTICLE DETECTORS

- Low $\mathrm{V}_{\mathrm{n}} \ldots \mathrm{I} . \mathrm{nV} / \sqrt{\mathrm{Hz}}$ Max at 10 Hz (2N6451, 2N6453)
- High |yfs| . . 20 mmho Min (2N6463, 2N6454)
- Low IGSS . . . 100 pA Max (2N6451, 2N6463)


## *mechanical data


*absolute maximum ratings at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)


NOTE 1: Derste Inearly to $175^{\circ} \mathrm{C}$ free-alr temperature at the rate of $2.4 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$.

## TYPES 2N6451 THRU 2N6454 <br> N-CHANNEL JUNCTION GATE FIELD-EFFECT TRANSISTORS

*electrical characteristics at $25^{\circ} \mathbf{C}$ free-air temperature (unless otherwise noted)

| PARAMETER |  | TEST CONDITIONS ${ }^{\dagger}$ | $2 \mathrm{Na451}$ |  | 2N8462 |  | 2N6453 |  | 2N8454 |  | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | MIN | MAX | MIN | MAX | MIN | MAX | MIN | MAX |  |
| $V_{\text {(BR) }}$ GSS | Gate-Source <br> Breakdown Voltage |  | $I_{G}=-1 \mu A, \quad V_{D S}=0$ | -20 |  | -25 |  | -20 |  | -25 |  | V |
| IGSS | Gate Reverse Current | $V_{G S}=-10 \mathrm{~V}, V_{D S}=0$ |  | -0.1 |  |  |  | -0.1 |  |  | nA |
|  |  | $V_{G S}=-15 \mathrm{~V}, \mathrm{~V}_{\text {DS }}=0$ |  |  |  | -0.5 |  |  |  | -0.5 |  |
|  |  | $\begin{aligned} & V_{G S}=-10 \mathrm{~V} . \\ & V_{D S}=0 \end{aligned} T_{A}=125^{\circ} \mathrm{C}$ |  | -0.2 |  |  | -0.2 |  | -1 |  | $\mu \mathrm{A}$ |
|  |  | $\begin{aligned} & V_{G S}=-15 \mathrm{~V} \\ & \mathrm{~V}_{\mathrm{DS}}=0 \end{aligned}$ |  |  |  | -1 |  |  |  |  |  |
| VGS(off) | Gate-Source Cutoff Voltage | $V_{D S}=10 \mathrm{~V}, \mathrm{I}_{\mathrm{D}}=0.5 \mathrm{nA}$ | -0.5 | -3.5 | -0.5 | -3.5 | -0.75 | -5 | -0.75 | -5 | $V$ |
| IDSS | Zero-Gate-Voltage Drain Current | $V_{D S}=10 \mathrm{~V}, \quad V_{G S}=0,$ <br> See Note 2 | 5 | 20 | 5 | 20 | 15 | 50 | 15 | 60 | mA |
| $\left\|\mathrm{Vfs}_{\text {f }}\right\|$ | Small-Signal <br> Common-Source <br> Forward Transfer <br> Admittance | $\begin{aligned} & V_{D S}=10 \mathrm{~V}, \quad I_{D}=5 \mathrm{~mA}, \\ & f=1 \mathrm{kHz} \end{aligned}$ | 15 | 30 | 15 | 30 |  |  |  |  | mmho |
|  |  | $\begin{array}{ll} V_{D S}=10 \mathrm{~V}, & \mathrm{I}_{\mathrm{D}}=15 \mathrm{~mA}, \\ \mathrm{f}=1 \mathrm{kHz}, & \text { See Note } 3 \\ \hline \end{array}$ |  |  |  |  | 20 | 40 | 20 | 40 |  |
| \|Yos| | Small-Signal Common-Source Output Admittance | $\begin{aligned} & V_{D S}=10 \mathrm{~V}, \quad I_{D}=5 \mathrm{~mA}, \\ & f=1 \mathrm{kHz} \end{aligned}$ |  | 50 |  | 50 |  |  |  |  | $\mu \mathrm{mho}$ |
|  |  | $\begin{array}{ll} V_{D S}=10 \mathrm{~V}, & \mathrm{I}_{\mathrm{D}}=15 \mathrm{~mA}, \\ \mathrm{f}=1 \mathrm{kHz}, & \text { See Note } 3 \end{array}$ |  |  |  |  |  | 100 |  | 100 |  |
| $\mathrm{C}_{\text {iss }}$ | Common-Source <br> Short-Circuit <br> Input Capacitance | $\begin{aligned} & V_{D S}=10 \mathrm{~V}, \quad I_{D}=5 \mathrm{~mA}, \\ & f=1 \mathrm{MHz} \end{aligned}$ |  | 25 |  | 25 |  |  |  |  | pF |
|  |  | $\begin{array}{ll} V_{D S}=10 \mathrm{~V}, & I_{D}=15 \mathrm{~mA} \\ f=1 \mathrm{MHz}, & \text { See Note } 3 \end{array}$ |  |  |  |  |  | 25 |  | 25 |  |
| Crss | Common-Source Short-Circuit | $\begin{aligned} & V_{D S}=10 \mathrm{~V}, \quad \mathrm{I}_{\mathrm{D}}=5 \mathrm{~mA}, \\ & f=1 \mathrm{MHz} \end{aligned}$ |  | 5 |  | 5 |  |  |  |  | pF |
|  | Reverse Transfer Capacitance | $\begin{array}{ll} V_{D S}=10 \mathrm{~V}, & I_{D}=15 \mathrm{~mA}, \\ f=1 \mathrm{MHz}, & \text { See Note } 3 \\ \hline \end{array}$ |  |  |  |  |  | 5 | 5 |  |  |

*operating characteristics at $\mathbf{2 5}{ }^{\circ} \mathrm{C}$ free-air temperature

| PARAMETER |  | TEST CONDITIONS ${ }^{+}$ | 2NB451 |  | 2N6452 |  | 2N3463 |  | 2N6464 |  | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | MIN | MAX | MIN | MAX | MIN | MAX | MIN | MAX |  |
| F | Common-Source Spot Noise Figure |  | $\begin{array}{ll} V_{D S}=10 \mathrm{~V}, & I_{D}=5 \mathrm{~mA}, \\ R_{G}=10 \mathrm{k} \Omega, & f=10 \mathrm{~Hz} \end{array}$ |  | 1.5 |  | 2.5 |  | 1.5 |  | 2.5 | dB |
| $V_{n}$ | Equivalent Input Noise Voltage | $\begin{aligned} & V_{D S}=10 \mathrm{~V}, \quad D_{D}=5 \mathrm{~mA}, \\ & f=10 \mathrm{~Hz} \end{aligned}$ |  | 5 |  | 10 |  | 5 |  | 10 | $\mathrm{nV} / \sqrt{\mathrm{Hz}}$ |
|  |  | $\begin{aligned} & V_{D S}=10 \mathrm{~V}, \quad I D=6 \mathrm{~mA}, \\ & f=.1 \mathrm{kHz} \end{aligned}$ |  | 3 |  | 8 |  | 3 |  | 8 |  |

## *JEDEC registerad date

${ }^{\dagger}$ The fourth lead (case) is connected to the source for all measurements.
NOTES: 2. Thls parameter must be measured using pulse techniques. $t_{w}=300 \mu_{s}$, duty cycle $<\mathbf{2 \%}$.
3. To obtain repeatable results, this parameter must be measured with bias conditions applied for less than five seconds.

## HIGH-VOLTAGE 10-WATT TRANSISTORS <br> FOR GENERAL PURPOSE AMPLIFIER APPLICATIONS IN LINE-OPERATED CIRCUITS

- Solid-State Relays
- High-Voltage Inverters
- Voltage Regulators
- Video Output
*mechanical data



## *absolute maximum ratings at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)



NOTES: 1. This value applies between 0 and 10 mA collector currant when the base-emitter diode is open-eircuired.
2. Derate linearly to $175^{\circ} \mathrm{C}$ free-eir temperature at the rate of $6.67 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$.
3. Derate lineariy to $175^{\circ} \mathrm{C}$ cese temperature at the rate of $66.7 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$.
-JEDEC registered data. This data sheot contains all applicable registered data in effect at the time of publication.
*electrical characteristics at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

| PARAMETER |  | TEST CONDITIONS | 2N6461 |  | 2N6462 |  | 2N6463 |  | 2N6464 |  | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | MIN | MAX | MIN | MAX | MIN | MAX | MiN | MAX |  |
| $V$ (BR)CBO | Collector-Base Breakdown Voltage |  | $I^{\prime} C=100 \mu A, \quad I_{E}=0$ | 300 |  | 300 |  | 250 |  | 250 |  | V |
| $V_{\text {(BR)CEO }}$ | Collector-Emitter Breakdown Voltage | $\begin{aligned} & I_{C}=10 \mathrm{~mA}, \quad I_{B}=0, \\ & \text { See Note } 4 \end{aligned}$ | 300 |  | 300 |  | 250 |  | 250 |  | $V$ |
| $V_{\text {(BR) }}$ EBO | Emitter-Base Breakdown Voltage | $I_{E}=100 \mu A, \quad I_{C}=0$ | 7 |  | 7 |  | 6 |  | 6 |  | V |
| ${ }^{\prime} \mathrm{CBO}$ | Collector Cutoff Current | $\mathrm{V}_{C B}=200 \mathrm{~V}, \mathrm{I}^{\prime}=0$ |  | 50 |  | 50 |  |  |  |  | nA |
|  |  | $V_{C B}=150 \mathrm{~V}, \mathrm{I}_{\mathrm{E}}=0$ |  |  |  |  |  | 50 |  | 50 |  |
|  |  | $\begin{aligned} & V_{C B}=200 \mathrm{~V}, \quad \mathrm{I}_{\mathrm{E}}=0, \\ & \mathrm{~T}_{\mathrm{A}}=125^{\circ} \mathrm{C} \end{aligned}$ |  | 20 |  | 20 |  |  |  |  | $\mu \mathrm{A}$ |
|  |  | $\begin{aligned} & V_{C B}=150 \mathrm{~V}, \quad I_{E}=0, \\ & T_{A}=125^{\circ} \mathrm{C} \end{aligned}$ |  |  |  |  |  | 20 |  | 20 |  |
| IEBO | Emitter Cutoff Current | $\mathrm{V}_{\text {EB }}=5 \mathrm{~V}, \quad \mathrm{C}=0$ |  | 10 |  | 10 |  | 10 |  | 10 | nA |
| hfe | Static Forward Current Transfer Ratio | $V_{C E}=10 \mathrm{~V}, I^{\prime}=4 \mathrm{~mA}$ | 20 |  | 20 |  | 20 |  | 20 |  |  |
|  |  | $V_{C E}=10 \mathrm{~V}, \quad I_{C}=20 \mathrm{~mA},$ <br> See Note 4 | 30 | 120 | 100 | 300 | 30 | 120 | 100 | 300 |  |
|  |  | $V_{C E}=10 \mathrm{~V}, \quad I_{C}=40 \mathrm{~mA},$ <br> See Note 4 |  |  |  |  | 30 |  | 40 |  |  |
| $V_{\text {BE }}$ | Base-Emitter Voltage | $V_{C E}=10 \mathrm{~V}, \quad I_{C}=20 \mathrm{~mA}$ <br> See Note 4 |  | 1 |  | 1 |  | 1 |  | 1 | V |
| VCE(sat) | Collector-Emitter Saturation Voltage | $I_{B}=2 m A, \quad I_{C}=20 m A,$ <br> See Note 4 |  | 1.1 |  | 1.1 |  | 1 |  | 1 | $V$ |
| $h_{\text {fe }} \mathrm{l}$ | Small-Signal Common-Emitter Forward Current Transfer Ratio | $\begin{aligned} & V_{C E}=20 \mathrm{~V}, \quad \mathrm{I}_{\mathrm{C}}=20 \mathrm{~mA}, \\ & \mathrm{f}=20 \mathrm{MHz} \end{aligned}$ | 3.5 | 10 | 3.5 | 10 | 3.5 | 10 | 3.5 | 10 | $\cdots$ |
| $\mathrm{C}_{\mathrm{cb}}$ | Collector-Base Capacitance | $\begin{array}{ll} \mathrm{V}_{\mathrm{CB}}=20 \mathrm{~V}, & \mathrm{l}_{\mathrm{E}}=0, \\ \mathrm{f}=1 \mathrm{MHz}, & \text { See Note } 5 \end{array}$ |  | 3 |  | 3 |  | 3 |  | 3 | pF |

NOTES: 4. These parameters must be measured using pulse techniques. $t_{w}=300 \mu s$, duty cycle $\leqslant 2 \%$.
5. $C_{c b}$ measurement employs a three-terminal capacitance bridge incorporating a guard circuit. The emitter is connected to the guard terminal of the bridge.

## THERMAL INFORMATION



# Typical 22db Power Gain at 30 MC <br> Migh Celn at lixit Tomperature <br> Designed for High Frequoncy - IF Aumpifiers <br> RF Amplifiers - Vidoo Auplifiers - Oscillators 

mechanical data
Welded case with glass-to-metal hermetic seal between case and leads. Unit weight is 1 gram. These units meet JEDEC outline TO-12 dimensions.


ALL CONNECTIONS INSULATED FROM CASE
ALL DINENSIONS R IMCHES
maximum ratings at $\mathrm{T}_{\mathrm{J}}=25^{\circ} \mathrm{C}$

junction temperature
Maximum Range

| design | Maximum teristics | Rangeaf $\mathrm{T}_{J}=25^{\circ} \mathrm{C}$ds maesuremenis | as indicated) |  |  | min | $-65$ | ${ }^{\circ} \mathrm{C}$ to | $150^{\circ} \mathrm{C}$ |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  | conditions |  |  | design centor | max | Malt |
|  | IcBo <br> BVcbo <br> BVebo <br> BV ceo <br> Rcs <br> $R_{B 1}-R_{B 2}$ | Collector Cutoff Current at $150^{\circ} \mathrm{C}$ <br> Breakdown Voltage <br> Breakdown Voltage <br> Breakdown Voltage <br> Saturation Resistance <br> Base-to-Base Resistance | $\begin{aligned} & V_{C B}=20 \mathrm{~V} \\ & V_{C B}=20 \mathrm{~V} \\ & I_{C}=50 \mu A \\ & I_{C}=50 \mu A \\ & I_{C}=1 \mathrm{~mA} \\ & I_{C}=5 m \mathrm{~mA} \\ & I_{B}=100 \mu \mathrm{~A} \end{aligned}$ | $\begin{aligned} & I_{\mathrm{E}}=0 \\ & I_{\mathrm{E}}=0 \\ & I_{B 2}=0 \\ & I_{B 2}=0 \\ & I_{B 2}=0 \\ & I_{B 2}=0 \end{aligned}$ | $\begin{aligned} & l_{B 2}=0 \\ & 1 \mathrm{B2}=0 \\ & l_{E}=0 \\ & l_{E}=0 \\ & l_{B 1}=0 \\ & I_{B 1}=1.0 \mathrm{~mA} \end{aligned}$ | $\begin{aligned} & 30 \\ & 1 \\ & 30 \end{aligned}$ | 0.005 <br> 60 <br> 45 <br> 150 <br> 10 K | $\begin{gathered} 0.4 \\ 400 \\ 300 \end{gathered}$ | $\mu A$ $\mu A$ $V$ $V$ $V$ $0 h m$ $0 h m$ |
|  | $\begin{aligned} & h_{f e} \\ & c_{o b} \\ & c_{H} \end{aligned}$ | Iow frequency measur Current Transfer Ratio <br> Output Capacity Header Capacity | $\begin{aligned} & V_{c}=20 \mathrm{~V} \\ & \mathrm{f}=1000 \mathrm{cps} \\ & V_{c}=20 \mathrm{~V} \\ & \mathrm{f}=1 \mathrm{Mc} \end{aligned}$ | $\begin{aligned} & I_{E}=-1.3 \mathrm{~mA} \\ & \mathrm{I}_{E}=-1.3 \mathrm{~mA} \end{aligned}$ | $\left\{\begin{array}{l} I_{82}=-100 \mu \mathrm{~A} \\ I_{\mathrm{B} 2}=-100 \mu \mathrm{~A} \end{array}\right.$ | 10 | $\begin{aligned} & 25 \\ & 1.5 \\ & 0.4 \end{aligned}$ |  | ${ }_{\mu \mu \prime \prime}$ |
|  |  | hlgh frequency measu <br> Current Transfer Ratio Series Input Resistance Parallel Output Resistance Paraliel Output Capacitance Alpha Cutoff Frequency Noise Figure Power Gain | $\text { monte }\}$ | $\begin{aligned} & V_{\mathrm{C}}=20 \mathrm{~V} \\ & \mathrm{I}_{\mathrm{E}}=-1.3 \mathrm{~mA} \\ & \mathrm{I}_{\mathrm{B} 2}=-100 \mu \mathrm{~A} \\ & \mathrm{f}=30 \mathrm{Mc} \end{aligned}$ | A $\}$ | $\begin{array}{r} 1.0 \\ 20 \\ 4 K \end{array}$ | 4 $100^{9 K}$ 1.5 $100^{2}$ 15 22 | $\left\lvert\, \begin{gathered} 300 \\ 15 K \\ 3 \\ 20 \end{gathered}\right.$ | Ohm Ohm $\mu \mathrm{m}$ f Mc db db |

# Typical 20db Power Gein at 70 MC <br> Hind Gan at Mah Tomperture <br> Dosignod for Hiph Froquong - IF Amplifiers <br> RF Amplifiors - Vidoo Amplifioes - Ondilletors 

## machanicel data



Welded case with glass-to-metal hermetic seal between case and leads. Unit weight is 1 gram. These units meet JEDEC outline TO-12 dimensions.


ALL CONRECTIONS INSULATED FRDM CASE
ALL DIMENSIONS W HNCNES
maximum retings af $\mathrm{T}_{\mathrm{J}}=25^{\circ} \mathrm{C}$
Emitter Current
Collector Current . . . . . . . . . . . . 20 mA
Base No 1 Co . . . . . . . . . . . . 20 mA

- • • • . . . . . . . . . . . . 5 mA
- • • • • . . . . . 5 mA

Collector Dissipation (Derate $1 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$ for Advanced Temperatures) . . . . 125 mW
Maximum Range
design characteristics at $\mathrm{TJ}_{\mathrm{J}}=25^{\circ} \mathrm{C}$. . . . . . . . . . $-65^{\circ} \mathrm{C}$ to $+150^{\circ} \mathrm{C}$

|  | de measurements | condtrion: |  |  | $\mathrm{m} / \mathrm{m}$ | dosign |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Icso | Collector Cutoff Current at $150^{\circ} \mathrm{C}$ | $V_{C B}=20 \mathrm{~V}$ |  |  | min | centor | $\frac{\max }{0.4}$ | unit |
| $\mathrm{BV}_{8 \mathrm{cbo}}$ | Breakdown Voltage | $V_{C B}=20 \mathrm{~V}$ $I_{C}=50 \mathrm{~A}$ | $\mathrm{l}_{\mathrm{E}}=0$ $\mathrm{C}_{\mathrm{B} 2}=0$ |  |  |  | 40 | ${ }_{\underline{\mu}{ }^{\mu}{ }^{\text {A }} \text { ( }}$ |
| BVEBO | Breakdown Voltage | $1 \mathrm{c}=50 \mathrm{~mA}$ | $\mathrm{l}_{\mathrm{B} 2}=0$ |  | ${ }_{1} 1$ | 60 |  | $v$ |
| ${ }_{\text {Res }}{ }_{\text {B }}$ | Breakdown Voltage Saturation Resistance | Ic $=1 \mathrm{~mA}$ | $182=0$ 182 | ${ }_{1} \mathrm{E}_{\mathrm{B}_{1}=0}$ | 30 | 45 |  | $v$ |
| ${ }_{\text {R }}^{\text {R }}$ - $-\mathrm{R}_{\mathrm{B} 2}$ | Base-to-Base Resistance | $i_{c}=5 \mathrm{~mA}$ $i_{B}=100 \mu \mathrm{~A}$ | $\mathrm{I}_{\mathrm{B} 2}=0$ | $\mathrm{I}_{\mathrm{BI}}=1.0 \mathrm{~mA}$ |  | 150 | 300 | Ohm |
|  | Iow trequency meesurements Current Transfer Ratio $\mid V_{c}=20 \mathrm{~V}$ |  |  |  |  |  |  |  |
| $\mathrm{hf}_{\text {fe }}$ |  |  | $\mathrm{I}_{\mathrm{E}}=-1.3 \mathrm{~mA}$ |  | 10 |  |  |  |
|  |  | $f=1000 \mathrm{cps}$ |  |  |  |  |  |  |
| ${ }_{\text {chab }}$ | Header Capacity | $\begin{aligned} & V_{c}=20 \mathrm{~V} \\ & \mathrm{f}=1 \mathrm{Mc} \end{aligned}$ | $\mathrm{I}_{\mathrm{E}}=-1.3 \mathrm{~mA}$ | $\mathrm{I}_{\mathrm{B} 2}=-10 \mu_{\mu} \mathrm{A}$ |  | 1.5 |  | $\mu \mu \mathrm{f}$ |
|  |  |  |  |  |  |  |  |  |
| $\mathrm{hfo}_{\text {fo }}$ |  |  |  |  |  |  |  |  |
| Tios | Current Transfer RatioSeries Input Resistance |  | $V_{C}=20 \mathrm{~V}$ |  |  |  |  |  |
| ${ }^{1} \mathrm{log}$ | Parallel Output Resistance |  | $\mathrm{I}_{\mathrm{E}}=-1.3 \mathrm{~mA}$ |  |  | ${ }^{50}$ | ${ }_{150}$ |  |
| ${ }_{\text {copp }}$ | Parallei Output CapacitanceAlpha Cutoff Frequency |  |  |  |  | ${ }_{2}$ | ${ }_{3}$ | Onm |
| NF | Noise Figure |  |  |  |  | 150 |  | Mc |
| $\mathrm{PG}_{6}$ | Power Gain |  | $f=70 \mathrm{Mc}$ |  |  | 9 | 14 | \% |

## TYPES 3N74 THRU 3N79 N-P-N SILICON TRANSISTORS

BULLETIN NO. DL-S 7211692 , MARCH 1972

## DOUBLE-EMITTER TRANSISTORS DESIGNED FOR CHOPPER APPLICATIONS

## - Low Offset Voltage

- Excellent Thermal Stability
- Very Low Leakage . . . 2 nA max at 15 V (3N74, 3N75, 3N76)
- High Breakdown Voltage . . . 18 V min (3N74, 3N75, 3N76)


## "mechanical data


*absolute maximum ratings at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

|  |  |
| :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- |
| 3N74 | 3N77 |
| 3N78 |  |

NOTES: 1. These values apply when the base and other emitter are open-eircuited.
2. These values apply when the collector is short-circulted to the base but open-circuited with respect to the emitters.
3. Derste linearly to $175^{\circ} \mathrm{C}$ free-air temperature at the rate of $2 \mathrm{~mW} / /^{\circ} \mathrm{C}$.
4. Derate linearly to $175^{\circ} \mathrm{C}$ case temperature at the rate of $4 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$.
-JE DEC registered data. This date sheet conteins all applleable registered data in effect at the time of publication.

## TYPES 3N74 THRU 3N79 <br> N-P-N SILICON TRANSISTORS

"electrical characteristics at $25^{\circ} \mathbf{C}$ free-air temperature (unless otherwise noted)

| Parameter |  | TEST CONDITIONS |  |  | 3N74 | 3N76 | 3N78 | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  | MIN MAX | MIN MAX | min max |  |
| $V_{\text {(ba)cbo }}$ | Brankdown Voltage | $I_{C}=100 \mu$ A, | $\mathrm{IE}_{\mathbf{1}}=\mathrm{IE}_{\mathrm{E}}=0$ |  | B0 | 60 | SO | V |
| $V_{\text {(BR)EBO }}$ | Emitter-Bate <br> Eraakdown Voltape | $I_{E}=10 \mu \mathrm{~A}$, | IC $=0$, | See Note 5 | 18 | 18 | 18 | $v$ |
| $V_{\text {(BR)E1E2 }}$ | Emitter-Emitter Breakdown Voltage | ${ }^{\prime} \mathrm{E}_{1}= \pm 10 \mu \mathrm{~A}$, | $V_{C s}=0$, | See Note 6 | $\pm 18$ | $\pm 18$ | $\pm 18$ | $v$ |
| IC8O | Collector Cutoff Current | $V_{C B}-30 V_{\text {c }}$ | $\mathrm{IEP}_{1} \mathrm{IE}_{5}=0$ |  | 10 | 10 | 10 | nA |
| IEBO | Emitter Cutoff Current | $V_{E B}=15 V_{1}$ | $\mathrm{IC}_{\mathrm{C}}=0$, | See Note 5 | 2 | 2 | 2 | nA |
| 'E1E2(off) | Emitter Cutoff Current | $V_{\text {E1 }} \mathrm{V}_{2}= \pm 15 \mathrm{~V}_{1}$ | $V_{C B}=0$, | See Note 6 | $\pm 2$ | $\pm 2$ | $\pm 2$ | nA |
|  |  | $\mathrm{V}_{\mathrm{E} 1 \mathrm{E} 2}= \pm 15 \mathrm{~V}, \mathrm{~V}_{\text {CB }}=0$, |  | $T_{A}=100^{\circ} \mathrm{C}$ <br> Sue Note 6 | $\pm 100$ | $\pm 100$ | $\pm 100$ |  |
| $\mid V_{\text {Eie2 }}$ (ot) $\mid$ | Emitter-Emittor Offset Voltage | $\begin{aligned} & \mathrm{I}_{B}=1 \mathrm{~mA}, \\ & \mathrm{~T}_{\mathrm{A}}=-25^{\circ} \mathrm{C}, 25^{\circ} \mathrm{C} \end{aligned}$ | $\begin{aligned} & I_{E_{1}}=I_{E 2}=0, \\ & { }^{C} \text {, and } 100^{\circ} \mathrm{C} \\ & \hline \end{aligned}$ | See Figure 1, | 60 | 100 | 200 | $\mu \mathrm{V}$ |
|  | Offret Voltage Change with Baes Current ${ }^{\dagger}$ | $\mathrm{I}_{\mathrm{B}}(1)=9.5 \mathrm{~mA}$, | $1 \mathrm{~B}(2)=0.6 \mathrm{~mA}$, | IE1-IE2=0 | 25 | 25 | 60 | $\mu \mathrm{V}$ |
| $\left.\Delta V_{E 1 E 2 \text { (ofol }}\right\|_{\Delta T_{A}}$ | Offeet Voltage Change with Temperature ${ }^{\dagger}$ | $\mathrm{I}=1 \mathrm{~mA}$, | $\mathrm{IE}_{1}=\mathrm{IE}_{2}=0$, | $\begin{aligned} & T_{A(1)}=100^{\circ} \mathrm{C}, \\ & T_{A(2)}=-28^{\circ} \mathrm{C} \end{aligned}$ | 75 | 126 | 175 | $\mu \mathrm{V}$ |
| ra1e2(on) | Smali-signal <br> Emitter-Emister <br> On-State Resirtance | $\begin{aligned} & I_{\mathrm{g}}=1 \mathrm{~mA}, \\ & \mathrm{f}=1 \mathrm{kHz}, \end{aligned}$ | $I_{E 1}=I_{E 2}=0$ | $\begin{aligned} & t_{e}=100 \mu A_{1} \\ & \text { Soe Figure } 2 \end{aligned}$ | $10 \quad 40$ | $10 \quad 40$ | i0 60 | $\Omega$ |
| thel | Small-Signal <br> Common-Emitter <br> Forward Current <br> Transfer Ratio | $\mathrm{V}_{\text {CE }}=5 \mathrm{~V}$, | $I^{\prime} \mathrm{C}=1 \mathrm{~mA}$, | $\mathrm{f}=\mathbf{2 0} \mathrm{MHz},$ <br> See Note 8 | 1.5 | 1.5 | 1.6 |  |
| Cobo | Common-Base Open-Circuit Output Capacitance | $\mathrm{V}_{\mathbf{C B}}=5 \mathrm{~V}$, | $\mathrm{I}_{\mathrm{E}}=1 \mathrm{l} 2=0$, | $1=140 \mathrm{kHz}$ | 8 | 8 | 8 | pF |
| Clibo | Common-Base <br> Open-Circuit <br> Input Capscitance | $\mathrm{VEB}^{\text {c }}=5 \mathrm{~V}$, | IC $=0, \quad$ f | $f=140 \mathrm{kHz},$ <br> See Note 5 | 5 | 5 | 6 | pF |

NOTES: 5. These limits apply separately for each emitter with the other emitter open-eircuited.
6. These parameters must be messured with the collector short-circuited to the bee but open-circuited with respect to the amirters. The limits apply to both polarities of emitter-to-emitter voltage.
${ }^{\dagger}$ Offaet Voltage Change is defined as the magnitude of the algabraic diffaranee batween the offeet voltagen at two specified base eurrente or temparatures.
-JEDEC registered data

## TYPES 3N74 THRU 3N79 N-P-N SILICON TRANSISTORS

*electrical characteristics at $\mathbf{2 5}{ }^{\circ} \mathbf{C}$ free-air temperature (unless otherwise noted)

| Parameter |  | TEST CONDITIONS |  |  | 3N77 <br> MIN MAX | 3N78 <br> MIN MAX | $\frac{\text { 3N79 }}{\text { MIN MAX }}$ | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  |  |  |  |  |
| $V_{\text {(br) }}$ cbo | Collector-Base Bruakdown Voltage | $I^{\prime} C=100 \mu A$, | $\mathrm{IE}_{1}-\mathrm{IE}_{2}=0$ |  | 40 | 40 | 40 | V |
| V(bR)EBO | Emitter-Base <br> Breakdown Voltage | $\mathrm{I}_{\mathrm{E}}=10 \mu \mathrm{~A}$, | Ic $=0$. | See Note 5 | 12 | 12 | 12 | $v$ |
| V(BR)E1E2 | Emitter-Emitter Breakdown Voltege | $\mathrm{IE}_{1}= \pm 10 \mu \mathrm{~A}$, | $V_{C s}=0$. | See Note 6 | $\pm 12$ | $\pm 12$ | $\pm 12$ | $\checkmark$ |
| Icror | Collector Cutoff Current | $V_{C B}=30 V_{\text {, }}$ | $\mathrm{IE1}^{\text {- }} \mathrm{IE} 2=0$ |  | 10 | 10 | 20 | nA |
| IEbo | Emitter Cutoff Current | $\mathrm{V}_{\mathrm{EB}}=5 \mathrm{~V}$, | Ic $=0$, | See Note 5 | 8 | 5 | 10 | nA |
|  |  | $\mathrm{V}_{\text {E1 }} \mathrm{E}^{2}= \pm 5 \mathrm{~V}$, | $\mathrm{V}_{\mathrm{CB}}=0$, | See Note 6 | $\pm 5$ | $\pm 5$ | $\pm 10$ |  |
| IE1E2(off) | Emitter Cutoff Current | $\mathrm{V}_{\mathrm{E} 122}= \pm 5 \mathrm{~V}$, | $\mathrm{V}_{C B}=0$, | $\begin{aligned} & T_{A}=100^{\circ} \mathrm{C}, \\ & \text { Soen Note } 6 \end{aligned}$ | $\pm 100$ | $\pm 100$ | $\pm 200$ | nA |
| $\left\|V_{\text {E1E2 }}(0 \rightarrow 3)\right\|$ | Emitter-Emittor Offret Voltape | $\begin{aligned} & I_{B}=1 \mathrm{~mA}, \\ & T_{A}=-25^{\circ} \mathrm{C}, 25^{\circ} \end{aligned}$ |  | See Figure 1 . | 60 | 100 | 200 | $\mu \mathrm{V}$ |
|  | Offeet Voltage Change with Beese Current ${ }^{\dagger}$ | $\mathrm{I}_{\mathrm{B}(1)}=1.5 \mathrm{~mA}$, | $\mathrm{I}_{\mathrm{B}}(2)=0.6 \mathrm{~mA}$, | le1 $=1 \mathrm{E} 2=0$ | 25 | 50 | 75 | $\mu \mathrm{V}$ |
| $\mid \Delta V_{E 1 E 2}$ (ofa) $\\|^{\text {a }} T_{A}$ | Otfret Voltage Change with Tamperature ${ }^{\dagger}$ | $\mathrm{I}_{\mathrm{B}}=1 \mathrm{~mA}$, | $\mathrm{IE}_{\mathbf{1}}=\mathrm{I}_{\mathbf{E} 2}=0$, | $\begin{aligned} & T_{A(1)}=100^{\circ} \mathrm{C}, \\ & T_{A(2)}=-25^{\circ} \mathrm{C} \end{aligned}$ | 75 | 125 | 178 | $\mu \mathrm{V}$ |
| re1e2(on) | Small-signal <br> Emitter-Emittar <br> On-State Resiatance | $\begin{aligned} & I_{B}=1 \mathrm{~mA}, \\ & \mathrm{f}=1 \mathrm{kHz}, \end{aligned}$ | $I_{E_{1}}=I_{E_{2}}=0,$ | $\begin{aligned} & I_{0}=100 \mu \mathrm{~A}, \\ & \text { See Figure } 2 \end{aligned}$ | $10 \quad 80$ | $10 \quad 60$ | $10 \quad 60$ | $\Omega$ |
| hfol | Small-signal Common-Emitter Forward Current Transfor Patio | VCE - EV. | Ic = 1 mA, | $\begin{aligned} & f=20 \mathrm{MHz}, \\ & \text { See Note E } \end{aligned}$ | 1.6 | 1.6 | 1.5 |  |
| Cobo | Common-Biase Open-Circuit Output Capacitance | $V_{C B}=5 \mathrm{~V}$, |  | $f=140 \mathrm{kHz}$ | 8 | 8 | 10 | pF |
| $C_{i b o}$ | Common-Base Open-Circuit Input Capacitance | $V_{E B}=5 \mathrm{~V}$, | Ic $=0$, | $f=140 \mathrm{kHz},$ <br> See Note 5 | 5 | 5 | 6 | pF |

NOTES: E. These limits apply saparataly for each emitter with the other emitter open-circuited.
6. These parameters must be measured with the collector short-circuited to the base but open-circuited with respect to the amitters. The limits apply to both polarities of emitter-to-mitter voltege.
toffent Voltage Change is defined es the magnitude of the algebrale difference between the offeet volteges at two specifled base eurrents or temperatures.

## PARAMETER MEASUREMENT INFORMATION



FIGURE 2

NOTES: 7. Care must be taken to avoid error due to thermocouple action.
8. The voltmeter impedance must be high enough that halving it does not change the measured value.
*JEDEC reglstared data

## TYPES 3N108 THRU 3N111 P-N-P SILICON TRANSISTORS

## HIGH-VOLTAGE DOUBLE-EMITTER TRANSISTORS DESIGNED FOR LOW-LEVEL, HIGH-SPEED CHOPPER APPLICATIONS REQUIRING VERY LOW OFFSET VOLTAGE

- May be Used in Some Circuits Designed for N-P.N Types by Reversing Collector and Base Terminations
- High Breakdown Voltages . . . 50 V Min (3N108, 3N109)
- Low Offset-Voltage/Temperature Sensitivity
- Extremely Low Leakage . . . 0.1 nA Max at 25 V (3N108, 3N109)
*mechanical data

*absolute maximum ratings at $25^{\circ} \mathbf{C}$ free-air temperature (unless otherwise noted)


NOTES: 1. These values apply when the baee and other emitter are open-circulted,
2. These values apply when the collector ls short-elrcuited to the bese but open-circulted with reapect to the emittera.
3. Derste linearly to $200^{\circ} \mathrm{C}$ free-air temparature at the rate of $1.71 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$.
4. Derate linearly to $200^{\circ} \mathrm{C}$ case tamparature at the rate of $3.43 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$.

# TYPES 3N108 THRU 3N111 P-N-P SILICON TRANSISTORS 

"electrical characteristics at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

| PARAMETER |  | TEST CONDITIONS |  | 3N108 |  | 3N109 |  | 3N110 |  | 3N111 |  | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | MIN | MAX | MIN | MAX | MIN | MAX | MIN | MAX |  |
| $V_{\text {(ba)cbo }}$ | Collector-Base Breakdown Voltage |  |  | ${ }^{\prime} \mathrm{C}=-1 \mu \mathrm{~A}$, | $I_{E 1}=I_{E 2}=0$ | -50 |  | -50 |  | -50 |  | $-50$ |  | v |
| V(BR)ECO E | Emitter-Collector Breakdown Voltage | ${ }^{\prime} \mathrm{E}=-1 \mu \mathrm{~A}$, | $I_{B}=0,$ <br> See Note 5 | -50 |  | -50 |  | -30 |  | -30 |  | $\checkmark$ |
| V(bR)EBO | Emitter-Base <br> Breakdown Voltage | ${ }^{\prime} E=-1 \mu A$, | $I^{\prime} C=0$ <br> See Note 5 | -50 |  | -50 |  | -30 |  | -30 |  | v |
| V(bR)E1E2 | Emitter-Emitter Breakdown Voltage | ${ }^{\prime} \mathrm{E}_{1}= \pm 1 \mu \mathrm{~A}$, | $V_{C B}=0,$ $\text { See Note } 6$ | $\pm 50$ |  | $\pm 50$ |  | $\pm 30$ |  | $\pm 30$ |  | V |
| ${ }^{\text {c cbo }}$ | Collector Cutoff Current | $V_{C B}=-30 \mathrm{~V}$, | $\mathrm{IEP}^{\prime}=1 \mathrm{IE}_{2}=0$ |  | -0.25 |  | -0.25 |  | -0.5 |  | -0.5 | nA |
| lebo | Emitter Cutoff Current | $V_{E B}=-25 \mathrm{~V},$ | $\begin{aligned} & I_{C}=0, \\ & \text { See Note } 5 \\ & \hline \end{aligned}$ |  | -0.1 |  | -0.1 |  | -0.5 |  | -0.5 | nA |
| 'E1E2loff) | Emitter Cutoff Current | $\mathrm{V}_{E 1 E 2}= \pm 25 \mathrm{~V},$ | $v_{C B}=0,$ $\text { See Note } 6$ |  | $\pm 0.1$ |  | $\pm 0.1$ |  | $\pm 0.5$ |  | $\pm 0.5$ | nA |
|  |  | $\begin{aligned} & V_{E 1 E 2}= \pm 25 \mathrm{~V}, \\ & T_{A}=100^{\circ} \mathrm{C}, \end{aligned}$ | $\begin{aligned} & V_{C B B}=0, \\ & \text { See Note } 6 \end{aligned}$ |  | $\pm 10$ |  | $\pm 10$ |  | 150 |  | $\pm 50$ |  |
| \| $\mathbf{E E 1 E 2}$ (ofs) $\mid$ | Emitter-Emitter Offset Voltage | $\begin{aligned} & I_{B}=-1 \mathrm{~mA}, \\ & T_{A}=-25^{\circ} \mathrm{C}, 25^{\circ} \end{aligned}$ | $I_{E 1}=I_{E 2}=0,$ <br> C , and $100^{\circ} \mathrm{C}$, <br> See Figure 1 |  | 30 |  | 150 |  | 30 |  | 150 | $\mu \mathrm{V}$ |
| $\mid \Delta V_{\text {E1E2 }}$ (ofs) $\left.\right\|_{\Delta l_{B}}$ | Offset Voltage Change with Base Current ${ }^{\dagger}$ | $\begin{aligned} & I_{B(1)}=-1.5 \mathrm{~mA}, I_{B(2)}=-0.5 \mathrm{~mA}, \\ & I_{E 1}=I_{E 2}=0 \end{aligned}$ |  |  | 20 | 50 |  | 20 |  | 50 |  | $\mu \mathrm{V}$ |
| $\left\|\Delta V_{E T E 2 \text { (ofs }}\right\| \Delta T_{A}$ | Offset Voltage Change with Temperature ${ }^{\dagger}$ | $\begin{aligned} & I_{B}=-1 \mathrm{~mA}, \\ & T_{A(1)}=100^{\circ} \mathrm{C}, \end{aligned}$ | $\begin{aligned} & I_{E 1}=I_{E 2}=0, \\ & T_{A(2)}=-25^{\circ} \mathrm{C} \end{aligned}$ |  | 50 | 150 |  | 50 |  | 150 |  | $\mu \mathrm{V}$ |
| $\mathrm{re}_{\text {ele2 }}$ (on) | Small-Signal Emitter-Emitter On-State Resistance | $\begin{aligned} & I_{B}=-1 \mathrm{~mA}, \\ & I_{e}=100 \mu \mathrm{~A}, \end{aligned}$ | $\begin{aligned} & I_{E 1}=I_{E 2}=0, \\ & f=1 \mathrm{kHz}, \\ & \text { See Figure } 2 \end{aligned}$ | 10 | 50 | 10 | 50 | 10 | 50 | 10 | 50 | $\Omega$ |
| hfel | Small-Signal Common-Emitter Forward Current Transfer Ratio | $\begin{aligned} & V_{C E}=-6 \mathrm{~V}, \\ & f=4 \mathrm{MHz}, \end{aligned}$ | $I_{C}=-1 \mathrm{~mA} .$ $\text { See Note } 5$ | 3 |  | 3 |  | 3 |  | 3 |  |  |
| $\mathrm{C}_{\text {obo }}$ | Common-Base Open-Circuit Output Capacitance | $\begin{aligned} & V_{C B}=-6 V, \\ & f=1 \mathrm{MHz} \end{aligned}$ | $\mathrm{I}_{\mathrm{E}_{1}}=\mathrm{I}_{E_{2}}=0$, |  | 10 |  | 10 |  | 10 |  | 10 | pF |
| $C_{\text {ibo }}$ | Common-Base Open-Circuit <br> Input Capacitance | $\begin{aligned} & V_{E B}=-6 V, \\ & f=1 \mathrm{MHz}, \end{aligned}$ | $I_{C}=0,$ <br> See Note 5 |  | 3 |  | 3 |  | 3 |  | 3 | pF |

NOTES: 5. These limits apply separately for each emitter with the other emitter open-circuited.
6. These parameters must be measured with the collector short-circuited to the base but open-circuited with respect to the emitters. The limits apply to both polarities of emitter-to-emitter voltage.
7. Care must be taken to avoid error due to thermocoupla action.
8. The voltmeter impedance must be high enough that halving it does not change the measured value.
$\dagger$ Offset Voltage Change is defined as the magnitude of the algebraic difference between the offset voltages at two specified base currents or temperatures.
*JEDEC registered data
*PARAMETER MEASUREMENT INFORMATION


FIGURE 1


FIGURE 2

## DEPLETION-TYPE MOS SILICON TRANSISTOR For Use in VHF Amplifier Applications to $\mathbf{3 0 0} \mathbf{~ M H z}$

- High |yfs| . . $\mathbf{5 0 0 0} \mu$ mho Min
- Low Feedback Capacitance, Crss . . 0.35 pF Max
*mechanical data

handling precautions
Curve-tracer testing and static-charge buildup are common causes of damage to insulated-gate devices. Permanent damage may result if either gate-voltage rating is exceeded even for extremely short time periods. Each transistor is protected during shipment by a gate-shorting device, which should be removed only during testing and after permanent mounting of the transistor. Personnel and equipment, including soldering irons, should be grounded.
*absolute maximum ratings at $25^{\circ} \mathbf{C}$ free-air temperature (unless otherwise noted)


NOTES: 1. This rating applies when the substrate is at the same potential as the source.
2. This value applies for $t_{w}<\mathbf{2 0} \mu \mathrm{s}$, duty cycle $<\mathbf{1 \%}$.
3. Derate linearly to $175^{\circ} \mathrm{C}$ free-air temperature at the rate of $2.2 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$.

*operating characteristics at $25^{\circ} \mathrm{C}$ free-air temperature

|  | PARAMETER | TEST CONDITIONS ${ }^{\text {t }}$ |  | MIN | MAX | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| $F$ | Common-Source Spot Noise Figure | $V_{D S}=15 \mathrm{~V}, I_{D}=5 \mathrm{~mA}$ <br> See Figure 1 | $f=200 \mathrm{MHz}$ |  | 5 | dB |
| $\mathrm{G}_{\mathrm{ps}}$ | Small-Signal Common-Source Insertion Power Gain | $V_{D D}=16 \mathrm{~V}, f=200 \mathrm{MHz}$, | See Figure 1 | 13.5 | 21 | dB |
| B | Bandwidth (6 dB) |  |  | 10 | 15 | M Hz |

${ }^{\dagger}$ All measurements are made with the substrate connected to the source.
NOTE 4: This parameter must be measured using pulse techniques. $\mathrm{t}_{\mathbf{w}} \leqslant \mathbf{2 0} \mathbf{m s}$, duty cycle $<\mathbf{1 5 \%}$.

## PARAMETER MEASUREMENT INFORMATION*



CIRCUIT COMPONENT INFORMATION
L1: 4\% turns \# 20 AWG, 3/16" dia., approx. 1/2" long, tapped 1 turn from ground end
L2: $31 / 2$ turns \# 20 AWG, 3/8' dia., approx. $1 / 2^{\prime \prime}$ long
${ }^{\dagger}$ Leadless disc ceramic capacitor
$\ddagger$ Noutralization fixed for a transistor having a typical value of Cras Equivalent paraliel input network:
$\mathbf{Y}_{G^{\prime}}=0.175 \mathrm{mmho}-$ ( $6.3 \pm 2.5$ ) mmha; input network loss $=0.8 \mathrm{~dB} ; 3 \mathrm{~dB}$ bandwidth $=20 \mathrm{MHz}$ Equivalent parallel output network:
$Y_{L^{\prime}}=0.5$ mmho $-\mathrm{j}(1.9 \pm 0.63)$ mmho; output network loss $=2 \mathrm{~dB} ; 3 \mathrm{~dB}$ bandwidth $=7.5 \mathrm{MHz}$
FIGURE 1

## -JEDEC registered data

## DEPLETION-TYPE MOS SILICON TRANSISTOR DESIGNED FOR CHOPPER AND SWITCHING APPLICATIONS

- Low rds(on) ... $300 \Omega$ Max
- Low Crss . . . 0.6 pF Max
- Low IGSS . . . 50 pA Max
*mechanical data
THE SUBSTRATE IS IN ELECTRICAL CONTACT WITH THE CASE


ALL JEDEC TO-72 DIMENSIONS AND NOTES ARE APPLICABLE

## handling precautions

Curve-tracer testing and static-charge buildup are common causes of damage to insulated-gate devices. Permanent damage may result if either gate-voltage rating is exceeded even for extremely short time periods. Each transistor is protected during shipment by a gate-shorting device, which should be removed only during testing and after permanent mounting of the transistor. Personnel and equipment, including soldering irons, should be grounded.
*absolute maximum ratings at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)


NOTES: 1. This value applies for $\mathrm{t}_{w}<\mathbf{2 0} \mathrm{ms}$, duty cycle $\leqslant \mathbf{1 0 \%}$.
2. Derate linearly to $175^{\circ} \mathrm{C}$ free-air temperature at the rate of $2.67 \mathrm{mw} /{ }^{\circ} \mathrm{C}$.
*electrical characteristics at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

| PARAMETER |  | TEST CONDITIONS ${ }^{\text {t }}$ |  |  | MIN MAX | $\begin{array}{\|c\|} \hline \text { UNIT } \\ \hline \text { pA } \\ \hline \end{array}$ |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| IGSSF | Gate-Terminal Forward Current | $V_{G S}=6 \mathrm{~V}$, | VDS $=0$ |  | 50 |  |
| 'Gsse | Gate-Terminal Reverse Current | $V_{G S}=-8 \mathrm{~V}$, | $V_{D S}=0$ |  | -50 | pA |
|  |  | $V_{G S}=-8 V^{\prime}$ | $V_{D S}=0$, | $\mathrm{T}_{\mathrm{A}}=125^{\circ} \mathrm{C}$ | -5 | nA |
| ID(off) | Drain Cutoff Current | $V_{D S}=1 \mathrm{~V}$, | $\mathrm{V}_{\text {GS }}=-8 \mathrm{~V}$ |  | 1 | nA |
|  |  | $V_{D S}=1 \mathrm{~V}$, | $V_{G S}=-8 \mathrm{~V}$, | $T_{A}=125^{\circ} \mathrm{C}$ | 1 | $\mu \mathrm{A}$ |
| ID(on) | On-State Drain Current | $V_{D S}=15 \mathrm{~V}$, | $\mathrm{V}_{\mathbf{G S}}=0$, | See Note 3 | 5 | mA |
| $\mathrm{r}_{\text {ds }}(\mathrm{on})$ | Small-Signal Drain-Source On-State Resistance | $V_{G S}=0$, | $I_{D}=0$, | $\mathrm{f}=1 \mathrm{kHz}$ | 300 | $\Omega$ |
| $\mathrm{C}_{\text {iss }}$ | Common-Source Short-Circuit Input Capacitance | $V_{D S}=0$, | $V_{G S}=-8 \mathrm{~V}$, | $\mathrm{f}=1 \mathrm{MHz}$ | 8 | pF |
| $\mathrm{Crss}^{\text {r }}$ | Common-Source Short-Circuit Reverse Transfer Capacitance | $V_{D S}=0$, | $V_{G S}=-8 \mathrm{~V}$, | $\mathrm{f}=1 \mathrm{MHz}$ | 0.6 | pF |
| $C_{\text {cs }}$ | Drain-Source Capacitance | $V_{D S}=0,$ <br> See Note 4 | $V_{G S}=-8 V,$ | $\mathrm{f}=1 \mathrm{MHz},$ | 3 | pF |

NOTES: 3. This parameter must be measured using pulse techniques. $t_{w}=\mathbf{3 0 0} \mu \mathrm{s}$, duty eycle $<\mathbf{2 \%}$.
4. $C_{d s}$ measurement employs a three-terminal capacitance bridge incorporating a guard circuit. The gate and case are connected to the guard terminal of the bridge.

[^110]
# ENHANCEMENT-TYPE $\dagger$ MOS SILICON TRANSISTORS 3N155, 3N155A, 3N156, and 3N156A <br> Are Characterized For Applications Requiring Very High Input Impedance, Such as Series and Shunt Choppers, Mutliplexers, and Commutators 

## 3N157, 3N167A, 3N158, and 3N158A <br> Are Characterized For Audio Amplifier Applications

- Channel Cut Off with Zero Gate Voltage
- Square-Law Transfer Characteristic Reduces Distortion
- Independent Substrate Connection Provides Flexibility in Biasing
"mechanical data

handling precautions
Curve-tracer testing and static-charge buildup are common causes of damage to insulatad-gate devices. Permanent damage may result if either gate-voltage rating is exceeded even for extremely short time periods. Each transistor is protected during shipment by a gate-shorting device which should be removed only during testing and after permanent mounting of the transistor. Personnel and equipment, including soldering irons, should be grounded.
absolute maximum ratings at $\mathbf{2 5}^{\circ} \mathbf{C}$ free-air temperature (unless otherwise noted)


NOTES: 1. Thase voltage ratings apply when the subatrate is at the same potential as the least-negative element.

- JEDE ${ }^{2}$. Derate linearly to $\mathbf{1 7 5} \mathrm{C}$ free-alr temparature at the rate of $\mathbf{2 ~ m W} /{ }^{\circ} \mathrm{C}$.
tedEC registersed data. This dats theet contains all applicable ragistared data in offect at time of publication.
${ }^{\dagger}$ Enhencement-mode operation entaifs the use of forward gate-source voltage to increase draln currant from loss, the drain current at onhancement-type trensistor is intion-mode operation wherein a reverse gate-source voltage is used to decrease drain eurrent. An onhancement-type trensistor is in the "off" state at $\mathrm{V}_{\mathbf{G S}} \mathbf{- 0} \mathbf{O}$ and hence will not operate normally in the depletion mode.


## TYPES 3N155 THRU 3N158, 3N155A THRU 3N158A P-CHANNEL ENHANCEMENT-TYPE INSULATED-GATE FIELD-EFFECT TRANSISTORS

*3N155 and 3N156 electrical characteristics at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

| PARAMETER |  | TEST CONDITIONS $\ddagger$ |  | 3N1B5 |  | 3N158 |  | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | MIN | MAX | MIN | MAX |  |
| 'gssf | Forwerd Gate-Terminal Current |  |  | $\mathrm{V}_{\text {GS }}=-25 \mathrm{~V}, \mathrm{~V}_{\text {DS }}=0$ |  |  | -10 |  | -10 | PA |
|  |  | $V_{\text {OS }}=-50 \mathrm{~V}, \mathrm{~V}_{\text {DS }}=0$ |  |  | -1 |  | -1 | nA |
| IGSSR - Reverse Gate-Terminal Current |  | $\mathrm{V}_{\text {GS }}=25 \mathrm{~V}, \mathrm{~V}_{\text {OS }}=0$ |  |  | 10 |  | 10 | PA |
|  |  | $V_{G S}=60 V_{1}, V_{\text {DS }}=0$ |  |  | 1 |  | 1 | nA |
| IDSS Zero-Gate-Voltage Drain Current |  | $V_{D S}=-10 \mathrm{~V}, \mathrm{~V}_{\text {GS }}=0$ |  |  | -1 |  | -1 | nA |
|  |  | $\mathrm{V}_{\text {DS }}=-10 \mathrm{~V}, \mathrm{~V}_{\text {GS }}=0$, | $\mathrm{T}^{\prime}=125^{\circ} \mathrm{C}$ |  | -1 |  | -1 | MA |
| $\mathrm{V}_{\text {GS }}($ th) | Gate-Source Threchold Voltage | $V_{D S}=-10 \mathrm{~V}, \mathrm{~T}_{\mathrm{D}}=-10$ |  | -1.5 | -3.2 | -3 | -5 | V |
| Ioton) | On-State Drain Current | $V_{\text {OS }}=-15 \mathrm{~V}, \mathrm{~V}_{\mathrm{GS}}=-1$ | See Note 3 | -5 |  | - |  | mA |
| Vos(on) | Drain-Source On-State Voltege | $V_{G S}=-10 \mathrm{~V}, \mathrm{I}_{\mathrm{D}}=-2 \mathrm{~m}$ |  |  | -1 |  | -1 | V |
| ros (on) | Static Small-Signal Drain-Source On-State Resiotance | $V_{G S}=-10 \mathrm{~V}, \mathrm{I}_{\mathrm{D}}=0$ |  |  | 600 |  | 600 | $\Omega$ |
| rdalon) | Small-Signal Drain-Source On-State Resistance | $V_{\text {OS }}=-10 \mathrm{~V}, \mathrm{I}=0$, | $\mathrm{f}=1 \mathrm{kHz}$ |  | 600 |  | 600 | $\Omega$ |
| $C_{\text {Ist }}$ | Common-Source Short-Circuit Input Capecitance | $V_{D S}=-18 \mathrm{~V}, \mathrm{~V}_{\text {GS }}=0$. | $f=140 \mathrm{kHz}$ |  | б |  | 5 | pF |
| $\mathrm{Crsa}^{\text {rem }}$ | Common-Source Short-Circult Reverse Transfor Capacitance | $V_{\text {DS }}=0, \quad V_{\text {GS }}=0$, | $f=140 \mathrm{kHz}$ |  | 1.3 |  | 1.3 | pF |

*3N165A and 3N156A electrical characteristics at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

| PARAMETER |  | TEST CONDITIONS* | 3N1E8A | 3N1EAA | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | MIN MAX | MIN MAX |  |
| IGssf | Forward Gate-Tarminal Current |  | $V_{G S}=-25 V, V_{D S}=0$ | -10 | -10 | DA |
|  |  | $V_{G S}=-60 V, V_{D S}=0$ | -1 | -1 | nA |
| IGSsR | Reverse Gate-Terminal Current | $V_{G S}=25 \mathrm{~V}, \quad V_{\text {DS }}=0$ | 10 | 10 | PA |
|  |  | $V_{G S}=60 \mathrm{~V}, \mathrm{~V}_{\text {DS }}=0$ | 1 | 1 | nA |
| IDSs | Zero-Gate-Voltage Drain Current | $V_{D S}=-10 \mathrm{~V}, \mathrm{~V}_{\text {GS }}=0$ | -0.25 | -0.25 | nA |
|  |  | $V_{D S}=-10 \mathrm{~V}, \mathrm{~V}_{G S}=0, \quad T_{A}=125^{\circ} \mathrm{C}$ | -250 | -250 |  |
| $V_{G S}(\mathrm{th})$ | Gate-Source Threshold Voltage | $\mathrm{V}_{\mathrm{DS}}=-10 \mathrm{~V}, \mathrm{I}_{\mathrm{D}}=-10 \mu \mathrm{~A}$ | -1.5 $\quad-3.2$ | -3 $\quad-5$ | V |
| ID(on) | On-State Drain Current | $V_{D S}=-15 \mathrm{~V}, \mathrm{~V}_{\mathrm{GS}}=-10 \mathrm{~V}$, See Note 3 | -5 | -5 | mA |
| VDsion) | Drain-Source On-State Voitage | $V_{G S}=-10 \mathrm{~V}, \mathrm{ID}=-2 \mathrm{~mA}$ | -1 | -1 | V |
| rosion) | Static Smali-Signal Drain-Source On-State Resistance | $V_{G S}=-10 \mathrm{~V}, \mathrm{I}_{\mathrm{D}}=0$ | 300 | 300 | $\Omega$ |
| rds(on) | Small-Signal Drain-Source On-State Resistance | $V_{G S}=-10 \mathrm{~V}, \mathrm{I}_{\mathrm{D}}=0, \quad f=1 \mathrm{kHz}$ | 300 | 300 | $\Omega$ |
| $C_{\text {ist }}$ | Common-Source Short-Circult Input Capacitance | $V_{\text {DS }}=-15 \mathrm{~V}, \mathrm{~V}_{\mathrm{GS}}=0, \quad \uparrow=140 \mathrm{kHz}$ | 5 | 5 | pF |
| $\mathrm{Crss}^{\text {rem }}$ | Common-Source Short-Circuit Reverse Transfer Capacitance | $V_{D S}=0, \quad V_{G S}=0 . \quad f=140 \mathrm{kHz}$ | 1.3 | 1.3 | pF |

NOTE 3: This parameter must be measured using pulee technlques. $t_{w}=300 \mu s$, duty eycle $<\mathbf{2 \%}$.
*JEDEC registered data
$\ddagger$ All mesaurements are made with the case and substrate connected to the source.

## TYPES 3N155 THRU 3N158, 3N155A THRU 3N158A P-CHANNEL ENHANCEMENT-TYPE INSULATED-GATE FIELD-EFFECT TRANSISTORS

*3N155, 3N155A, 3N156, 3N156A switching characteristics at $25^{\circ} \mathrm{C}$ free-air temperature

|  | PARAMETER | TEST CONDITIONS $\ddagger$ | MAX | UNIT |
| :---: | :---: | :---: | :---: | :---: |
| $t_{\text {d }}($ on) | Turn-On Delay Time | $\begin{array}{ll} V_{D O}=-10 \mathrm{~V}, & I_{D(\text { on })}=-2 \mathrm{~mA}, \\ V_{G S(\text { on })}=-10 \mathrm{~V}, & V_{G S(\text { off })}=0, \\ \text { See Figure } 1 \end{array}$ | 45 | ns |
| $t_{r}$ | Rise Time |  | 65 | ns |
| $\mathrm{t}_{\mathrm{d} \text { ( } \mathrm{fff})}$ | Turn-Off Delay Time |  | 60 | ns |
| $t_{f}$ | Fall Time |  | 100 | ns |

$\ddagger_{\text {All measurements are made with the case and substrate connected to the source. }}$
PARAMETER MEASUREMENT INFORMATION

test circuit


VOLTAGE WAVEFORMS

NOTES: a. The input waveform is supplied by a generator with the following characteristics: $Z_{o u t}=50 \Omega, t_{r} \leq 2 n s, t_{f} \leqslant 2 n s, t_{w}>10 \mu s$, duty cycle $\approx 2 \%$
b. Waveforms are monitored on an oscilloscope with the following characteristics: $\mathrm{t}_{\mathrm{F}} \leqslant 10 \mathrm{~ns}, \mathrm{R}_{\mathrm{in}} \geq 1 \mathrm{M} \Omega, \mathrm{C}_{\mathrm{in}}<1 \mathrm{pF}$.
figure 1

## TYPES 3N155 THRU 3N158, 3N155A THRU 3N158A P-CHANNEL ENHANCEMENT-TYPE INSULATED-GATE FIELD-EFFECT TRANSISTORS

*3N157 and 3N158 electrical characteristics at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

*3N157A and 3N158A electrical characteristics at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

| PARAMETER |  | TEST CONDITIONS $\ddagger$ | 3N157A | 3N158A | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | MIN MAX | MIN MAX |  |
| ${ }^{\prime}$ GSSF | Forward Gate-Terminal Current |  | $\mathrm{V}_{\mathrm{GS}}=-25 \mathrm{~V}, \mathrm{~V}_{\text {DS }}=0$ | -10 | -10 | pA |
|  |  | $\mathrm{V}_{\text {GS }}=-50 \mathrm{~V}, \mathrm{~V}_{\text {DS }}=0$ | -1 | -1 | nA |
|  |  | $\mathrm{V}_{\mathrm{GS}}=-25 \mathrm{~V}, \mathrm{~V}_{\mathrm{DS}}=0, \quad \mathrm{~T}_{\mathrm{A}}=55^{\circ} \mathrm{C}$ | -10 | -10 | nA |
|  |  | $V_{G S}=-50 \mathrm{~V}, \mathrm{~V}_{\text {DS }}=0, \quad \mathrm{~T}_{\mathrm{A}}=55^{\circ} \mathrm{C}$ | -1 | -1 | $\mu \mathrm{A}$ |
| 'GSSR | Reverse Gate-Terminal Current | $V_{\text {GS }}=25 \mathrm{~V}, \mathrm{~V}_{\text {DS }}=0$ | 10 | 10 | pA |
|  |  | $\mathrm{V}_{\text {GS }}=50 \mathrm{~V}$, $\mathrm{V}_{\text {DS }}=0$ | 1 | 1 | nA |
| IDSs | Zero-Gate-Voltage Drain Current | $\mathrm{V}_{\text {DS }}=-15 \mathrm{~V}, \mathrm{~V}_{\mathrm{GS}}=0$ | -0.25 | -0.25 | nA |
|  |  | $\mathrm{V}_{\mathrm{DS}}=-50 \mathrm{~V}, \mathrm{~V}_{\mathrm{GS}}=0$ | -10 | -10 | $\mu \mathrm{A}$ |
| $V_{\text {GS( }}$ th) | Gate-Source Threshold Voltage | $V_{D S}=-15 \mathrm{~V}, I_{D}=-10 \mu \mathrm{~A}$ | -1.5 -3.2 | -3 | V |
| $\mathrm{V}_{\text {GS }}$ | Gate-Source Voltage | $\mathrm{V}_{\text {DS }}=-15 \mathrm{~V}, \mathrm{I}_{\mathrm{D}}=-0.5 \mathrm{~mA}$ | -1.5 | -3 | V |
| ID(on) | On-State Drain Current | $\mathrm{V}_{\mathrm{DS}}=-15 \mathrm{~V}, \mathrm{~V}_{\mathrm{GS}}=-10 \mathrm{~V}$, See Note 3 | -5 | -5 | mA |
| $\left\|y_{f s}\right\|$ | Small-Signal Common-Source Forward Transfer Admittance | $V_{D S}=-15 \mathrm{~V}, \mathrm{I}^{\prime}=-2 \mathrm{~mA}, \quad f=1 \mathrm{kHz}$ | 14 | 14 | mmho |
| \|Vos| | Small-Signal Common-Source Output Admittance |  | 60 | 60 | $\mu \mathrm{mho}$ |
| $C_{\text {iss }}$ | Common-Source Short-Circuit Input Capacitance | $V_{\text {DS }}=-15 \mathrm{~V}, \mathrm{~V}_{\mathrm{GS}}=0, \quad f=140 \mathrm{kHz}$ | 5 | 5 | pF |
| $\mathrm{C}_{\text {rss }}$ | Common-Source Short-Circuit <br> Reverse Transfer Capacitance |  | 1.3 | 1.3 | pF |

[^111]*JEDEC registered data
末All measurements are made with the case and substrate connected to the source.

## ENHANCEMENT-TYPE $\dagger$ MOS SILICON TRANSISTOR

For Applications Requiring Very High Input Impedance, Such as Series and Shunt Choppers, Multiplexers, and Commutators

- Channel Cut Off with Zero Gate Voltage
- Square-Law Transfer Characteristic Reduces Distortion
- Independent Substrate Connection Provides Flexibility in Biasing
- Diode-Protected Version Available . . . 3N161
*mechanical data



## handling precautions

Curve-tracer testing and static-charge buildup are common causes of damage to insulated-gate devices. Permanent damage may result if either gate-voltage rating is exceeded even for extremely short time periods. Each transistor is protected during shipment by a gate-shorting device, which should be removed only during testing and after permanent mounting of the transistor. Personnel and equipment, including soldering irons, should be grounded.
*absolute maximum ratings at $25^{\circ} \mathbf{C}$ free-air temperature (unless otherwise noted)
Drain-Gate Voltage . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . -25 V
Drain-Source Voltage . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . -25 V
Forward Gate-Source Voltage . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . - 25 V
Reverse Gate-Source Voltage . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 25 V
Continuous Drain Current . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . - 125 mA
Continuous Device Dissipation at (or below) $25^{\circ} \mathrm{C}$ Free-Air Temperature (See Note 1) . . . . . . . . . 360 mW
Continuous Device Dissipation at (or below) $25^{\circ} \mathrm{C}$ Case Temperature (See Note 2) . . . . . . . . . . . 1.8 W
Storage Temperature Range . . . . . . . . . . . . . . . . . . . . . . . . . . . $-65^{\circ} \mathrm{C}$ to $\mathbf{2 0 0 ^ { \circ }} \mathrm{C}$
Lead Temperature $1 / 16$ Inch from Case for 10 Seconds . . . . . . . . . . . . . . . . . . . . . 300 C
NOTES: 1. Derate linearly to $175^{\circ} \mathrm{C}$ free-air temperature at the rate of $2.4 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$.
2. Derate inearly to $175^{\circ} \mathrm{C}$ case temperature at the rate of $12 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$.
*JEDEC registered date. This data sheet contains all applicable registered data in effect at the time of publication.
${ }^{\dagger}$ Enhancement-mode oparation entails the use of a forward gate-source voltage to Increase drain current from IDSS, the drain current at
$V_{G S}=0$, as opposed to depletion-mode operation wherein a revarse gate-source voltage is used to decrease draln current. An enhancement-type transistor is in the "off" state at $\mathrm{V}_{\mathbf{G S}}=0$ and hence wlll not operate normally in the depletion mode.

## TYPE 3N160 <br> P-CHANNEL ENHANCEMENT-TYPE INSULATED-GATE FIELD-EFFECT TRANSISTOR

*electrical characteristics at $25^{\circ} \mathbf{C}$ free-air temperature (unless otherwise noted)


NOTE 3: These parameters must ba measured using pulse techniques. $t_{p} \approx 100 \mathrm{~ms}$, duty cycle $\leqslant 10 \%$.

- JEDEC registered data
$\dagger$ All measurements are made with the third lead (case and substrate) connected to the fourth lead (source).


## THERMAL INFORMATION

FREE-AIR TEMPERATURE DISSIPATION DERATING CURVE


FIGURE 1

CASE TEMPERATURE DISSIPATION DERATING CURVE


FIGURE 2

# DIODE-PROTECTED ENHANCEMENT-TYPE ${ }^{\text {M MOS SILICON TRANSISTOR }}$ 

For Applications Requiring Very High Input Impedance, Such as Series and Shunt Choppers, Multiplexers, and Commutators

- Channel Cut Off with Zero Gate Voltage
- Square-Law Transfer Characteristic Reduces Distortion
- Independent Substrate Connection Provides Flexibility in Biasing
- Internally Connected Diode Protects Gate from Damage due to Overvoltage
- Version Available without Diode Protection . . . 3N160


## description

This device is designed for applications requiring very high input impedance, such as choppers, commutators, and logic switches. The device is protected from excessive input voltage by a shunting diode connected from the gate to the substrate. This eliminates the need for most precautionary handling procedures associated with unprotected MOS devices.
*mechanical data

*absolute maximum ratings at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)
Drain-Gate Voltage . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . -25 V
Drain-Source Voltage . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . -25 V
Continuous Forward Gate-Terminal Current . . . . . . . . . . . . . . . . . . . . . . . . - 0.1 mA
Continuous Reverse Gate-Terminal Current . . . . . . . . . . . . . . . . . . . . . . . . . 10 mA
Continuous Drain Current . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . - 125 mA
Continuous Device Dissipation at (or below) $25^{\circ} \mathrm{C}$ Free-Air Temperature (See Note 1) . . . . . . . . 360 mW
Continuous Device Dissipation at (or below) $25^{\circ} \mathrm{C}$ Case Temperature (See Note 2) . . . . . . . . . . . 1.8 W
Storage Temperature Range . . . . . . . . . . . . . . . . . . . . . . . . . . . $-65^{\circ} \mathrm{C}$ to $\mathbf{2 0 0}{ }^{\circ} \mathrm{C}$
Lead Temperature $\mathbf{1 / 1 6}$ Inch from Case for 10 Seconds . . . . . . . . . . . . . . . . . . . . . $300^{\circ} \mathrm{C}$
NOTES: 1. Derate linearly to $175^{\circ} \mathrm{C}$ free-air temperature at the rate of $2.4 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$.
2. Derate linearly to $175^{\circ} \mathrm{C}$ case temperature at the rate of $12 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$.

- JEDEC registered data. This data sheet contains all applicable registered data in effect at the time of publication.
${ }^{\dagger}$ Enhancement-mode operation entalls the use of a forward gate-source voltage to increase drain current from loss, the drain current at $V_{G S}=0$, as opposed to depletion-mode operation wherein a reverse gate-source voltage is used to decrease drain current. An enhancement-type transistor is in the "off" state at $\mathrm{V}_{\mathrm{GS}}=0$ and hence will not operate normally in the depletion made. The protective shunting diode is reverse-biased by the application of forward gate-source voltage.
"electrical characteristics at $\mathbf{2 5}^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

| PARAMETER | TEST CONDITIONS ${ }^{\dagger}$ |  | MIN | MAX | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: |
| V(BR)GSSF Forward Gate-Source Breakdown Voltage | $I_{G}=-0.1 \mathrm{~mA}, V_{D S}=0$, | See Note 3 | -25 |  | V |
| IGSSE Forw | $V_{G S}=-25 \mathrm{~V}, \mathrm{~V}_{\text {DS }}=0$ |  |  | -0.1 | nA |
| IGSSF Forward Gate-Terminal Current | $V_{G S}=-25 V, V_{D S}=0$, | $\mathrm{TA}=100^{\circ} \mathrm{C}$ |  | -10 | nA |
| Inss Zero-Gate-Voltse Drain Current | $V_{D S}=-15 \mathrm{~V}, V_{G S}=0$ |  |  | -10 | nA |
| DSSS Zero-GatoVoltoge Dram Current | $\mathrm{V}_{\text {DS }}=-26 \mathrm{~V}, \mathrm{~V}_{\text {GS }}=0$ |  |  | -10 | $\mu \mathrm{A}$ |
| $\nabla_{\text {GS(th }}$ Gate-Source Threshold Voltage | $V_{\text {DS }}=-15 \mathrm{~V}, \mathrm{I}^{\prime}=-10 \mu \mathrm{~A}$ |  | -1.5 | -5 | $V$ |
| VGS Gate-Source Voltage | $V_{\text {DS }}=-16 \mathrm{~V}, \mathrm{I}_{\mathrm{D}}=-8 \mathrm{~mA}$ |  | -4.5 | -8 | V |
| ID(on) On-State Drain Current | $V_{D S}=-15 \mathrm{~V}, \mathrm{~V}_{\mathrm{GS}}=-15 \mathrm{~V}$, | See Note 4 | -40 | -120 | mA |
| $\|$Small-Signal Common-Sourca |  |  | 3.5 | 6.5 | mmho |
| \|Yos| Output Admittance | $V_{D S}=-15 \mathrm{~V}, \mathrm{ID}^{\prime}=-8 \mathrm{~mA}$ |  |  | 0.25 | mmho |
| $C_{\text {iss }}$ Common-Source Short-Circuit <br>  Input Capacitance |  | $\mathrm{f}=1 \mathrm{MHz}$ |  | 10 | pF |
| Crss Common-Source Short-Circuit <br> Reverse Transfer Capacitance |  |  |  | 4 | pF |

NOTES: 3. To ensure that the gate-shunting diode is functioning properly, this voltage is measured while the device is conducting rated forward gate-terminal current.
4. This parameter must be measured using pulse techniques. $t_{p} \approx 100 \mathrm{~ms}$, duty cycle $\leqslant 10 \%$.
*JEDEC reglstered data
tAll messurements are made with the third lead (case and substrate) connected to the fourth lead (source).

## THERMAL INFORMATION

FREE-AIR TEMPERATURE DISSIPATION DERATING CURVE


FIGURE 1

CASE TEMPERATURE DISSIPATION DERATING CURVE


FIGURE 2

# ENHANCEMENT-TYPE ${ }^{\dagger}$ MOS SILICON TRANSISTORS 

For Applications Requiring Very High Input Impedance, Such as<br>Series and Shunt Choppers, Multiplexers, and Commutators

- Channel Cut Off with Zero Gate Voltage
- Square-Law Transfer Characteristic Reduces Distortion
- Independent Substrate Connection Provides Flexibility in Biasing
*mechanical data
THE SUBSTRATE IS IN ELECTRICAL CONTACT WITH THE CASE


## handling precautions

Curve-tracer testing and static-charge buildup are common causes of damage to insulated-gate devices. Permanent damage may result if either peak gate-voltage rating is exceeded even for extremely short time periods. Each transistor is protected during shipment by a gate-shorting device which should be removed only during testing and after permanent mounting of the transistor. Personnel and equipment, including soldering irons, should be grounded.
absolute maximum ratings at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)


NOTES: 1. These voltage ratings appiy when the substrate is ot the same potentiol as the least-negative element.
2. The working voltege ratings are based on fong-term reliability considerations and may be exceeded for short intervals.
3. Derste linearly to $150^{\circ} \mathrm{C}$ free-air temperature at the rate of $\mathbf{3} \mathrm{mW} /{ }^{\circ} \mathrm{C}$.

- JEDEC registared data. This data sheet contains all applicable registered data in effect at time of publication.
t Enhancement-mode operation entails the use of a forward gate-source voltage to increase drain current from loss, the drain current at $V_{G S}=0$, as opposed to depletion-mode operation wherein a reverse gata-source voltage is usad to decrease drain eurrent. An enhancement-type trensistor is in the "off" state at $\mathrm{V}_{\mathbf{G S}}=\mathbf{0}$ and hence will not operate normally in the depletion mode.


## TYPES 3N163, 3N164 P-CHANNEL ENHANCEMENT-TYPE INSULATED-GATE FIELD-EFFECT TRANSISTORS

*3N163 electrical charactaristics at $\mathbf{2 5}{ }^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

| PARAMETER | TEST CONDITION\% $\ddagger$ | MIN MAX | UNIT |
| :---: | :---: | :---: | :---: |
| Forward Gate-Terminal Current | $V_{G S}=-40 \mathrm{~V}, \mathrm{~V}_{\text {DS }}=0$ | -10 | pA |
|  | $V_{G S}=-40 \mathrm{~V}, \mathrm{VDS}=0, \quad \mathrm{TA}=125^{\circ} \mathrm{C}$ | -26 |  |
| IGSSR Reverse Gate-Torminal Current | $V_{G S}=40 \mathrm{~V}, V_{D S}=0$ | 10 | pA |
| Zero-Gate-Voltege Drain Current | $V_{D S}=-15 \mathrm{~V}, \mathrm{~V}_{\text {GS }}=0$ | -0.2 | nA |
|  | $V_{D S}=-40 \mathrm{~V}, \mathrm{~V}_{G S}=0$ | -10 | $\mu \mathrm{A}$ |
| Zero-Gate-Voltege Source Current | $V_{S D}=-20 V_{1} V_{G D}=0, \quad$ See Note 4 | -0.4 | nA |
|  | $V_{S D}=-40 \mathrm{~V}, \mathrm{~V}_{\mathrm{GD}}=0, \quad$ See Note 4 | $-10$ | $\mu \mathrm{A}$ |
| VGS(th) Gate-Source Threshold Voltege | $V_{D S}=-15 V_{1} I_{D}=-10 \mu \mathrm{~A}$ | -2 -6 | V |
|  | $V_{D S}=V_{G S} . \quad I_{D}=-10 \mu \mathrm{~A}$ | -2 -5 |  |
| VGS Gate-Source Voltage | $V_{D S}=-15 \mathrm{~V}, I_{D}=-0.6 \mathrm{~mA}$ | $\begin{array}{ll}-3 & -6.5\end{array}$ | $V$ |
| ID(on) On-State Drain Current | $\mathrm{V}_{\mathrm{DS}}=-15 \mathrm{~V}, \mathrm{~V}_{\mathrm{GS}}=-10 \mathrm{~V}$, See Note 5 | $-5 \quad-30$ | mA |
| rDS(on) Static Drain-Source On-State Resistance | $V_{G S}=-20 \mathrm{~V}, I_{D}=-100 \mu \mathrm{~A}$ | 250 | $\Omega$ |
| W $\mathrm{Vfs}^{\text {a }}$ Small-Signal Common-Source Forward Transfer Admittance | $\begin{aligned} & V_{D S}=-15 \mathrm{~V}, \mathrm{I}_{\mathrm{D}}=-10 \mathrm{~mA}, f=1 \mathrm{kHz} \text {, } \\ & \text { See Note } 6 \end{aligned}$ | $2 \quad 4$ | mmho |
| Vos ${ }^{\text {S }}$ Smatl-Signal Common-Source Output Admittance |  | 250 | $\mu \mathrm{mho}$ |
| $\mathrm{C}_{\text {iss }}$ Common-Source Short-Circuit Input Capacitance | $V_{D S}=-15 V, I_{D}=-10 \mathrm{~mA}, f=1 \mathrm{MHz},$ <br> See Note 6 | 2.5 | pF |
| $\mathrm{C}_{\text {rss }}$ Common-Source Short-Circuit Reverse Transfer Capacitance |  | 0.7 | pF |
| $\mathrm{C}_{\text {oss }}$ Common-Source Short-Circuit Output Capacitance |  | 3 | pF |

*3N164 electrical characteristics at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

| PARAMETER |  | TEST CONDITIONS $\ddagger$ | MIN MAX | $\begin{array}{\|c\|} \hline \text { UNIT } \\ \hline \text { PA } \\ \hline \end{array}$ |
| :---: | :---: | :---: | :---: | :---: |
| IGSSF | Forward Gate-Terminal Current | $V_{G S}=-30 \mathrm{~V}, V_{D S}=0$ | -10 |  |
|  |  | $V_{G S}=-30 V, V_{D S}=0, \quad T_{A}=125^{\circ} \mathrm{C}$ | -25 |  |
| IGSSR | Reverse Gate-Terminal Current | $V_{G S}=30 \mathrm{~V}, V_{D S}=0$ | 10 | PA |
| IDSs | Zero-Gate-Voltage Drain Current | $V_{D S}=-15 V_{1} V_{G S}=0$ | -0.4 | nA |
|  |  | $V_{D S}=-30 \mathrm{~V}, \mathrm{~V}_{\text {GS }}=0$ | -10 | $\mu \mathbf{A}$ |
| ISDS | Zero-Gate-Voltage Source Current | $V_{S D}=-20 \mathrm{~V}, \mathrm{~V}_{\mathrm{GD}}=0, \quad$ See Note 4 | -0.8 | nA |
|  |  | $V_{S D}=-30 \mathrm{~V}, V_{G D}=0, \quad$ See Note 4 | -10 | $\mu \mathrm{A}$ |
| $\mathbf{V G S}_{\text {GS }}$ (th) | Gate-Source Threshold Voltage | $V_{D S}=-15 \mathrm{~V}, I_{D}=-10 \mu \mathrm{~A}$ | -2 -5 | V |
|  |  | $V_{D S}=V_{G S}, \quad I_{D}=-10 \mu A$ | -2 -5 |  |
| $V_{\text {GS }}$ | Gate-Source Voltage | $V_{D S}=-15 \mathrm{~V}, I_{D}=-0.5 \mathrm{~mA}$ | -2.5 -6.5 | $V$ |
| ID(on) | On-State Drain Current | $\mathrm{V}_{\mathrm{DS}}=-15 \mathrm{~V}, \mathrm{~V}_{\mathrm{GS}}=-10 \mathrm{~V}$, See Note 5 | -3 -30 | mA |
| rDS(on) | Static Drain-Source On-State Resistance | $V_{G S}=-20 \mathrm{~V}, I_{D}=-100 \mu \mathrm{~A}$ | 300 | $\Omega$ |
| Vfs | Small-Signal Common-Source Forward Transfer Admittance | $\begin{aligned} & V_{D S}=-15 \mathrm{~V}, \mathrm{I}_{\mathrm{D}}=-10 \mathrm{~mA}, f=1 \mathrm{kHz}, \\ & \text { See Note } 6 \end{aligned}$ | 14 | mmho |
| Yos | Small-Signal Common-Source Output Admittance |  | 250 | $\mu \mathrm{mho}$ |
| $\mathrm{C}_{\mathrm{igs}}$ | Common-Source Short-Circuit Input Cepecitance | $V_{D S}=-15 \mathrm{~V}, \mathrm{I}_{\mathrm{D}}=-10 \mathrm{~mA}, f=1 \mathrm{MHz}$ <br> See Note 6 | 2.5 | pF |
| $\mathrm{Crgs}^{\text {reser }}$ | Common-Source Short-Circuit Reverse Transfer Capacitance |  | 0.7 | pF |
| $\mathrm{C}_{085}$ | Common-Source Short-Circuit Output Cepacitance |  | 3 | pF |

NOTES: 4. For the masurement of isOS, the substrate must be connected to the drain.
5. This parameter must be measured using pulee techniques. $\mathrm{t}_{\mathrm{w}}=300 \mu \mathrm{~s}$, dutv cycie $<\mathbf{2 \%}$.
6. These parameters must be measured with biss conditions applied for less than 5 seconds to avoid overhesting.
*JEDEC registerad data
$\ddagger$ All masurements except ISDS are made with the case and substrate connected to the source.

## TYPES 3N163, 3N164 <br> P-CHANNEL ENHANCEMENT-TYPE <br> INSULATED-GATE FIELD-EFFECT TRANSISTORS

*switching characteristics at $\mathbf{2 5}{ }^{\mathbf{\circ}} \mathbf{C}$ free-air temperature

| PARAMETER | TEST CONDITIONS $\ddagger$ | MAX | UNIT |
| :---: | :---: | :---: | :---: |
| $t_{\text {difon) Turn-On Delay Time }}$ | $\begin{array}{ll} V_{D D}=-15 \mathrm{~V}, & I_{D(o n)}=-10 \mathrm{~mA}, \\ V_{G S(o n)}=-10 \mathrm{~V}, & V_{G S(\text { off })}=0, \\ \text { See Figure } 1 & \end{array}$ | 12 | ns |
| $\mathrm{tr}_{\mathbf{r}} \quad$ Rise Time |  | 24 | ns |
| $\mathrm{t}_{\text {off }}$ Turn-Off Time |  | 50 | ns |

## PARAMETER MEASUREMENT INFORMATION



FIGURE 1

NOTES: A. The input waveform is supplied by a generator with the following characteristics: $Z_{\text {out }}=50 \Omega$, duty cycle $\approx 2 \%, t_{r} \leqslant 2$ ns, $\mathrm{t}_{\mathrm{f}} \leqslant 2 \mathrm{~ns}, \mathrm{t}_{\mathrm{w}} \geqslant 200 \mathrm{~ns}$.
b. Waveforms are monitored on an oscilloscope with the following charecteristics: $t_{r}<0.2 \mathrm{~ns}, \mathrm{R}_{\text {in }} \geqslant 10 \mathrm{M} \Omega, \mathrm{C}_{\text {in }} \leqslant 2 \mathrm{pF}$.
*JEDEC registered data
$\ddagger$ All measurements except ISDS are made with the case and substrate connected to the source.

## ENHANCEMENT-TYPE ${ }^{\dagger}$ MOS SILICON TRANSISTORS

## For Applications Requiring Very High Input Impedance, Such as Series and Shunt Choppers, Multiplexers, and Commutators

- Channel Cut Off with Zero Gate Voltaga
- Independent Substrate Connection Provides Flexibility in Biasing


## *mechanical data



## handling precautions

Curve-tracer testing and static-charge buildup are common cuases of damage to insulated-gate devices. Permanent damage may result if either gate-voltage rating is exceeded even for extremely short time periods. Each transistor is protected during shipment by a gate-shorting device which should be removed only during testing and after permanent mounting of the transistor. Personnel and equipment, including soldering irons, should be grounded.
absolute maximum ratings at $25^{\circ} \mathbf{C}$ free-air temperature (unless otherwise noted)
*Drain-Gate Voltage . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . $\quad \mathbf{\pm 3 5} \mathrm{V}$
"Drain-Source Voltage (See Note 1) . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 25 V
*Forward Gate-Source Voltage . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 35 V
*Reverse Gate-Source Voltage . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . -35 V
*Continuous Drain Current . . . . . . . .
Continuous Device Dissipation at (or below) $25^{\circ} \mathrm{C}$ Free-Air Temperature (See Note 2) . . . . . . . . . 300 mW
*Continuous Device Dissipation at (or below) $\mathbf{2 5}^{\circ} \mathrm{C}$ Case Temperature (See Note 3) . . . . . . . . . . 800 mW
${ }^{*}$ Storage Temperature Range . . . . . . . . . . . . . . . . . . . . . . . . . . . $\mathbf{- 6 5}^{\mathbf{6}} \mathrm{C}$ to $\mathbf{2 0 0}{ }^{\circ} \mathrm{C}$
*Lead Temperature $\mathbf{1 / 1 6}$ Inch from Case for $\mathbf{6 0}$ Seconds . . . . . . . . . . . . . . . . . . . . $240^{\circ} \mathrm{C}$

NOTES: 1. This voltage rating applies when the substrate is at the same potential as the least-negative element.
2. Derate linearly to $200^{\circ} \mathrm{C}$ free-air temperature at the rate of $1.71 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$.
3. Derate linearly to $200^{\circ} \mathrm{C}$ case temperature at the rate of $4.56 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$.
-JEDEC registered data. This data sheot contains all applicable registered data in affect at time of publication.
${ }^{\dagger}$ Enhencemant-mode operation entails the use of a forward gate-source voltage to incrase drain current from IDSS, the drain current at $V_{G S}=0$, as opposed to depletion-mode operation wherein a reverse gate-source voltage is used to dacrease drain current. An enhancement-type transistor is in the "off" state at $\mathrm{V}_{G S}=\mathbf{0}$ and hence will not operate normally in tha depletion mode.

## TYPES 3N169, 3NT50, 3N771

 N-CHANNEL ENHANCEMENT-TYPE INSULATED-GATE FIELD-EFFECT TRANSISTORSelectrical characteristics at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

| PARAMETER |  | TEST CONDITIONS ${ }^{\dagger}$ |  | MIN | Max | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| $V_{\text {(BR) }}$ OSS | Drain-Source Breakdown Voltage | $\mathrm{I}_{\mathrm{D}}=10 \mu \mathrm{~A}, \quad \mathrm{~V}_{\mathrm{GS}}=0$ |  | 25 |  |  |
| ${ }^{*}$ IGSSF | Forward Gate-Terminal Current | $V_{G S}=35 \mathrm{~V}, \mathrm{~V}_{\text {DS }}=0$ |  |  | 10 | pA |
|  |  | $\mathrm{V}_{\mathrm{GS}}=35 \mathrm{~V}, \mathrm{~V}_{\mathrm{DS}}=0$, | $\mathrm{T}_{\mathrm{A}}=125^{\circ} \mathrm{C}$ |  | 100 |  |
| *GSSR | Reverse Gate-Terminal Current | $\mathrm{V}_{\mathrm{GS}}=-35 \mathrm{~V}, \mathrm{~V}_{\mathrm{DS}}=0$ |  |  | -10 | PA |
| *IDSS | Zero-Gate-Voltage Drain Current | $\mathrm{V}_{\mathrm{DS}}=10 \mathrm{~V}, \mathrm{~V}_{\mathrm{GS}}=0$ |  |  | 10 | nA |
|  |  | $\mathrm{V}_{\mathrm{DS}}=10 \mathrm{~V}, \mathrm{~V}_{\mathrm{GS}}=0$, | $\mathrm{T}_{\mathrm{A}}=125^{\circ} \mathrm{C}$ |  | 1 | $\mu \mathrm{A}$ |
| ${ }^{*} \mathrm{~V}_{\mathrm{GS}}(\mathrm{th})$ | Gate Source Threshold Voltage | $\mathrm{V}_{\mathrm{DS}}=10 \mathrm{~V}, \mathrm{ID}^{\text {d }}=10 \mu \mathrm{~A}$ | 3N169 | 0.5 | 1.5 | $v$ |
|  |  |  | 3N170 | 1 | 2 |  |
|  |  |  | 3N171 | 1.5 | 3 |  |
| *ID(on) | On-State Drain Current | $\mathrm{V}_{\mathrm{DS}}=10 \mathrm{~V}, \mathrm{~V}_{\mathrm{GS}}=10 \mathrm{~V}$, | See Note 4 | 10 |  | mA |
| ${ }^{-}$VDS(on) | Drain-Source On-State Voltage | $\mathrm{V}_{G S}=10 \mathrm{~V}, \mathrm{I}_{\mathrm{D}}=10 \mathrm{~mA}$ |  |  | 2 | V |
| *ras(on) | Small-Signai Drain-Source On-State Resistance | $\mathrm{V}_{\mathrm{GS}}=10 \mathrm{~V}, \mathrm{I}^{\text {d }}=0$. | $\mathrm{f}=1 \mathrm{kHz}$ |  | 200 | $\Omega$ |
| \| ffs | | Small-Signal Common-Source Forward Transfer Admitrance | $\mathrm{V}_{\mathrm{DS}}=10 \mathrm{~V}, \mathrm{I}^{\prime}=2 \mathrm{~mA}$, | $\mathrm{f}=1 \mathrm{kHz}$ | 1 |  | mmho |
| ${ }^{*} \mathrm{C}_{\text {iss }}$ | Common-Source Short-Circuit Input Capacitance | $V_{\text {DS }}=10 \mathrm{~V}, \mathrm{~V}_{\mathrm{GS}}=0$, | $\mathrm{f}=\mathbf{1} \mathrm{MHz}$ |  | 5 | pF |
| ${ }^{*} \mathrm{C}_{\text {rss }}$ | Common-Source Short-Circuit Reverse Transfer Capacitance | $V_{\text {OS }}=0, \quad V_{\text {GS }}=0$, | $f=1 \mathrm{MHz}$ |  | 1.3 | of |
| ${ }^{*} \mathrm{C}_{\text {ds }}$ | Drain-Source Capacitance | $\begin{aligned} & \mathrm{V}_{\mathrm{DS}}=10 \mathrm{~V} . \quad \mathrm{V}_{\mathrm{GS}}=0, \\ & \text { See Note } 5 \end{aligned}$ | $f=1 \mathrm{MHz},$ |  | 5 | pF |

NOTES: 4. This parameter must be measured using pulse techniques. $t_{w}=300 \mu \mathrm{~s}$, duty cycle $\leqslant 2 \%$.
5. $\mathrm{C}_{\text {ds }}$ measurement employs a three-terminal capacitance bridge incorporating a guard circuit. The gate and the case are connected to the guard terminal of the bridge.
*switching characteristics at $\mathbf{2 5}^{\circ} \mathrm{C}$ free-air temperature

| PARAMETER |  | TEST CONDITIONS ${ }^{\text { }}$ |  | MAX | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: |
| tod(on) | Turn-On Delay Time | $\begin{array}{ll} V_{D D}=10 \mathrm{~V}, & I_{D(o n)}=10 \mathrm{~mA}, \\ V_{G S(\text { on })}=10 \mathrm{~V}, & V_{G S(\text { off })}=0, \end{array}$ <br> See Figure 1 |  | 3 | ns |
| ${ }_{T}$ | Rise Time |  |  | 10 | ns |
| $\mathrm{t}_{\mathrm{d}}$ (off) | Turn-Off Delay Time |  |  | 3 | ns |
| $\mathrm{t}_{4}$ | Fall Time |  |  | 15 | ns |

${ }^{\dagger}$ All measurements are made with the case and substrate connected to the source.

- JEDEC registored data


## PARAMETER MEASUREMENT INFORMATION



TEST CIRCUAT

NOTES: a. The input waveform is supplied by a generator with the following characteristics: $Z_{\text {out }}=\mathbf{5 0} \Omega$, duty cycle $\leq 1 \%, t_{r} \leqslant 0.33 \mathrm{~ns}$, $\mathrm{t}_{\mathrm{f}} \leqslant 0.33 \mathrm{~ns}, \mathrm{t}_{\mathrm{w}} \approx 0.4 \mu \mathrm{~s}$.
b. Waveforms are monitored on an oscilloscope with the following characteristics: $\mathrm{t}_{\mathrm{r}} \leqslant 0.4 \mathrm{~ns}, \mathrm{R}_{\mathrm{in}}=50 \Omega, \mathrm{c}_{\mathrm{in}} \leqslant 2 \mathrm{pF}$.

FIGURE 1

# ENHANCEMENT-TYPE ${ }^{\dagger}$ MOS SILICON TRANSISTOR 

For Applications Requiring Very High Input Impedance, Such as<br>Series and Shunt Choppers, Multiplexers, and Commutators

- Channel Cut Off with Zero Gate Voltage
- Square-Law Transfer Characteristic Reduces Distortion
- Independent Substrate Connection Provides Flexibility in Biasing
- Similar to 2N4065
*mechanical data



## handling precautions

Curve-tracer testing and static-charge buildup are common causes of damage to insulated-gate devices. Permanent damage may result if either gate-voltage rating is exceeded even for extremely short time periods. Each transistor is protected during shipment by a gate-shorting device which should be removed only during testing and after permanent mounting of the transistor. Personnel and equipment, including soldering irons, should be grounded.
absolute maximum ratings at $\mathbf{2 5}{ }^{\circ} \mathbf{C}$ free-air temperature (unless otherwise noted)

> *Drain-Gate Voltage
> *Drain-Source Voltage (See Note 1) -30 V
> Source-Drain Voltage (See Note 1) -30 V
> *Forward Gate-Source Voltage -30 V
> *Reverse Gate-Source Voltage . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 30 V
> Gate-Substrate Voltage . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . -30 V
> *Continuous Drain Current . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . - 20 mA
> *Continuous Device Dissipation at (or below) $25^{\circ} \mathrm{C}$ Free-Air Temperature (See Note 2) . . . . . . . 360 mW
> *Storage Temperature Range $-65^{\circ} \mathrm{C}$ to $200^{\circ} \mathrm{C}$
> *Lead Temperature 1/16 Inch from Case for 10 Seconds $300^{\circ} \mathrm{C}$

NOTES: 1. These voltage ratings apply whon the substrate is at the same potential as the least-negative element.
2. Derate linearly to $175^{\circ} \mathrm{C}$ free-air temperature at the rate of $2.4 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$.

* JEDEC registered data
$\dagger$ Enhancement-mode operation entails the use of a forward gate-source voltage to increase drain current from Ioss, the drain current at $V_{G S}=0$, as opposed to depletion-mode operation whergin a reverse gate-source voltage is used to decrease drain current. An enhancement-type transistor is in the "off" state at $V_{G S}=0$ end hence will not operate normally in the depletion mode.

USES CHIP MP93

## TYPE 3N174 P-CHANNEL ENHANCEMENT-TYPE INSULATED-GATE FIELD-EFFECT TRANSISTOR

## *electrical characteristics at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

|  | PARAMETER | TEST CONDITIONS ${ }^{\text {t }}$ |  | MIN | MAX | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| ${ }^{\text {' GSSF }}$ | Forward Gate-Terminal Current | $\mathrm{V}_{\mathbf{G S}}=-30 \mathrm{~V}$. | $V_{D S}=0$ |  | -2.5 | pA |
|  |  | $\begin{aligned} & V_{G S}=-30 \mathrm{~V}, \\ & T_{A}=150^{\circ} \mathrm{C} \end{aligned}$ | $V_{\text {DS }}=0$, |  | -100 | nA |
| IGSSR | Reverse Gate-Terminal Current | $V_{\text {GS }}=30 \mathrm{~V}$, | $V_{\text {DS }}=0$ |  | 2.5 | pA |
| IDSS | Zero-Gate-Voltage Drain Current | $V_{\text {DS }}=-30 \mathrm{~V}$, | $V_{G S}=0$ |  | -5 | nA |
|  |  | $\begin{aligned} & V_{D S}=-30 \mathrm{~V}, \\ & T_{A}=150^{\circ} \mathrm{C} \end{aligned}$ | $V_{G S}=0$, |  | -5 | $\mu \mathrm{A}$ |
| IsDS | Zero-Gate-Voltage Source Current | $V_{S D}=-30 \mathrm{~V}$, | $\mathrm{V}_{\mathrm{GD}}=0,$ <br> See Note 3 |  | -5 | nA |
| VGS(th) | Gate Source Threshold Voltage | $\mathrm{V}_{\text {DS }}=-15 \mathrm{~V}$ | $\mathrm{ID}^{\text {a }}$ - $10 \mu \mathrm{~A}$ | -2 | -6 | V |
| ${ }^{1}$ D(on) | On-State Drain Current | $\mathrm{V}_{\text {DS }}=-15 \mathrm{~V}$, | $V_{G S}=-15 V$ <br> See Note 4 | $-3$ | -12 | mA |
| VDS(on) | Drain-Source On-State Voltage | $V_{G S}=-15 \mathrm{~V}$. | $\mathrm{I}_{\mathrm{D}}=-1 \mathrm{~mA}$ |  | -1 | V |
| $r^{\text {ds }}$ (on) | Small-Signal Drain-Source On-State Resistance | $\begin{aligned} & V_{G S}=-15 \mathrm{~V} \\ & f=1 \mathrm{kHz} \end{aligned}$ | $I_{D}=0$, |  | 1 | $k \Omega$ |
| $\mid \mathrm{y} \mathrm{fs}^{\text {\| }}$ | Small-Signal Common-Source Forward Transfer Admittance | $\begin{aligned} & V_{D S}=-15 \mathrm{~V} \\ & f=1 \mathrm{kHz} \end{aligned}$ | $V_{G S}=-15 \mathrm{~V}$ <br> See Note 5 | 400 |  | $\mu \mathrm{mho}$ |
| \|ros ${ }^{\text {\| }}$ | Small-Signal Common-Source Output Admittance |  |  |  | 200 | $\mu \mathrm{mho}$ |
| $\mathrm{C}_{\text {iss }}$ | Common-Source Short-Circuit Input Capacitance | $\begin{aligned} & V_{D S}=-15 \mathrm{~V}, \\ & f=1 \mathrm{MHz}, \end{aligned}$ | $V_{G S}=-15 \mathrm{~V} .$ <br> See Note 5 |  | 4 | pF |
| Crss | Common-Source Short-Circuit Reverse Transfer Capacitance | $\begin{aligned} & V_{D S}=0 . \\ & f=1 \mathrm{MHz} \end{aligned}$ | $V_{G S}=0$, |  | 0.7 | pF |
| $\mathrm{C}_{\text {ds }}$ | Drain-Source Capacitance | $\begin{aligned} & V_{D S}=-15 \mathrm{~V}, \\ & f=1 \mathrm{MHz}, \end{aligned}$ | $V_{G S}=0$ <br> See Note 6 |  | 3 | pF |

*switching characteristics at $\mathbf{2 5}{ }^{\circ} \mathrm{C}$ free-air temperature

| PARAMETER |  | TEST CONDITIONS ${ }^{\text {+ }}$ |  | MAX | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: |
| $t_{\text {d }}$ (on) | Turn-On Delay Time | $\begin{array}{ll} V_{D D}=-10 \mathrm{~V}, & I_{D(o n)}=-1 m A \\ V_{G S}(o n)=-15 \mathrm{~V}, & V_{G S(o f f)}=0, \\ R_{G}=50 \Omega, & \text { See Figure } 1 \end{array}$ |  | 30 | ns |
| $t_{r}$ | Rise Time |  |  | 50 | ns |
| $\mathrm{t}_{\text {d }}$ (off $\}$ | Turn-Off Delay Time |  |  | 15 | ns |
| $\mathrm{t}_{\mathrm{f}}$ | Fall Time |  |  | 100 | ns |

NOTES: 3. For the measurement of ISDS, the substrate must be connected to the drain.
4. This parameter must be measurad using puise techniques. $t_{p} \approx 100 \mathrm{~ms}$, duty cycle $\leqslant 10 \%$.
6. These parameters must be measured with bias conditions applied for less than 5 seconds to avoid overheating.
6. Cds measurement employs a three-terminal capacitance bridge incorporating a guard circuit. The gate and case are connected to the guard terminal of the bridge.
${ }^{t}$ All measurements exchpt ISDS are made with the case and substrate connected to the source.

## PARAMETER MEASUREMENT INFORMATION



TEST CIRCUIT


VOLTAGE WAVEFORMS

FIGURE 1
NOTES: a. The input waveform is supplied by a genergtor with the following characteristics: $\mathbf{Z}_{\text {out }}=\mathbf{5 0} \Omega$, duty cycle $\approx \mathbf{2 \%}, \mathrm{t}_{\mathrm{r}} \leqslant \mathbf{1} \mathbf{n s}$
$t_{f} \leqslant 1 \mathrm{~ns}, t_{p}=200 \mathrm{~ns}$.
b. Waveforms are monitored on an oscilloscope with the following characteristics: $t_{\mathrm{r}} \leq 0.75 \mathrm{~ns}, \mathrm{R}_{\mathrm{in}} \geq 1 \mathrm{M} \Omega, \mathrm{C}_{\mathrm{in}} \leqslant 2 \mathrm{pF}$.
*JEDEC registered data

## DEPLETION-TYPE MOS SILICON TRANSISTORS

- Monolithic Gate-Protection Diodes
- Low Crss . . . 0.03 pF Max
- High lyfsl . . . 12, $000 \mu \mathrm{mhos}$ Typ


## description

The 3N201, 3N202, and 3N203 are N-channel, depletion-type, dual-gate, metal-oxide-semiconductor transistors. They are protected from excessive input voltages by integrated back-to-back diodes between gates and source, thus eliminating precautionary handling procedures required by unprotected MOS transistors. These transistors are ideally suited for many applications which previously only vacuum tubes could fulfill.

The 3N201 is intended for use in VHF pre-amplifiers where linear, low-noise amplification is required. Its extremely low feedback capacitance permits high stable gain without the use of neutralization.

The 3N202 is intended for use as a VHF mixer and is well suited for TV tuners. Its use as a mixer minimizes cross-modulation distortion and provides low-noise operation.

The 3N203 is designed for application in tuned high-frequency amplifiers such as TV IF strips. Its extremely low feedback capacitance permits high stage gain and stability without the necessity for neutralization.
*mechanical data


## *absolute maximum ratings at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

Drain-Gate-One Voltage . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 30 V
Drain-Gate-Two Yoltage . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 30 V
Drain-Source Voltage . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 10 ma
Reverse Gate-One-Terminal Current . . . . . . . . . . . . . . . . . . . . . . . . . . . - 10 mA
Reverse Gate-Two-Terminal Current . . . . . . . . . . . . . . . . . . . . . . . . . . . -10 mA
Continuous Drain Current . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 50 mA
Continuous Device Dissipation at (or below) $\mathbf{2 5}^{\circ} \mathrm{C}$ Free-Air Temperature (See Note 2) . . . . . . . . . 360 mW
Continuous Device Dissipation at (or below) $\mathbf{2 5}{ }^{\circ} \mathrm{C}$ Case Temperature (See Note 3) . . . . . . . . . . . 1.2 W
Storage Temperature Range
$-65^{\circ} \mathrm{C}$ to $200^{\circ} \mathrm{C}$
Lead Temperature 1/16 Inch from Case for 10 Seconds $300^{\circ} \mathrm{C}$

NOTES: 1. Forward gate-terminal current is the current into a gate terminal with a forward gatesource voltage applied. This voltage is of such polarity that an increase in its magnitude causes the channel resletance to decrease.
2. Derate linearly to $175^{\circ} \mathrm{C}$ free-air temperature at the rate of $\mathbf{2 . 4} \mathrm{mW} / \mathrm{P} \mathrm{C}$.
3. Derate linearly to $175^{\circ} \mathrm{C}$ case temperature at the rate of $8 \mathrm{~mW} / \mathrm{C}$.
*JEDEC registered data. This data sheet contalns all applicable registered data in effect at the time of publication.
USES CHIP MN81

## TYPES 3N201, 3N202, 3N203

N-CHANNEL DUAL-GATE DEPLETION-TYPE INSULATED-GATE FIELD-EFFECT TRANSISTORS
"electrical characteristics at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

| PARAMETER |  | TEST CONDITIONS |  |  | MIN | MAX | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| $V_{\text {(BR) }}$ | Drain-Source Breakdown Voltage | $1 D^{\prime}=10 \mu A$, | $\mathrm{V}_{\mathrm{G1S}}=\mathrm{V}_{\text {G2S }}=-5 \mathrm{~V}$ |  | 25 |  | $V$ |
| $V_{\text {(BR) }}$ (18SF | Gate-Ono-Source Forwerd Breakdown Voltage | l $\mathrm{G}_{1}=10 \mathrm{~mA}$, | $\mathrm{V}_{\mathrm{G} 2 \mathrm{~S}}=\mathrm{V}_{\mathrm{DS}}=0$. | See Note 4 | 6 | 30 | $V$ |
| V(BR)G1SSR | Gate-One-Source Roverse Breakdown Voltage | IG1 $=-10 \mathrm{~mA}$, | $V_{\text {G2S }}=V_{\text {DS }}=0$, | Soe Note 4 | -6 | -30 | V |
| $V_{\text {(BR) }}$ (2ssf | Gate-Two-Source Forward Breakdown Voltage | IG2 $=10 \mathrm{~mA}$, | $V_{G 1 S}=V_{D S}=0$, | See Note 4 | 6 | 30 | $V$ |
| $V_{\text {(BR)G2SSR }}$ | Gate-Two-Source Reverse Breakdown Voltage | $1 \mathrm{I}_{2}=\mathbf{- 1 0} \mathrm{mA}$, | $V_{G 1 S}=V_{D S}=0$, | See Note 4 | -8 | -30 | $v$ |
| lG1ssf | Gate-One-Terminal Forward Current | $\mathrm{V}_{\mathrm{G} 18}=6 \mathrm{~V}$, | $V_{G 2 S}=V_{D S}=0$ |  |  | 10 | nA |
| IG158R | Gate-Ong-Terminal Reverse Current | $\mathrm{V}_{\mathrm{G} 1 \mathrm{~S}}=-5 \mathrm{~V}$, | $V_{G 2 S}=V_{\text {OS }}=0$ |  |  | -10 | nA |
|  |  |  | $\mathrm{V}_{\mathrm{G} 2 \mathrm{~S}}=\mathrm{V}_{\mathrm{DS}}=0$, | $T^{\prime}=150^{\circ} \mathrm{C}$ |  | -10 | $\mu \mathrm{A}$ |
| IG2SSF | Gat-Two-Terminal Forward Current | $V_{G 2 S}=5 \mathrm{~V}$, | $V_{G 1 S}=V_{D S}=0$ |  |  | 10 | nA |
| IG2SSR | Gate-Two-Terminal <br> Reverse Current | $\mathrm{V}_{\mathrm{G} 2 \mathrm{~S}}=-5 \mathrm{~V}$, | $V_{G 1 S}=V_{D S}=0$ |  |  | -10 | nA |
|  |  | $\mathrm{V}_{\text {G2S }}=-5 \mathrm{~V}$, | $\mathrm{V}_{\mathrm{G1S}}=\mathrm{V}_{\text {DS }}=0$, | $\mathrm{T}_{\mathrm{A}}=150^{\circ} \mathrm{C}$ |  | -10 | $\mu \mathrm{A}$ |
| IDS | Zero-Gate-One-Voltage Drain Current | $\begin{aligned} & V_{D S}=15 \mathrm{~V}, \\ & V_{G 2 S}=4 \mathrm{~V}, \end{aligned}$ | $V_{G 1 s}=0$ <br> See Note 5 | $\begin{aligned} & 3 N 201 \\ & \text { 3N202 } \\ & \hline \end{aligned}$ | 6 | 30 | mA |
|  |  |  |  | 3N203 | 3 | 15 |  |
| $V_{\text {G1S }}$ (off) | Gate-One-Source Curoff Voltage | $V_{D S}=15 \mathrm{~V}$, | $\mathrm{V}_{\mathrm{G} 2 \mathrm{~S}}=4 \mathrm{~V}$, | ${ }^{\prime} \mathrm{D}=20 \mu \mathrm{~A}$ | -0.5 | -5 | V |
| $V_{\text {G2S }}$ (off) | Gate-Two-Source Cutoff Voltage | $V_{\text {DS }}=15 \mathrm{~V}$, | $\mathrm{VGiS}^{\text {a }}=0$, | $I_{\text {d }}=20 \mu \mathrm{~A}$ | -0.2 | -б | $v$ |
| Nfs ${ }^{\text {l }}$ | Small-Signal Common-Source <br> Forward Transfer Admittance | $\begin{aligned} & V_{D S}=15 \mathrm{~V}, \\ & V_{G 2 S}=4 \mathrm{~V} \end{aligned}$ | $\begin{aligned} & V_{G 1 S}=0, \\ & f=1 \mathrm{kHz}, \end{aligned}$ | $\begin{aligned} & \text { 3N201 } \\ & \text { 3N202 } \end{aligned}$ | 8 | 20 | mmho |
|  |  | See Note 6 |  | 3N203 | 7 | 15 |  |
| Crss | Common-Source Short-Circuit Reverse Transfer Capacitance | $\begin{aligned} & V_{D S}=15 \mathrm{~V}, \\ & \mathrm{f}=1 \mathrm{MHz} \end{aligned}$ | $V_{G 2 S}=4 V,$ | $1 \mathrm{D}=10 \mathrm{~mA}$, | 0.005 | 0.03 | pF |

NOTES: 4. All gate breakdown voltages are measured while the device is conducting rated gate current. This ensures that the gate-voltage-limiting network is functioning properly.
5. This parameter must be measured using pulse techniques. $\mathbf{t}_{\mathbf{w}}=\mathbf{3 0 0} \mu \mathrm{s}$, duty cycle $\leqslant \mathbf{2 \%}$.
6. This parameter must be measured with bias voltages applied for less than 5 seconds to avold overheating.
*3N201 operating characteristics at $25^{\circ} \mathrm{C}$ free-air temperature

| PARAMETER |  | TEST CONDITIONS |  | 3N201 |  | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | MIN | MAX |  |
| NF | Common-Source Spot Noise Figure |  |  | $\begin{aligned} & V_{D O}=18 \mathrm{~V}, \\ & f=200 \mathrm{MHz} \end{aligned}$ | $\mathrm{V}_{\mathrm{GG}}=7 \mathrm{~V}$, See Figure 1 |  | 4.5 | dB |
| $\mathrm{G}_{\mathrm{ps}}$ | Small-Signal Common-Source Insertion Power Gain | 15 | 25 |  |  | dB |
| BW | Bandwidth | 5 | 9 |  |  | MHz |
| $V_{G G}(\mathrm{GC})$ | Gain-Control Gate-Supply Voltage | $\begin{aligned} & V_{D D}=18 \mathrm{~V}, \\ & f=200 \mathrm{MHz}, \end{aligned}$ | $\begin{aligned} & \Delta G_{\mathrm{ps}}=-30 \mathrm{~dB}^{\dagger}, \\ & \text { Se日 Figure } 1 \end{aligned}$ | 0 | -3 | $v$ |

[^112]
## TYPES 3N2O1, 3N202, 3N203 <br> N-CHANNEL DUAL-GATE DEPLETION-TYPE INSULATED-GATE FIELD-EFFECT TRANSISTORS

*3N202 operating characteristics at $25^{\circ} \mathrm{C}$ free-air temperature

| PARAMETER |  | TEST CONDITIONS |  | 3N202 |  | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | MIN | MAX |  |
| $Q_{\text {ppiconv) }}$ | Smail-Signal Converaion Power Galn |  |  | $\begin{aligned} & V_{D D}=18 \mathrm{~V}, \\ & \text { f }_{2}=200 \mathrm{MHz}, \end{aligned}$ | $\text { fLO }=24 \mathrm{BHz} \ddagger$ <br> See Figure 2 | 15 | 25 | dB |
| BW | Bandwidth | 4.5 | 7.5 |  |  | MHz |

\$Amplitude at input from locel ovelliator is 3 volte rme.
" 3 N203 operating characteristics at $\mathbf{2 5}{ }^{\circ} \mathrm{C}$ free-air temperature

| PARAMETER |  | TEST CONDITIONS |  | 3N203 |  | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | MIN | MAX |  |
| NF | Common-Source Spot Nobe Figure |  |  | $\begin{aligned} & V_{D D}=18 \mathrm{~V}, \\ & f=45 \mathrm{MHz}, \end{aligned}$ | $v_{G G}=6 v$ <br> See Figure 3 |  | 6 | dB |
| $G_{p t}$ | Smail-shanal Common-Source Insertion Power Gain | 20 | 30 |  |  | dB |
| BW | Bandwidth | 3 | 6 |  |  | MHz |
| Vgalse) | Gain-Control Gete-Supply Voltage | $\begin{aligned} & V_{D D}=18 \mathrm{~V}, \\ & \mathrm{f}=45 \mathrm{MHz}, \end{aligned}$ | $\Delta G_{p t}=-30 d B 8 \text {, }$ $\text { See Figure } 3$ | 0 | -3 | V |

$8 \Delta G_{p ;}$ is defined as the change $\ln G_{p s}$ from the value at $V_{G G}=\mathbf{6}$ volta.

## *PARAMETER MEASUREMENT INFORMATION



FIGURE 1-200MHz POWER GAIN, GAIN-CONTROL VOLTAGE, AND NOISE FIGURE TEST CIRCUIT FOR 3N201

[^113]
# TYPES 3N201, 3N202, 3N203 <br> N-CHANNEL DUAL INSULATED-GATE PLANAR SILICON FIELD-EFFECT TRANSISTORS 



FIGURE 2-200-MHz-to-45-MHz CIRCUIT FOR CONVERSION POWER GAIN FOR 3N202


L1: $14 \mathrm{~T}, \# 30$ copper, close-wound on 7/32" OD form with Arnold Engineering type " J " tuning core
L2: $10 \mathrm{~T}, \# 30$ copper, close-wound on $7 / 32$ " OD form with Arnold Engineering type " J " tuning core
FIGURE 3-45-MHz POWER GAIN, GAIN-CONTROL VOLTAGE, AND NOISE FIGURE TEST CIRCUIT FOR 3N203

[^114]
# TYPES 3N201, 3N202, 3N203 N-CHANNEL DUAL INSULATED-GATE PLANAR SILICON FIELD-EFFECT TRANSISTORS 

TYPICAL CHARACTERISTICS AT TA $\mathbf{= 2 5} \mathbf{5}^{\circ} \mathrm{C}$

3N201
RELATIVE SMALLSIGNAL
POWER-GAIN
vs
GAIN-CONTROL GATE-SUPPLY VOLTAGE


FIGURE 4

## 3N201

SMALLSIGNAL COMMON-SOURCE INSERTION POWER GAIN
vs
DRAIN CURRENT


FIGURE 5

3N201
COMMON-SOURCE SPOT NOISE FIGURE vs GAIN-CONTROL GATE-SUPPLY VOLTAGE


FIGURE 6

3N202
SMALL.SIGNAL CONVERSION POWER GAIN vs INPUT FROM LOCAL OSCILLATOR


FIGURE 7

3N203
SMALL-SIGNAL COMMON-SOURCE INSERTION POWER GAIN vs GAIN-CONTROL SUPPLY VOLTAGE


FIGURE 8

TYPES 3N204, 3N205, 3N206
N-CHANNEL DUAL-GATE DEPLETION-TYPE INSULATED-GATE FIELD-EFFECT TRANSISTORS

## DEPLETION-TYPE MOS SILICON TRANSISTORS

- Monolithic Gate-Protection Diodes
- Low Crss . . . 0.03 pF Max
- High lyfs! . . . 14,000 $\mu$ mhos Typ

The 3N204, 3N205, and 3N206 are N-channel, depletion-type, dual-gate, metal-oxide-semiconductor transistors. They are protected from excessive input voltages by integrated back-to-back diodes between gates and source, thus eliminating precautionary handling procedures required by unprotected MOS transistors. These transistors are ideally suited for many applications which previously only vacuum tubes could fulfill.

The 3N204 is intended for use in VHF pre-amplifiers where linear, low-noise amplification is required. Its extremely low feedback capacitance permits high stable gain without the use of neutralization.

The 3N205 is intended for use as a VHF mixer and is well suited for TV tuners. Its use as a mixer minimizes cross-modulation distortion and provides low-noise operation.

The 3N206 is designed for application in tuned high-frequency amplifiers such as TV IF strips. Its extremely low feedback capacitance permits high stage gain and stability without the necessity for neutralization.
*mechanical data

*absolute maximum ratings at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

> such polarity that an increase in its magnitude causes the channel resistan
> 2. Derate linearly to $175^{\circ} \mathrm{C}$ free-air temperature at the rate of $2.4 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$
> 3. Derate linearly to $175^{\circ} \mathrm{C}$ case temperature at the rate of $8 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$.

## TYPES 3N204, 3N205, 3N206 N-CHANNEL DUAL-GATE DEPLETION-TYPE INSULATED-GATE FIELD-EFFECT TRANSISTORS

*electrical characteristics at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

| PARAMETER |  | TEST CONDITIONS |  |  | MIN MAX |  | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| $V_{\text {(BR) }}$ DS | Drain-Source Breakdown Voltage | $I_{D}=10 \mu \mathrm{~A}$, | $\mathrm{V}_{\mathrm{G} 1 \mathrm{~S}}=\mathrm{V}_{\mathrm{G} 2 \mathrm{~S}}=-5 \mathrm{~V}$ |  |  |  | V |
| $V_{(B R) G 1 S S F}$ | Gate-One-Source Forward Breakdown Voltage | $\mathbf{I}_{\mathbf{G 1}}=10 \mathrm{~mA}$, | $V_{G 2 S}=V_{\text {DS }}=0$, | See Note 4 | 6 | 30 | $v$ |
| V(BR)G1SSR | Gate-One-Source Reverse Breakdown Voltage | $\mathbf{I}_{\mathbf{G} 1}=\mathbf{- 1 0} \mathbf{m A}$, | $\mathbf{V G R S}^{\text {( }}=\mathrm{V}_{\text {DS }}=0$, | See Note 4 | -6 | -30 | V |
| $V_{\text {(BR) }}$ G2SSF | Gate-Two-Source Forward Breakdown Voltage | $\mathrm{I}_{\mathrm{G} 2}=10 \mathrm{~mA}$. | $\mathbf{V G 1 S}^{\text {( }}=\mathbf{V}_{\mathbf{D S}}=0$, | See Note 4 | 6 | 30 | V |
| V(BR)G2SSR | Gate-Two-Source Reverse <br> Breakdown Voltage | $\mathbf{I G 2}^{\text {a }}=-10 \mathrm{~mA}$, | $V_{G 1 S}=V_{D S}=0$, | See Note 4 | -6 | -30 | V |
| IG1SSF. | Gate-One-Terminal Forward Current | $\mathrm{V}_{\mathrm{G1}} \mathrm{~S}^{\prime}=5 \mathrm{~V}$, | $V_{G 2 S}=V_{D S}=0$ |  |  | 10 | nA |
| IGISSR | Gate-One-Terminal Reverse Current | $\mathrm{V}_{\mathrm{G1S}}=-5 \mathrm{~V}$, | $V_{\text {G2S }}=V_{\text {DS }}=0$ |  |  | -10 | nA |
|  |  | $\mathrm{V}_{\mathrm{G} 1 \mathrm{~S}}=-5 \mathrm{~V}$, | $V_{\text {G2S }}=V_{\text {DS }}=0$, | $\mathrm{T}_{A}=150^{\circ} \mathrm{C}$ |  | -10 | $\mu \mathrm{A}$ |
| 'G2SSF | Gate-Two-Terminal Forward Cursent | $\mathrm{V}_{\mathbf{G 2 S}}=5 \mathrm{~V}$, | $V_{G 1 S}=V_{\text {DS }}=0$ |  |  | 10 | nA |
| IG2SSR | Gate-Two-Terminal Reverse Current | $\mathrm{V}_{\mathrm{G} 2 \mathrm{~S}}=-5 \mathrm{~V}$, | $V_{\text {G1S }}=V_{\text {DS }}=0$ |  |  | -10 | nA |
|  |  | $\mathrm{V}_{\text {G2S }}=-5 \mathrm{~V}$, | $V_{G 1 S}=V_{\text {DS }}=0$, | $\mathrm{T}_{\mathrm{A}}=150^{\circ} \mathrm{C}$ |  | -10 | $\mu \mathrm{A}$ |
| IDS | Zero-Gate-One-Voltage <br> Drain Current | $\begin{aligned} & V_{D S}=15 \mathrm{~V}, \\ & V_{G 2 S}=4 \mathrm{~V} . \end{aligned}$ | $V_{G 1 S}=0,$ <br> See Note 5 | $\begin{aligned} & \text { 3N204 } \\ & \text { 3N205 } \end{aligned}$ | 6 | 30 | mA |
|  |  |  |  | 3N206 | 3 | 15 |  |
| VG1S(off) | Gate-One-Source Cutoff Voltage | $V_{D S}=15 \mathrm{~V}$, | $V_{G 2 S}=4 \mathrm{~V}$. | $I_{D}=20 \mu \mathrm{~A}$ | -0.5 | -4 | V |
| $V_{G 2 S}$ (off) | Gate-Two-Source Cutoff Voltage | $\mathrm{V}_{\mathrm{DS}}=15 \mathrm{~V}$, | $V_{G 15}=0$, | $I_{D}=20 \mu A$ | -0.2 | -4 | V |
| \| Fs | | Small-Signal Common-Source Forward Transfer Admittance | $\begin{aligned} & V_{D S}=15 \mathrm{~V}, \\ & V_{G 2 S}=4 \mathrm{~V} \end{aligned}$ | $\begin{aligned} & V_{G 1 S}=0, \\ & f=1 \mathrm{kHz} . \end{aligned}$ | $\begin{aligned} & \text { 3N2O4 } \\ & \text { 3N205 } \end{aligned}$ | 10 | 22 | mmho |
|  |  |  |  | 3N206 | 7 | 17 |  |
| Crss | Common-Source Short-Circuit Reverse Transfer Capacitance | $\begin{aligned} & V_{D S}=15 \mathrm{~V}, \\ & f=1 \mathrm{MHz} \end{aligned}$ | $V_{\text {G2S }}=4 \mathrm{~V}$, | $l \mathrm{D}=10 \mathrm{~mA}$, | 0.005 | 0.03 | pF |

NOTES: 4. All gate breakdown voltages are measured while the device is conducting rated gate current. This ensures that the gate-voltage-limiting network is functioning properly.
5. This parameter must be measured using pulse techniques. $t_{w}=300 \mu$, duty cycle $\leqslant 2 \%$.
6. This parameter must be measured with bias voltages applied for less than 5 seconds to avoid overheating
"3N204 operating characteristics at $\mathbf{2 5}^{\circ} \mathrm{C}$ free-air temperature

| PARAMETER | TEST CONDITIONS |  | 3N204 |  | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  | MIN | TYP MAX |  |
| F Common-Source Spot Noise Figure | $\begin{aligned} & V_{D D}=18 \mathrm{~V} \\ & f=200 \mathrm{MHz} \end{aligned}$ | $V_{G G}=7 \mathrm{~V} .$ <br> See Figure 1 |  | 3.5 | dB |
| $\mathrm{G}_{\mathrm{ps}} \quad$ Small-Signal Common-Source Insertion Power Gain |  |  | 20 | 28 | dB |
| B Bandwidth |  |  | 7 | 12 | MHz |
| VGG(GC) Gain-Control Gate-Supply Voltage | $\begin{array}{ll} V_{\mathrm{DD}}=18 \mathrm{~V}, & \Delta \mathrm{G}_{\mathrm{ps}}=-30 \mathrm{~dB}^{\dagger}, \\ \mathrm{f}=200 \mathrm{MHz}, & \text { See Figure } 1 \\ \hline \end{array}$ |  | 0 | -2 | V |
| F Common-Source Spot Noise Figure | $\begin{aligned} & V_{D S}=15 \mathrm{~V}, \quad V_{G 2 S}=4 \mathrm{~V}, \\ & I_{D}=10 \mathrm{~mA}, \quad f=450 \mathrm{MHz}, \\ & \text { See Figures } 2 \text { and } 4 \end{aligned}$ |  |  | 5 | dB |
| $\mathbf{G}_{\mathbf{p s}} \quad$ Small-Signal Common-Source Insertion Power Gain |  |  | 14 |  | dB |
| F Common-Source Spot Naise Figure | $\begin{array}{ll} \hline V_{D S}=15 \mathrm{~V}, & V_{G 2 S} \approx 4 \mathrm{~V}, \\ I_{D}=10 \mathrm{~mA}, & f=900 \mathrm{MHz}, \\ \text { See Figures } 3 \text { and } 5 \\ \hline \end{array}$ |  |  | 7 | d8 |
| $\mathbf{G}_{\mathbf{p s}} \quad$ Small-Signal Common-Source Insertion Power Gain |  |  |  | 12 | dB |

${ }^{\dagger} \Delta G_{p s}$ is defined as the change in $G_{p s}$ from the value at $V_{G G}=7$ volts.

- JEDEC registared data


## TYPES 3N204, 3N205, 3N206 N-CHANNEL DUAL-GATE DEPLETION-TYPE INSULATED-GATE FIELD-EFFECT TRANSISTORS

*3N205 operating characteristics at $25^{\circ} \mathrm{C}$ free-air temperature

| PARAMETER | TEST CONDITIONS | 3N206 |  | UNIT |
| :---: | :---: | :---: | :---: | :---: |
|  |  | MIN | MAX |  |
| $\mathrm{G}_{\mathrm{ps}(\mathrm{conv})}$ Small-Signal Conversion Power Gain | $\begin{array}{ll} V_{D D}=18 \mathrm{~V}, & f \text { fo }=245 \mathrm{MHz} \ddagger, \\ f_{R F}=200 \mathrm{MHz}, & \text { See Figure } 6 \end{array}$ | 17 | 28 | dB |
| B Bandwidth |  | 4 | 7 | MHz |

母Amplitude at input from local oscillator is $\mathbf{3}$ volts rms.
*3N206 operating characteristics at $25^{\circ} \mathrm{C}$ free-air temperature

| PARAMETER |  | TEST CONDITIONS |  | 3N206 |  | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | MIN | MAX |  |
| F | Common-Source Spot Noise Figure |  |  | $\begin{aligned} & V D D=24 \mathrm{~V} \\ & \mathrm{f}=45 \mathrm{MHz} \end{aligned}$ | $V_{G G}=6 \mathrm{~V},$ <br> See Figure 7 |  | 4 | dB |
| $\mathrm{G}_{\mathrm{ps}}$ | Small-Signal Common-Source Insertion Power Gain | 25 | 35 |  |  | dB |
| B | Bandwidth | 3 | 6 |  |  | MHz |
| $V_{G G(G C)}$ | Gain-Control Gate-Supply Voltage | $\begin{aligned} & V_{D D}=24 \mathrm{~V}, \\ & \mathrm{f}=45 \mathrm{MHz}, \end{aligned}$ | $\Delta G_{p s}=-30 \mathrm{~dB} \S,$ <br> See Figure 7 |  | +0.6 -1.6 | V |

$\delta_{\mathbf{G}_{\mathbf{p s}}}$ is defined as the ehange in $\mathbf{G}_{\mathbf{p s}}$ from the value at $V_{\mathbf{G G}}=\mathbf{6}$ volts.

## PARAMETER MEASUREMENT INFORMATION



CIRCUIT COMPONENT INFORMATION
$\mathrm{C} 1, \mathrm{C} 2$, \& C3: Leadiess disc ceramic, $0.001 \mu \mathrm{~F}$
C4: ARCO 462, 5-80 pF, or equivaient
L1: 3T \#18, 3/16-inch-dia aluminum slug
L2: 9T \#20, 3/16-inch-dia aluminum slug

FIGURE 1-200-MHz POWER GAIN, GAIN CONTROL VOLTAGE, AND NOISE FIGURE TEST CIRCUIT FOR 3N204*

[^115]
## TYPES 3N204, 3N205, 3N206 N-CHANNEL DUAL-GATE DEPLETION-TYPE INSULATED-GATE FIELD-EFFECT TRANSISTORS

PARAMETER MEASUREMENT INFORMATION

(ADJUST FOR $\mathrm{ID}=10 \mathrm{~mA}$ )
CIRCUIT COMPONENT INFORMATION
C1 thru C4: See Figure 30, Note D
C5: $0.001 \mu \mathrm{~F}$ leadless disc capacitor
C6 thru C10: Allen-Bradiey F5AU $0.001 \mu \mathrm{~F}$ feed-through capacitors
Li \& L.2: See Figure 30
FIGURE 2-4E0-MHz PONER GAIN AND NOISE TEST CIRCUIT FOR 3N204*


C2, C4, a C6: $0.001 \mu \mathrm{~F}$ leadiess disc cmpacitor
C3 \& C7: Johenson 3901, 1-15 pF, or equlvalent
L. \& L. 2 are $1 / 4$ inch slotted cyclinders, $3 / 16$ Inch Inside diameter, with a shorting ring adjusted by a nyion screw. Minimum slot lengths are $3 / 4$ inch for L1 and 1 Inch for L2.
RFC: 10 T \#30, $3 / 16$ inch dia, 5/16 inch in length
NOTE A: This terminal is provided for gain control, if desired. If not used for this purpose, it should be left open.
*JEDEC registered deta
FIGURE 3-900-MHz POWER GAIN AND NOISE TEST CIRCUIT FOR 3N204

NOTES:
A. All dimansions are in inches.
B. The removable top of test fixture is not shown.
C. For clarity, the 02 kn releletor, the source and getto-2 socket pins, and Inculating stand-off terminali (ISOT) coldered into the fold of L1 mind L2 respeetively for mechanion support, sre not shown in visw $A$.
D. C1 and C2 (C3 and CA) conalat of thim brate and the "C" portion of L1 (L2) eoperated by air and the mylier tape covering the "C" portion of L1 (L2).


NOTE:
E. The four views surrounding the center view are as they would appear before the matal is bent up to form the sides.


[^116]FIGURE 4-4EO-MHz POWER GAIN AND NOISE TEST FIXTURE*

NOTES:
A. All dimensions are in inctree.
B. The ramovable top of test fixture is not shown.
C. L1 and L2 are attuotved to the beok of the trett fixture by ingulating ormad-off terminals (ISOT) locoted mann.
D. The four viows surrounding the conter viow we met thoy would appeer betore the metal is bent up to form the aldes.


FIGURE 5-900-MHZ POWER GAIN AND NOISE TEST FIXTURE


CIRCUIT COMPONENT INFORMATION
C1: Areo 404 (or equivaient), 8 to 60 pF
C2: Arco 400 (or equivatent), 0.9 to 7 pF
FIGURE 6-200-MHz-to-4E-MHz CIRCUIT FOR CONVERSION POWER GAIN FOR 3N206*


CIRCUIT COMPONENT INFORMATION
C1: Leadless disc ceramic, $0.001 \mu \mathrm{~F}$
C2: Leadless disc ceramic, $0.01 \mu \mathrm{~F}$
L1: 8 T \# 28, 5/32-inch-dia form, type "J" slug
L2: 9T \# 28, 5/32-inch-dia form, type "J" slug
FIGURE 7-45-MHz POWER GAIN AND NOISE FIGURE TEST CIRCUIT FOR 3N206*

## TYPES 3N204, 3N205, 3N206 N-CHANNEL DUAL-GATE DEPLETION-TYPE INSULATED-GATE FIELD-EFFECT TRANSISTORS



NOTE 7: Test conditions at $45 \mathrm{MHz}, 200 \mathrm{MHz}, 450 \mathrm{MHz}$, and 900 MHz are the conditions given in the tables of operating characteristics for 3N204 and 3N206.

## TWO ENHANCEMENT-TYPE ${ }^{\text {M }}$ MOS SILICON TRANSISTORS WITHIN A SINGLE MONOLITHIC CHIP

For Applications Requiring Very High Input Impedance, Such as Series and Shunt Choppers, Multiplexers, and Commutators

- Designed to be Interchangeable with General Instrument Type MEM551
- Channel Cut Off with Zero Gate Voltage
- Substrate Connection Provides Flexibility in Biasing
- Similar Diode-Protected Version Available . . . 3N208
- Matched on VGS
*mechanical data



## handling precautions

Curve-tracer testing and static-charge buildup are common causes of damage to insulated-gate devices. Permanent damage may result if either gate-voltage rating is exceeded even for extremely short time periods. Each transistor is protected during shipment by a gate-shorting device, which should be removed only during testing and after permanent mounting of the transistor. Personnel and equipment, including soldering irons, should be grounded.
*absolute maximum ratings at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)
TOTAL NOTE 1: Derate fineariy to $175^{\circ} \mathrm{C}$ free-air temperature at the rates of $2 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$ for each transistor and $4 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$ for the totel devices.
*JEDEC registered data. This data shet contains all applicable registered data in effact at the time of publlcation.
${ }^{\dagger}$ Enhancement-mode oparation entalis the use of forward gatesource voltage to incrase drain current from loss. the drain current at enhencement-type transistor is in the "off" stete to $V_{0 S}=0$ and hence will gate-source voitage is used to decrease drain current. An enhencement-type transistor is in the "off" stete at $V_{\mathbf{G S}}=0$ and hence will not operste normally in the depletion mode.
*electrical characteristics at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)
individual transistor characteristics (see note 2)

| PARAMETER | TEST CONDITIONS | MIN MAX | UNIT |
| :---: | :---: | :---: | :---: |
| Forward Gate-Terminal Current | $V_{G S}=-25 \mathrm{~V}, \mathrm{~V}_{\text {DS }}=0$ | -4 | PA |
|  | $V_{G S}=-25 \mathrm{~V}, \mathrm{~V}_{\mathrm{DS}}=0, \quad \mathrm{~T}_{\mathrm{A}}=150^{\circ} \mathrm{C}$ | -200 | nA |
| IGSSR Reverse Gate-Terminal Current | $V_{G S}=25 V_{\text {, }} \quad V_{D S}=0$ | 4 | pA |
| Zero-Gate-Voltage Drain Current | $V_{\text {DS }}=-20 \mathrm{~V}, V_{G S}=0$ | -10 | nA |
|  | $V_{D S}=-20 \mathrm{~V}, \mathrm{~V}_{\mathrm{GS}}=0, \quad \mathrm{~T}_{\mathrm{A}}=150^{\circ} \mathrm{C}$ | -10 | $\mu \mathrm{A}$ |
| ISDS Zero-Gate-Voltage Source Current | $V_{S D}=-20 \mathrm{~V}, V_{G D}=0$ | -10 | nA |
| $\mathrm{V}_{\text {GS }}(\mathrm{th})$ Gate-Source Threshold Voltage | $V_{D S}=-15 \mathrm{~V}, \mathrm{I}_{\mathrm{D}}=-10 \mu \mathrm{~A}$ | -3 | $V$ |
| ID(on) On-State Drain Current | $V_{D S}=-15 \mathrm{~V}, \mathrm{~V}_{\mathrm{GS}}=-15 \mathrm{~V}$. See Note 3 | -1.5 | mA |
| rds(on) Small-Signal Drain-Source On-State Resistance | $\mathrm{V}_{\text {GS }}=-15 \mathrm{~V}, \mathrm{I}_{\mathrm{D}}=0, \quad \mathrm{f}=1 \mathrm{kHz}$ | 400 | $\Omega$ |
| $\mathrm{C}_{\text {iss }}$ Common-Source Short-Circuit input Capacitance | $\mathrm{V}_{\mathrm{DS}}=-20 \mathrm{~V}, \mathrm{~V}_{\mathrm{GS}}=0, \quad \mathrm{f}=1 \mathrm{MHz}$ | 4 | pF |
| Crss ${ }_{\text {Common-Source Short-Circuit Reverse Transfer Capacitance }}$ | $V_{D S}=0, \quad V_{G S}=0, \quad i=\left\{\begin{array}{l}\text { MHz }\end{array}\right.$ | 2.5 | pF |
| $\mathrm{C}_{\mathrm{ds}} \quad$ Drain-Source Capacitance | $V_{D S}=-20 \mathrm{~V}, \mathrm{~V}_{\mathrm{GS}}=0, \quad f=1 \mathrm{MHz},$ <br> See Note 4 | 3 | pF |

transistor matching characteristics (see note 5)

| PARAMETER | TEST CONDITIONS | MIN MAX | UNIT |
| :--- | ---: | ---: | :---: |
| $\left\|V_{G S 1}-V_{G S 2}\right\|$ Gate-Source Voltage Differential | $V_{D S}=-15 \mathrm{~V}, \mathrm{I}_{\mathrm{D}}=-250 \mu \mathrm{~m}$ | $\mathbf{2 0 0}$ | mV |

NOTES: 2. For all individual-transistor measurements except $C_{d s \text {, }}$ the drain, source, and gate leads of the transistor not under test and the common substrate are grounded. For testing ISDS, ground is the drain of the transistor under test but for all other measuremente, it is the source.
3. This parameter must be measured using puise techniques. $t_{w}=\mathbf{3 0 0} \mu \mathrm{s}$, duty cycle $\leqslant \mathbf{2 \%}$.
4. Cds measurement employs a three-terminal capacitance bridge incorporating a guard circuit. The case and all terminals of both transistors except the drain and source of the transistor under test are connected to the guard terminal of the bridge.
5. Trangistor matching characteristics are measured with both sources connected to the substrate.
-JEDEC registered data

## TWO DIODE-PROTECTED ENHANCEMENT-TYPE $\dagger$ MOS SILICON TRANSISTORS WITHIN A SINGLE MONOLITHIC CHIP

For Applications Requiring Very High Input Impedance, Such as Series and Shunt Choppers, Multiplexers, and Commutators

- Designed to be Interchangeable with General Instrument Type MEM550
- Channel Cut Off with Zero Gate Voltage
- Substrate Connection Provides Flexibility in Biasing
- Internally Connected Diode Protects Gate from Damage due to Overvoltage
- Version Available without Diode Protection . . . 3N207


## description

This device is designed for applications requiring very high input impedance, such as choppers, commutators, and logic switches. Each transistor is protected from excessive input voltage by a shunting diode connected from its gate to the substrate. This eliminates the need for most precautionary handling procedures associated with unprotected MOS devices.
*mechanical data

*absolute maximum ratings at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

$$
\begin{gathered}
\text { EACH TOTAL } \\
\text { TRANSISTOR DEVICE } \\
-25 \mathrm{~V} \\
-25 \mathrm{~V} \\
-0.1 \mathrm{~mA} \\
10 \mathrm{~mA} \\
-100 \mathrm{~mA} \\
300 \mathrm{~mW} \quad 600 \mathrm{~mW} \\
-65^{\circ} \mathrm{C} \text { to } 200^{\circ} \mathrm{C} \\
\leftarrow-300^{\circ} \mathrm{C} \longrightarrow
\end{gathered}
$$

Drain-Gate Voltage
Drain-Source Voltage
Continuous Forward Gate-Terminal Current
Continuous Reverse Gate-Terminal Current
Continuous Drain Current
Continuous Device Dissipation at (or below) $25^{\circ} \mathrm{C}$ Free-Air Temperature (See Note 1) . . $300 \mathrm{~mW} \quad 600 \mathrm{~mW}$
Storage Temperature Range
Lead Temperature $\mathbf{1 / 1 6}$ Inch from Case for 10 Seconds
NOTE 1: Derate linearly to $175^{\circ} \mathrm{C}$ free-air temperature at the rates of $2 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$ for each transistor and $4 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$ for the total device.
JEDEC registered data. This data sheet contains all applicabie registered data in effect at the time of publication.
$t$ Enhencement-mode operation ent
 onhancem opere operation wherein a reverse gate-source voltage is used to decrease drain current. An onancement-type transistor is in the "off" state at $V_{G S}=0$ and hence will not operate normally in the depletion mode. The protective shunting diode is reverse-biased by the application of forward gate-source voltage.
*electrical characteristics at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)


NOTES: 2. To ensure that the gate-shunting diode is functioning properily, this voltege is measured while the device is conducting rated forward gate-terminal current.
3. This parameter must be measured using pulse techniques. $t_{w}=300 \mu_{\mathrm{s}}$, duty cycle $<2 \%$.
4. Cds measurement employs a three-terminal capacitance bridge incorporating a guard circuit. The case and all terminals of both transistors except the drain and source of the transistor under test are connected to the guard terminal of the bridge.

[^117]
## DEPLETION-TYPE MOS SILICON TRANSISTORS

- Monolithic Gate-Protection Diodes
- Low Crss . . . 0.05 pF Max
- High $|\mathrm{yfs}|$. . . $30,000 \mu \mathrm{mhos}$ Typ for 3 N 211 and 3 N 212


## description

The 3N211, 3N212, and 3N213 are N-channel, depletion-type, dual-gate, metal-oxide-semiconductor transistors, They are protected from excessive input voltages by Integrated back-to-back diodes between gates and source, thus elliminating precautionary handling procedures required by unprotected MOS transistors.

The 3N211 is intended for use in VHF pre-amplifiers where linear, low-noise amplification is required. Its extremely low feedback capacitance permits high stable gain without the use of neutralization.

The 3N212 is intended for use as a VHF mixer and is well suited for TV tuners. Its use as a mixer minimizes cross-modulation distortion and provides low-noise operation.

The 3N213 is designed for application in tuned high-frequency amplifiers such as TV If strips. Its extremely low feedback capacitance permits high stage gain and stability without the necessity for neutralization.
"mechanical data
THE SUESTRATE AND SOURCE ARE IN ELECTRICAL CONTACT WITH THE CASE
*absolute maximum ratings at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)


## TYPES 3N211, 3N212, 3N213 <br> N-CHANNEL DUAL-GATE DEPLETION-TYPE INSULATED-GATE FIELD-EFFECT TRANSISTORS

## *electrical characteristics at $\mathbf{2 5}{ }^{\circ} \mathbf{C}$ free-air temperature (unless otherwise noted)

|  | PARAMETER | TEST CONDITIONS |  | $3{ }^{\text {N2 }} 11$ |  | 3N212 |  | 3N213 |  | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  | MIN | MAX | MIN | MAX | MIN | MAX |  |
| $V$ (BR)Ds | Drain-Source <br> Breakdown Voltage | $\begin{aligned} & l D=10 \mu A, \\ & t=6 ; \end{aligned}$ | $V_{G 15}=V_{G 2 S}=-4 V_{1}$ | 27 |  | 27 |  | 35 |  | V |
| V(BA)DS | Instantaneous Draln-Source Breakdown Voltege | $I_{D}=10 \mu A$, | $V_{G 18}=V_{\text {G28 }}=-4 V$ | 25 |  | 25 |  | 30 |  | $V$ |
| $V_{\text {(RR) }} 18 \mathrm{ESF}$ | Gata-One-Source Forward Breakdown Voltage | $\begin{aligned} & \mathrm{IG}_{1}-10 \mathrm{~mA}, \\ & \text { See Note } 4 \end{aligned}$ | $V_{G 2 S}-V_{D S}=0,$ | 6 |  | 6 |  | 6 |  | V |
| V(ER)O18SR | Gate-One-Eource Reverve <br> Breakdown Voltege | $\mathrm{I}_{\mathrm{G} 1}=-10 \mathrm{~mA},$ See Nots 4 | $V_{G 2 S}=V_{D S}=0$ | -6 |  | -6 |  | -6 |  | $V$ |
| V(BR)G2SSF | Gate-Two-Source Forward Breakdown Voltage | $\begin{aligned} & \text { TG2 }=10 \mathrm{~mA} \\ & \text { See Note } 4 \end{aligned}$ | $V_{G 1 S}=V_{D S}=0,$ | 6 |  | 6 |  | 6 |  | V |
| V(BR)G2SSR | Gate-Two-Source Reverse Breakdown Voltage | $\mathrm{I}_{\mathrm{G} 2}=-10 \mathrm{~mA},$ <br> See Note 4 | $V_{\mathrm{G} 1 \mathrm{~S}}=\mathrm{V}_{\mathrm{DS}}=0,$ | -6 |  | -6 |  | -6 |  | $V$ |
| IG1ssF | Gate-One-Terminal Forward Current | $\mathbf{V}_{G 15}=5 \mathrm{~V}$. | $V_{G 2 S}=V_{\text {DS }}=0$ |  | 10 |  | 10 |  | 10 | nA |
| IG1SSR | Gate-One-Terminal Reverse Current | $V_{G 1 S}=-5 V_{1}$ | $V_{G 2 S}=V_{0 S}=0$ |  | -10 |  | -10 |  | -10 | nA |
|  |  | $\begin{aligned} & V_{G 1 S}=-5 V, \\ & T_{A}=160^{\circ} \mathrm{C} \end{aligned}$ | $V_{G 2 S}=V_{D S}=0,$ |  | -10 |  | -10 |  | -10 | MA |
| IG2ssf | Gate-Two-Terminal Forward Current | $V_{G 2 S}=5 \mathrm{~V}$. | $V_{G 1 S}=V_{\text {DS }}=0$ |  | 10 |  | 10 |  | 10 | nA |
| IG2SSR | Gate-Two-Terminal Reverse Current | $V_{G 2 S}=-5 \mathrm{~V}$, | $V_{G 1 S}=V_{\text {DS }}=0$ |  | -10 |  | -10 |  | $-10$ | nA |
|  |  | $\begin{aligned} & V_{G 25}=-5 V \\ & T_{A}=160^{\circ} \mathrm{C} \end{aligned}$ | $V_{G 1 S}=V_{D S}=0$ |  | -10 |  | -10 |  | -10 | $\mu \mathrm{A}$ |
| IDS | Zero-Gate-One-Voltage Drain Current | $\begin{aligned} & V_{\text {DS }}=16 \mathrm{~V}, \\ & V_{G 2 S}=4 \mathrm{~V} \\ & \hline \end{aligned}$ | $\begin{aligned} & \hline \mathrm{V}_{\mathrm{G} 15}-\mathbf{0}, \\ & \text { See Note } 5 \end{aligned}$ | 6 | 40 | 6 | 40 | 6 | 40 | mA |
| $\mathbf{V}_{\mathrm{G} 13 \text { (off) }}$ | Gate-One-Source Cutoff Voltage | $\begin{aligned} & V_{D S}=15 V, \\ & I_{D}=20 \mu A \end{aligned}$ | $V_{G 2 S}=4 V,$ | -0.5-5.5 |  | $-0.5 \quad-4$ |  | -0.6-5.5 |  | V |
| VG2s(oft) | Gate-Two-Source Cutoff Voltage | $\begin{aligned} & V_{D S}=15 V \\ & I_{D}=20 \mu \mathrm{~A} \end{aligned}$ | $V_{G 1 S}=0,$ | -0.2 | -2.5 | -0.2 | -4 | -0.2 | -4 | V |
| \|Vfs| | Small-Signal Common-Source Forward Transfer Admittance | $\begin{aligned} & V_{D S}=15 \mathrm{~V} \\ & V_{G 2 S}=4 \mathrm{~V} \\ & \text { See Note } 6 \end{aligned}$ | $\begin{aligned} & \mathrm{V}_{\mathrm{G} 1 \mathrm{~S}}=0, \\ & \mathrm{f}=1 \mathrm{kHz}, \end{aligned}$ | 17 | 40 | 17 | 40 | 15 | 35 | mmho |
| Crgs | Common-Source <br> Short-Circuit <br> Revarse Transfer Capacitance | $\begin{aligned} & V_{D S}=15 \mathrm{~V}, \\ & 1_{D}=1 \mathrm{~mA}, \end{aligned}$ | $\begin{aligned} & \mathrm{V}_{\mathrm{G} 2 \mathrm{~S}}=4 \mathrm{~V}, \\ & \mathrm{f}=1 \mathrm{MHz} \end{aligned}$ | 0.006 | 0.05 | 0.005 | 0.06 | 0.005 | 0.05 | pF |

NOTES: 4. All gate breakdown voltages are maasured while the device is conducting rated gate current. This ensures that the gate-voltage-limiting network is functioning properly.
5. This parameter must be measured uaing pulse techniques. $t_{w}=300 \mu s$, duty cycie $<\mathbf{2 \%}$.
6. This paramater must be measured with bias voltages applied for less than 5 seconds to avoid overheating. The slgnal is applied to gate 1 with gate 2 at a-c ground.

[^118]
## TYPES 3N211, 3N212, 3N213

N-CHANNEL DUAL-GATE DEPLETION-TYPE
INSULATED-GATE FIELD-EFFECT TRANSISTORS
*3N211 operating characteristics at $25^{\circ} \mathrm{C}$ free-air temperature

| PARAMETER | TEST CONDITIONS |  | 3N211 |  | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  | MIN | TYP MAX |  |
| F Common-Source Spot Noise Figure | $\begin{aligned} & \mathrm{V}_{\mathrm{DD}}=24 \mathrm{~V}, \\ & \mathrm{f}=45 \mathrm{MHz}, \end{aligned}$ | $V_{G G}=6 \mathrm{~V} .$ <br> See Figure 5 |  | 4 | dB |
| $\mathrm{G}_{\mathrm{ps}} \quad$ Small-Signal Common-Source Insertion Power Gain |  |  | 29 | 37 | d8 |
| B Bandwidth |  |  | 3.5 | 6 | MHz |
| $V_{G G(G C)}$ Gain-Control Gate-Supply voltage | $\begin{aligned} & V_{D D}=24 \mathrm{~V}, \\ & f=45 \mathrm{MHz}, \end{aligned}$ | $\Delta G_{p s}=-30 d B^{\top}$ <br> See Figure 5 |  | +1 -1 | V |
| F Common-Source Spot Noise Figure | $\begin{aligned} & V_{D D}=18 \mathrm{~V}, \\ & f=200 \mathrm{MHz} \end{aligned}$ | $V_{G G}=7 \mathrm{~V},$ <br> See Figure 6 |  | 3.5 | dB |
| $\mathrm{G}_{\mathrm{ps}} \quad$ Small-Signal Common-Source Insertion Power Gain |  |  | 24 | 35 | dB |
| B $\quad$ Bandwidth |  |  | 5 | 12 | MHz |
| $V_{\text {GG(GG) }}$ Gain-Control Gate-Supply Voltage | $\begin{aligned} & \mathrm{V}_{\mathrm{DD}}=18 \mathrm{~V}, \\ & \mathrm{f}=200 \mathrm{MHz}, \end{aligned}$ | $\Delta G_{p s}=-30 d B \neq$ <br> See Figure 6 | 0 | -2 | $V$ |
| F Common-Source Spot Noise Figure | $\begin{array}{ll} V_{D S}=15 \mathrm{~V}, & V_{G 2 S}=4 \mathrm{~V} \\ I_{D}=15 \mathrm{~mA}, & f=450 \mathrm{MHz} \end{array}$ <br> See Figures 7 and 9 |  | 5 |  | dB |
| $\mathrm{G}_{\mathrm{ps}} \quad$ Small-Signal Common-Source Insertion Power Gain |  |  | 21 |  | dB |

[^119]*3N212 operating characteristics at $25^{\circ} \mathrm{C}$ free-air temperature

| PARAMETER | TEST CONDTIONS | 3N212 |  | UNIT |
| :---: | :---: | :---: | :---: | :---: |
|  |  | MIN | MAX |  |
| $\mathrm{G}_{\mathrm{ps}(\mathrm{conv})}$ Small-Signal Conversion Power Gain | $\begin{array}{ll} \hline V_{D D}=18 \mathrm{~V}, & f_{L O}=245 \mathrm{MHz} \delta, \\ f_{\text {RF }}=200 \mathrm{MHZ}, & \text { See Figure } 8 \\ \hline \end{array}$ | 21 | 28 | dB |
| B Bandwidth |  | 4 | 7 | $\underline{M H z}$ |

§ Amplitude at input from local oscillator is adjusted for maximum $\mathbf{G}_{\mathrm{p}}$ (conv).
*3N213 operating characteristics at $25^{\circ} \mathrm{C}$ free-air temperature

| PARAMETER | TEST CONDITIONS |  | 3N213 |  | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  | MIN | MAX |  |
| F Common-Source Spot Noise Figure | $\begin{aligned} & V_{D D}=24 \mathrm{~V}, \\ & f=45 \mathrm{MHz} \end{aligned}$ | $V_{G G}=6 \mathrm{~V},$ <br> See Figure 5 |  | 4 | dB |
| $\mathrm{G}_{\mathrm{ps}} \quad$ Small-Signal Common-Source Insertion Power Gain |  |  | 27 | 35 | dB |
| B Bandwidth |  |  | 3.5 | 6 | MHz |
| VGG(GC) Gain-Control Gate-Supply Voltage | $\begin{aligned} & V_{D D}=24 \mathrm{~V} . \\ & f=45 \mathrm{MHz}, \end{aligned}$ | $\Delta G_{p s}=-30 d B^{t}$ <br> See Figure 5 |  | +1 -1 | $V$ |

${ }^{t} \Delta G_{\mathrm{ps}}$ at 45 MHz is defined as the change in $\mathrm{G}_{\mathrm{ps}}$ from the value at $\mathrm{V}_{\mathrm{GG}}=6$ vaits.

# N-CHANNEL DUAL-GATE DEPLETION-TYPE INSULATED-GATE FIELD-EFFECT TRANSISTORS 

## TYPICAL CHARACTERISTICS AT $\mathrm{T}_{\mathrm{A}}=\mathbf{2 5}{ }^{\circ} \mathrm{C}$

3N211
SMALL-SIGNAL COMMON-SOURCE INSERTION POWER GAIN
vs

figure 1

3N211
COMMON-SOURCE SPOT NOISE FIGURE
vs
GAIN-CONTROL GATE-SUPPLY VOLTAGE


Figure 3

3N211
RELATIVE SMALL-SIGNAL POWER GAIN vs


VGG(GC)-Gain-Control Gate-Supply Voltage-V $^{\text {- }}$
figure 2

3N211
OPTIMUM SPOT NOISE FIGURE
FREQUENCY


NOTE 7: Test conditions at $45 \mathrm{MHz}, 200 \mathrm{MHz}$, and 450 MHz are the conditions given in the table of operating characteristics for 3 N 211 .

PARAMETER MEASUREMENT INFORMATION


CIRCUIT COMPONENT INFORMATION
C1: Leadiess disc ceramic, $0.001 \mu \mathrm{~F}$
C2: Leadless disc ceramic, $0.01 \mu \mathrm{~F}$
L1: 8T \# 28, 5/32-inch-dia form, type "J" alug
L2: 9T \# 28, 5/32-inch-dia form, type "J" stug
FIGURE 5-46-MHz POWER GAIN AND NOISE FIGURE TEST CIRCUIT FOR 3N211 AND 3N213*


FIGURE 6-200-MHz POWER GAIN, GAIN-CONTROL VOLTAGE, AND NOISE FIGURE TEST CIRCUIT FOR 3N211*

## PARAMETER MEASUREMENT INFORMATION



FIGURE 7-450-MHZ POWER GAIN AND NOISE TEST CIRCUIT FOR 3N211


L1: 7 \# \#34, 1/4-inch dia., aluminum slug
L2: 3T \#20, 1/4-inch dia., aluminum slug
L3: 7T \#24, /4-inch dia.. air core

T1: Pri: 25T \#30, close wound on 1/4-inch-dia form, type "j" slug Sec: 4T \#30, centered over primary

FIGURE 8-200-MHz-to-45-MHz CIRCUIT FOR CONVERSION POWER GAIN FOR 3N212*

[^120]
## NOTES:

A. All dimensions are in inches.
B. The removable top of test fixture is not shown.
C. For clarity, the $62 \mathrm{k} \Omega$ resistor, the source and gate-2 sacket pins, and insulating stand-off terminais (ISOT) soldered into the fold of L1 and $\mathrm{L2}$ respectively for mechanical support, are not shown in view $\mathbf{A}$.
D. C1 and C2 (C3 and C4) consist of shim brass and the "C" portion of L1 (L2) separated by air and the mylar tape covering the "C" portion of L.1
(L2).


FIGURE $9-450-\mathrm{MHz}$ POWER GAIN AND NOISE TEST FIXTURE

## DIODEPROTECTED DEPLETION-TYPE MOS SILICON TRANSISTORS

## For Low-Power Chopper or Switching Applications

- Low rds(on) ... $20 \Omega \operatorname{Max}(3 N 214)$
- Low Crss . . 2 pF Max
- Low Ciss . . 6 pF Max
- Internally Connected Diode Protects Gate from Damage due to Overvoltage


## *mechanical data


*absolute maximum ratings at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)
Drain-Gate Voltage ..... 20 V
Drain-Source Voltage ..... 20 V ..... 20 V
Drain-Substrate Voltage
Drain-Substrate Voltage ..... 20 V
Source-Substrate Voltage
Source-Substrate Voltage
Forward Gate-Terminal Current (See Note 1) ..... 1 mA
Reverse Gate-Terminal Current ..... $-1 \mathrm{~mA}$
Continuous Drain Current ..... 50 mA
Continuous Device Dissipation at (or below) $25^{\circ} \mathrm{C}$ Free-Air Temperature (See Note 2) ..... 360 mW
Storage Temperature Range ..... $-65^{\circ} \mathrm{C}$ to $200^{\circ} \mathrm{C}$ ..... $-65^{\circ} \mathrm{C}$ to $200^{\circ} \mathrm{C}$ ..... $300^{\circ} \mathrm{C}$Lead Temperature 1/16 Inch from Case for 10 Seconds
NOTES: 1. Forward gate-terminal current is the current into a gate terminal with a forward gate-source voltage applied. This voltage is of such polarity that an increase in its magnitude causes the channel resistance to decrease.
2. Derme linearly to $175^{\circ} \mathrm{C}$ free-air tempersture at the rate of $2.4 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$.
*electrical characteristice at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

| PARAMETER |  | TEST CONDITIONS |  |  | MIN | Max | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| $\mathrm{V}_{\text {(BR) }}$ Gssf | Gate-Souree Forward Breakdown Voltage | $\begin{aligned} & \mathrm{I}_{\mathrm{G}}=1 \mathrm{~mA}, \\ & \text { See Note } 3 \end{aligned}$ | $V_{D s}=0,$ | Vus $=0$. | 7 |  | $v$ |
| $V_{\text {(BR) }}$ GSSR | Gate-Source Rewerse Braakdown Voitage | $\begin{aligned} & I_{G}=-1 m A_{1} \\ & \text { Seo }^{\prime} \text { Note } 3 \end{aligned}$ | $V_{D S}=0$ | Vus $=0$, | -7 |  | $v$ |
| IGSSF | Gato-Torminal Forward Currant | VGS $=7 \mathrm{~V}$, | $V_{\text {DS }}=0$, | $V_{\text {US }}=0$ |  | 10 | nA |
| IGSSR | Gete-Terminal Reverse Current | $\mathrm{V}_{\text {Gs }}=-7 \mathrm{~V}_{\text {, }}$ | $\mathrm{V}_{\text {DS }}=0$, | Vus $=0$ |  | 10 | nA |
|  |  | $\begin{aligned} & V_{G S}=-7 \mathrm{~V}, \\ & T_{A}=125^{\circ} \mathrm{C} \\ & \hline \end{aligned}$ | $v_{D S}=0,$ | Vus $=0$, |  | 600 |  |
| IS(off) | Source Cutoff Current | $\mathrm{V}_{\text {SD }}=12 \mathrm{~V}$, | $V_{G D}=-6 V$ | $V_{U D}=0$ |  | 1 | $\mu \mathrm{A}$ |
|  |  | $\begin{aligned} & V_{S D}=12 \mathrm{~V}, \\ & T_{A}=125^{\circ} \mathrm{C} \end{aligned}$ | $V_{G D}=-6 V,$ | $V_{U D}=0$ |  | 500 |  |
|  |  | $\mathrm{V}_{\text {SD }}=12 \mathrm{~V}$ | $V_{G D}=-8 V$ | $V_{U D}=-6 \mathrm{~V}$ |  | 1 |  |
|  |  | $\begin{aligned} & V_{S D}=12 \mathrm{~V}, \\ & T_{A}=125^{\circ} \mathrm{C} \end{aligned}$ | $V_{G D}=-6 V,$ | $V U D=-6 V$ |  | 500 |  |
| 'Dloff) | Drain Cutoff Current | $\mathrm{V}_{\text {DS }}=12 \mathrm{~V}$. | $V_{\text {GS }}=-6 \mathrm{~V}$, | Vus-0 |  | 100 | nA |
|  |  | $\begin{aligned} & V_{D S}=12 V_{1} \\ & T_{A}=125^{\circ} \mathrm{C} \end{aligned}$ | $V_{G S}=-6 \mathrm{~V},$ | $\text { Vus }=0$ |  | 50 | $\mu \mathrm{A}$ |
|  |  | $\mathrm{V}_{\text {DS }}=12 \mathrm{~V}$, | VGS $=-6 \mathrm{~V}$, | $V_{\text {US }}=-6 \mathrm{~V}$ |  | 100 | nA |
|  |  | $\begin{aligned} & V_{D S}=12 \mathrm{~V} \\ & T_{A}=125^{\circ} \mathrm{C} \\ & \hline \end{aligned}$ | $V_{G S}=-6 V .$ | $\text { Vus }=-6 \mathrm{~V}$ |  | 50 | $\mu \mathrm{A}$ |
| IUss | Substrate Reverse Current | $\mathrm{V}_{\text {US }}=-20 \mathrm{~V}$, | $V_{\text {DS }}=0$. | $V_{G S}=0$ |  | -10 | $\mu \mathrm{A}$ |
| ' ${ }^{\text {(on) }}$ | On-State Drain Current | VOS $=3 \mathrm{~V}$, See Note 4 | $V_{G S}=6 \mathrm{~V},$ | $\text { vus }=-6 \mathrm{~V} \text {. }$ | 50 |  | mA |
| rdslon) | Small-Signal Drain-Source On-State Resistance | $\begin{aligned} & V_{G S}=6 \mathrm{~V}, \\ & V_{U S}=0 . \end{aligned}$ | $\begin{aligned} & I_{D}=0, \\ & f=1 \mathrm{kHz} \end{aligned}$ | 3N214 |  | 20 | $\Omega$ |
|  |  |  |  | 3N215 |  | 35 |  |
|  |  |  |  | 3N216 |  | 50 |  |
|  |  |  |  | 3N217 |  | 70 |  |
| $\mathrm{C}_{\text {iss }}$ | Common-Source Short-Circuit Input Capacitance | $\begin{aligned} & V_{D S}=12 \mathrm{~V} \\ & f=1 \mathrm{MHz} \end{aligned}$ | $V_{G S}=-6 \mathrm{~V},$ | $V_{U S}=0$ |  | 6 | pF |
| $\mathrm{C}_{\text {rss }}$ | Common-Source Short-Circuit Reverse Transfer Capacitance | $\begin{aligned} & V_{D S}=0, \\ & f=1 \mathrm{MHz} \end{aligned}$ | $V_{G S}=-6 \mathrm{~V},$ | $V_{U S}=0$. |  | 2 | pF |
| $\mathrm{C}_{\mathrm{ds}}$ | Drain-Source Capacitance | $\begin{aligned} & V_{D S}=12 \mathrm{~V}, \\ & f=1 \mathrm{MHz}, \\ & \hline \end{aligned}$ | $V_{G S}=-6 V,$ $\text { See Note } 5$ | $V_{U S}=0$ |  | 5 | pF |

NOTES: 3. Both gate braakdown voltages ore masured while the device is condueting rated gate current. This ensuras that the getevoltegelimiting network is functioning properly.
4. This parameter must be measured using pulse techniquet. $t_{w}=300 \mu s$ duty cycle $\leqslant 2 \%$.
. Cds measurement employs a threeterminal capacitance bridge incorporating a guard circuit. The gate and casa are connected to the guard terminal of the bridge.

## TWO MATCHED FIELD-EFFECT TRANSISTORS

- High $\mid \mathrm{Yfs}_{s} / / \mathrm{C}_{\text {iss }}$ Ratio (High-Frequency Figure-of-Merit)
- Low Input Capacitance, Ciss: $\mathbf{8}$ pF Max
- Low Differential Gate Current: $\mathbf{1 0 n A}$ Max at $\mathrm{TA}_{\mathrm{A}}=10 \mathbf{0}^{\circ} \mathrm{C}$
- Low Noise Figure: 5 dB Max at 10 Hz
- Recommended for Low-Level D.C Amplifiers, Sample-Hold Circuits, and Serien-Shunt Choppors
mechanical data

absolute maximum ratings at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)


NOTE 1: Derate lineariv to $975^{\circ} \mathrm{C}$ free-air temperature at the rates of $\mathbf{2} \mathrm{mW} /{ }^{\circ} \mathrm{C}$ for each triode and $4 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$ for total davice.

## TYPES TIS25, TIS26, TIS27 <br> DUAL N-CHANNEL SILICON JUNCTION FIELD-EFFECT TRANSISTORS

## electrical characteristics at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

individual triode characteristics (see note 2)

| PARAMETER |  | TEST CONDITIONS |  |  | MIN | MAX | $\frac{\text { UNIT }}{V}$ |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| $V_{\text {(BR) }}$ GSS | Gate-Source Breakdown Voltage | $\mathrm{I}_{\mathrm{G}}=-1 \mu \mathrm{~A}$, | $V_{\text {DS }}=0$ |  | -50 |  |  |
| 'Gss | Gate Cutoff Current | $V_{\mathrm{GS}}=-30 \mathrm{~V}, \mathrm{~V}_{\mathrm{DS}}=0$ |  |  | -0.25 |  | nA |
|  |  | $\mathrm{V}_{\mathrm{GS}}=-30 \mathrm{~V}$, | $V_{D S}=0$, | $T_{A}=150^{\circ} \mathrm{C}$ |  | -250 |  |
| IDSS | Zero-Gate-Voltage Drain Current | $V_{\text {DS }}=15 \mathrm{~V}$. | $V_{G S}=0$ |  | 0.6 | 8 | mA |
| $V_{\text {GS }}$ | Gate-Source Voltage | $V_{\text {OS }}=15 \mathrm{~V}$, | $I_{D}=50 \mu \mathrm{~A}$ |  | -0.5 | -4 | V |
| VGS(off) | Gate-Source Cutoff Voltage | $V_{D S}=15 \mathrm{~V}$, | $\mathrm{I}^{\prime}=0.5 \mathrm{nA}$ |  |  | $-6$ | V |
| rds ${ }^{\text {con) }}$ | Small-Signal Drain-Source On-State Resistance | $L_{D}=0$, | $V_{G S}=0$, | $f=1 \mathrm{kHz}$ |  | 500 | $\Omega$ |
| $\left\|y_{\text {fs }}\right\|$ | Small-Signal Common-Source Forward Transfer Admittance | $V_{\text {DS }}=15 \mathrm{~V}$. | $V_{G S}=0$, | $f=1 \mathrm{kHz}$ | 1500 | 6000 | $\mu \mathrm{mho}$ |
| Mos | Small-Signal Common-Source Output Admittance | $V_{D S}=15 \mathrm{~V}$, | $V_{G S}=0$, | $\mathrm{f}=1 \mathrm{kHz}$ |  | 25 | Mmho |
| Ciss | Small-Signal Common-Source Input Capacitance | $V_{\text {DS }}=15 \mathrm{~V}$, | $V_{G S}=0$, | $f=1 \mathrm{MHz}$ |  | 8 | pF |
| $C_{\text {rss }}$ | Small-Signal Common-Source Reverse Transfer Capacitance | $V_{D S}=15 \mathrm{~V}$, | $V_{G S}=0$, | $\mathrm{f}=1 \mathrm{MHz}$ |  | 4 | pF |
| $\left\|y_{f s}\right\|$ | Small-Signal Common-Source Forward Transfer Admittance | $V_{D S}=15 \mathrm{~V}$, | $V_{G S}=0$, | $f=100 \mathrm{MHz}$ | 1500 |  | $\mu \mathrm{mho}$ |

triode matching characteristics

| PARAMETER |  | TEST CONDITIONS | TIS25 |  | TIS26 |  | TIS27 |  | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | MIN | MAX | MIN | MAX | MIN | MAX |  |
| $\left\|\mathbf{I G S S 1}^{-1} \mathbf{G S S 2}\right\|$ | Differential Gate Cutoff Current |  | $\begin{aligned} & V_{G S}=-15 \mathrm{~V}, V_{D S}=0, \\ & T_{A}=100^{\circ} \mathrm{C} \end{aligned}$ |  | 10 |  | 10 |  | 10 | nA |
| 'DSS1 | Zero-Gate-Voltage <br> Drain Current Ratio | $\begin{array}{ll} V_{D S}=15 \mathrm{~V}, & V_{G S}=0 \\ \text { See Note } 3 \end{array}$ | 0.95 | 1 | 0.9 | 1 | 0.8 | 1 |  |
| $\left\|V_{\mathbf{G S 1}}-\mathrm{V}_{\mathbf{G S 2}}\right\|$ | Gate-Source-Voltage Differential | $V_{D S}=15 \mathrm{~V}, \mathrm{I}_{\mathrm{D}}=50 \mu \mathrm{~A}$ |  | 8 |  | 16 |  | 32 | mV |
|  |  | $V_{D S}=15 \mathrm{~V}, \mathrm{I}_{\mathrm{D}}=500 \mu \mathrm{~A}$ |  | 5 |  | 10 |  | 15 |  |
| $\left\|\Delta\left(V_{G S 1}-V_{G S 2}\right)_{\Delta T_{A}}\right\|$ <br> Gate-Source-Voltage-Differential <br> Change with Temperature |  | $\begin{aligned} & V_{D S}=15 \mathrm{~V}, \quad I_{D}=500 \mu \mathrm{~A}, \\ & T_{A(1)}=25^{\circ} \mathrm{C}, \quad T_{A(2)}=-40^{\circ} \mathrm{C} \end{aligned}$ |  | 5 |  | 10 |  | 15 | mV |
|  |  | $\begin{aligned} & V_{D S}=15 \mathrm{~V}, \quad T_{D}=500 \mu \mathrm{~A}, \\ & T_{A(1)}=25^{\circ} \mathrm{C}, \quad T_{A(2)}=100^{\circ} \mathrm{C} \end{aligned}$ |  | 5 |  | 10 |  | 15 |  |
| $\frac{\mathrm{Vfs}_{\mathrm{fs}} 1}{\sqrt{\mathrm{fs} / 2}}$ | Small-Signal Common-Source <br> Forward Transfer Admittance Ratio | $\begin{array}{ll} V_{\text {DS }}=15 \mathrm{~V}, & V_{G S}=0, \\ \mathrm{f}=1 \mathrm{kHz}, & \text { See Note } 3 \end{array}$ | 0.95 | 1 | 0.9 | 1 | 0.8 | 1 |  |

operating characteristics at $\mathbf{2 5}{ }^{\circ} \mathrm{C}$ free-air temperature
individual triode characteristics (see note 2)

| PARAMETER |  | TEST CONDITIONS | TIS25 | TIS26 | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | MAX | MAX |  |
| F | Spot Noise Figure |  | $\begin{array}{ll} V_{D S}=15 \mathrm{~V}, & V_{G S}=0, \quad f=10 \mathrm{~Hz}, \\ R_{G}=1 \mathrm{M} \Omega, & \text { Noise Bandwidth }=5 \mathrm{~Hz} \end{array}$ | 5 | 5 | dB |
| $V_{n}$ | Equivalent Input Noise Voltage | $V_{D S}=15 \mathrm{~V}, \quad V_{G S}=0, \quad f=10 \mathrm{~Hz},$ <br> Noise Bandwidth $=5 \mathrm{~Hz}$ | 200 | 200 | $n \mathrm{~V} / \sqrt{\mathrm{Hz}}$ |

NOTES: 2. The terminals of the triode not under test are apen-circuited for the measurement of these characteristics.
3. The lower of the two characteristic readings is taken as the numerator.

# TYPES TIS37, TIS38, TIS137, TIS138 <br> P-N-P SILICON TRANSISTORS 

BULLETIN NO. DL-S 7311580 , NOVEMBER 1971-REVISED MARCH 1973

## SILECT ${ }^{\dagger}$ TRANSISTORS $\ddagger$ RECOMMENDED AS LOW-NOISE DESIGN REPLACEMENTS FOR GERMANIUM DRIFT TRANSISTORS IN:

- AM Radio RF and IF Converter Applications
- TV Video and AGC Amplifiers, Sync Amplifiers and Separators, and Emitter Followers


## mechanical data

These transistors are encapsulated in a plastic compound specifically designed for this purpose, using a highly mechanized process developed by Texas instruments. The case will withstand soldering temperatures without deformation. These devices exhibit stable characteristics under high-humidity conditions and are capable of meeting MIL-STD-202C, Method 106B. The transistors are insensitive to light.

absolute maximum ratings at $\mathbf{2 5}{ }^{\circ} \mathbf{C}$ free-air temperature (unless otherwise noted)


NOTES: 1. This value applies when the base-emitter diode is open-circuited.
2. Derate linearly to $150^{\circ} \mathrm{C}$ free-air tempersture at the rate of $5 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$.
${ }^{\dagger}$ Tradernark of Texas Instruments
$\ddagger$ U.S. Patent No. 3,439,238
USES CHIP P24

## TYPES TIS37, TIS38, TIS137, TIS138 P-N-P SILICON TRANSISTORS

electrical characteristics at $25^{\circ} \mathrm{C}$ free-air temperature

| PARAMETER | TEST CONDITIONS | $\begin{gathered} \text { TIS37 } \\ \text { TIS137 } \end{gathered}$ |  | $\begin{gathered} \text { TIS38 } \\ \text { TIS138 } \end{gathered}$ |  | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | MIN | TYP MAX | MIN | TYP MAX |  |
| $\mathrm{V}_{\text {(BR) }}$ CBO Collector-Base Breakdown Voltage | $I_{C}=-100 \mu A, I_{E}=0$ | -35 |  | -35 |  | V |
| $\mathrm{V}_{\text {(BR)CEO }}$ Collector-Emitter Breakdown Voltage | $\mathrm{I}_{\mathrm{C}}=-1 \mathrm{~mA}, \mathrm{I}_{\mathrm{B}}=0, \quad$ See Note 3 | -32 |  | -32 |  | V |
| $V_{\text {(BR) }}$ EBO Emitter-Base Breakdown Voltage | $\mathrm{I}_{\mathrm{E}}=-100 \mu \mathrm{~A}, \mathrm{I}^{\prime} \mathrm{C}=0$ | -6 |  | -4 |  | V |
| 1 CBO Collector Cutoff Current | $\mathrm{V}_{C B}=-10 \mathrm{~V}, \mathrm{I}_{\mathrm{E}}=0$ |  | $-100$ |  | -100 | nA |
| hFE Static Forward Current <br> Transfer Ratio | $V_{C E}=-9 \mathrm{~V}, \quad \mathrm{I}^{\text {c }}=-1 \mathrm{~mA}$ | 45 |  | 25 |  |  |
| Small-Signal Common-Emitter | $V_{C E}=-9 \mathrm{~V}, 1 \mathrm{C}=-1 \mathrm{~mA}, \mathrm{f}=455 \mathrm{kHz}$ | 35 | 45 | 30 | 40 | dB |
| Mfel Forward Current Transfer Ratio | $\mathrm{V}_{\text {CE }}=-9 \mathrm{~V}, \mathrm{I}^{\text {c }}=-1 \mathrm{~mA}, f=10 \mathrm{MHz}$ | 18 | 30 | 14 | 26 | dB |
| $\left\|y_{f e}\right\|$ Small-Signal Common-Emitter <br> Forward Transfer Admittance | $V_{C E}=-9 \mathrm{~V}, \quad \mathrm{I}^{\prime}=-1 \mathrm{~mA}, \mathrm{f}=455 \mathrm{kHz}$ | 32 | 35 | 32 | 35 | mmho |
| $\mathrm{f}_{\mathrm{T}}$ Trensition Frequency | $V_{C E}=-9 \mathrm{~V}, \quad I_{C}=-1 \mathrm{~mA}$, See Note 4 | 80 | 320 | 50 | 200 | MHz |
| $\mathrm{C}_{\mathrm{cb}} \quad$ Collector-Base Capacitance | $V_{C B}=-9 V, I_{E}=0$, $f=1 \mathrm{MHz}$, <br>  See Note 5 | 0.5 | 1.11 .7 | 0.5 | 1.11 .7 | pF |
| $\mathrm{rb}^{\prime} \mathrm{C}_{\mathrm{c}} \quad$ Collector-Base Time Constant | $V_{C B}=-9 \mathrm{~V}, \mathrm{I}_{\mathrm{E}}=1 \mathrm{~mA}, \quad \mathrm{f}=79.8 \mathrm{MHz}$ |  | $30 \quad 70$ |  | $30 \quad 70$ | ps |

operating characteristics at $25^{\circ} \mathrm{C}$ free-air temperature

| PARAMETER |  | TEST CONDITIONS | Tis37 <br> TIS137 | UNIT |
| :---: | :---: | :---: | :---: | :---: |
|  |  | TYP |  |
| NF | Spot Noise Figure |  | $\mathrm{V}_{\mathrm{CE}}=-9 \mathrm{~V}, \mathrm{I}^{\mathrm{C}}=-1 \mathrm{~mA}, \mathrm{R}_{\mathrm{G}}=75 \Omega, f=1 \mathrm{MHz}$ | 2.5 | dB |
|  |  | $\mathrm{V}_{\text {CE }}=-9 \mathrm{~V}, \mathrm{I}^{\text {C }}=-1 \mathrm{~mA}, \mathrm{R}_{\mathrm{G}}=1 \mathrm{k} \Omega, f=1 \mathrm{MHz}$ | 1 | dB |

## TYPICAL CHARACTERISTICS AT TA $=25^{\circ} \mathrm{C}$



NOTES: 3. This parameter must be measured using puise techniques, $\mathrm{t}_{\mathbf{w}}=300 \mu \mathrm{~s}$, duty cycle $\leqslant 2 \%$.
4. To obtain $\mathrm{f}_{\mathrm{T}}$, the $\mathrm{hfe}_{\mathrm{fe}}$ response with frequency is extrapolated at the rate of -6 dB per octave from $\mathrm{f}=10 \mathrm{MHz}$ to the frequency at which $\mathrm{h}_{\mathrm{fa}} \mid=1$.
5. $\mathrm{C}_{\mathrm{cb}}$ measurement employs a three-terminal capacitance bridge incorporating a guard circuit. The emitter is connected to the guard terminal of the bridge.
texas instruments reserves the richt to mane changes at ahy time in order to lmprove design and to supply the best product possigle.

# PLANAR UNIJUNCTION SILECT ${ }^{\dagger}$ TRANSISTOR $\ddagger$ FOR APPLICATION IN SCR DRIVERS, MOTOR SPEED CONTROLS, TIMERS, WAVEFORM GENERATORS, MULTIVIBRATORS, RING COUNTERS, ELECTRONIC ORGANS, AND MILITARY FUZES 

- Low Leakage Allows More Accurate Timing Circuit Design
- Provides Wider Range of Design Applications than Bar-Type Unijunction Transistors
- 2N4891 is Recommended for New Designs


## mechanical data

This transistor is encapsulated in a plastic compound specifically designed for this purpose, using a highly mechanized process developed by Texas Instruments. The case will withstand soldering temperatures without deformation. This device exhibits stable characteristics under high-humidity conditions and is capable of meeting MIL-STD-202C, Method 106B. The transistor is insensitive to light.

absolute maximum ratings at $\mathbf{2 5}^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

| , |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Interbase Voltage |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Continuous Emitter Current . . . . . . . . . . . . . . . . . . . . . . . 50 mA |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Peak Emitter Current (See Note 2) . . . . . . . . . . . . . . . . . . . . . . 1 A |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Continuous Device Dissipation at (or below) $25^{\circ} \mathrm{C}$ Free-Air Temperature (See Note 3) . . . . 360 mW Continuous Device Dissipation at (or below) $25^{\circ} \mathrm{C}$ Lead Temperature (See Note 4) . . . . 500 mW |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Storage Temperature Range . . . . . . . . . . . . . . . . . . . . $-65^{\circ} \mathrm{C}$ to $150^{\circ} \mathrm{C}$ |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |


2. This value applies for a capaciser discharge through the emithor-bose-one diade. Current must fall to 0.37 a withia 3 ms and pulso-ropelition rate must mot axceed 10 pps.
3. Derate linearly to $150^{\circ} \mathrm{C}$ tree-air temperature of the rate of $2.8 \mathrm{Et} \mathrm{mW} / \mathrm{deg}$.
4. Derate linearly to $150^{\circ} \mathrm{C}$ lend temperature at the rate of $4 \mathrm{mw} / \mathrm{deg}$. Lead temperature is measured on the base- two lead $1 / 16$ inch from the case.
${ }^{\dagger}$ Trademark of Texas Instruments
$\ddagger$ U. S. Patent No. 3,439,238

## electrical characteristics of $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

| PARAMETER |  | TEST CONDITIONS | MIN | MAX | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: |
| $\mathrm{T}_{\mathrm{BB}}$ | Static Interbase Resistance | $V_{\text {B2-E1 }}=3 V_{1} I_{E}=0$ | 4 | 9.1 | k $\Omega$ |
| $\alpha_{\text {reb }}$ | Interbase Resistance Temperature Coefficient | $\begin{aligned} V_{\mathrm{B} 2-\mathrm{B1}}=3 \mathrm{~V}, \mathrm{I}_{\mathrm{E}}=0, \mathrm{I}_{\mathrm{A}}= & -65^{\circ} \mathrm{C} \text { to } 100^{\circ} \mathrm{C} \\ & \text { See Note } 5 \end{aligned}$ | 0.1 | 0.9 | \%/deg |
| $\eta$ | Intrinsic Standoff Ratio | $\bar{V}_{92-\mathrm{al}}=10 \mathrm{~V}$, See Figure 1 | 0.55 | 0.82 |  |
| $l_{\text {animod] }}$ | Modulated Interbase Current | $V_{87-8_{1}}=10 \mathrm{~V}, I_{E}=50 \mathrm{~mA}$ | 10 |  | mA |
| $\mathrm{IEBE}^{2}$ | Emitter Reverse Current | $V_{B 2-E}=30 \mathrm{~V}, 1_{B 1}=0$ |  | -10 | $n$ A |
| $\mathrm{If}_{\mathrm{P}}$ | Peak-Point Emitter Current | $\mathrm{V}_{82-81}=25 \mathrm{~V}$ |  | 5 | $\mu \mathrm{A}$ |
| $V_{\text {EBII (sat) }}$ | Emitter - Base-One Saturation Voltage | $V_{\mathrm{az}-\mathrm{si}}=10 \mathrm{~V} \mathrm{I}_{\mathrm{s}}=50 \mathrm{~mA}$, See Note 6 |  | 4 | $\checkmark$ |
| Iv | Volley-Point Emitter Current | $V_{\text {E2- } \mathrm{B}_{1}}=20 \mathrm{~V}$ | 2 |  | mA |
| Vom | Base-One Peak Pulse Voltage | See Figure 2 | 3 |  | $\checkmark$ |

NOIES: 5. Temperature coefficient, $\alpha_{\mathrm{r}}$, is determined by the following formula:

$$
\begin{aligned}
& \alpha_{\mathrm{r}} \mathrm{BE}=\left[\frac{\left(r_{\mathrm{BB}} @ 100^{\circ} \mathrm{C}\right)-\left(r_{\mathrm{BB}} @-55^{\circ} \mathrm{C}\right)}{\left.f_{\mathrm{BB}} @ 25^{\circ} \mathrm{C}\right)}\right] \frac{100 \%}{155 \mathrm{deg}} \\
& \mathrm{r}_{\mathrm{BB}(2)}=\left[\mathrm{r}_{\mathrm{BB}} @ 25^{\circ} \mathrm{C}\right]\left[\mathrm{I}+\left(\alpha_{\mathrm{rBB}} / 100\right)_{\left(\mathrm{T}_{\mathrm{A}(2)}-25^{\circ} \mathrm{C}\right]}\right.
\end{aligned}
$$

To obtain $\mathrm{r}_{\mathrm{B} 日}$ for 0 given temperalure $\mathrm{T}_{\mathrm{A}(2)}$, use the following formula:
6. This paramater is measured using pulse techniques. $\mathrm{i}_{\mathrm{p}}=300 \mu \mathrm{~s}$, duty cycle $\leq 2 \%$.

## PARAMETER MEASUREMENT INFORMATION




FIGURE 3 - GENERAL STATIC EMITTER CHARACTERISTIC CURVE

# SILECT ${ }^{\text {FIELD-EFFECT TRANSISTORS } \ddagger+1}$ <br> For Industrial and Consumer Small.Signal Applications <br> - Coded IDSS Ranges for Precise Circuit Design <br> - Low Crss . . $\leqslant 3$ pF <br> - High yfs/Ciss Ratio (High-Frequency Figure-of-Merit) <br> - 2N5949 thru 2N5953 Are Recommended for New Designs 

## mechanical data

These transistors are encapsulated in a plastic compound specifically designed for this purpose, using a highly mechanized process developed by Texas instruments. The case will withstand soldering temperatures without deformation. These devices exhibit stable characteristics under high-humidity conditions and are capable of meeting MIL-STD-202C, Method 106B. The transistor is insensitive to light.

absolute maximum ratings af $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

|  |
| :---: |
|  |  |
|  |  |
|  |  |
|  |  |
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|  |  |
|  |  |
|  |  |

NOTE 1: Derate linearly to $150^{\circ} \mathrm{C}$ free-air temperature at the rate of $2.88 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$.

## TYPES TIS58, TIS59 <br> N-CHANNEL SILICON JUNCTION FIELD-EFFECT TRANSISTORS

## olectrleal characteristics at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

| PARAMETER | TEST CONDITIONS |  |  |  | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: |
| V (0xjess Guto-Source Breakdown Voltage | $\mathrm{I}_{6}=-1 \mu \mathrm{~h}, V_{\text {DS }}=0$ |  | -25 | -25 | Y |
| Gate Cutoff Current | $V_{\text {OS }}=-15 V_{,} Y_{\text {OS }}=0$ |  | -4 | 4 | $n /$ |
|  | $V_{G S}=-15 V_{,} V_{\text {DS }}=0$, | $T_{A}=100^{\circ} \mathrm{C}$ | -2 | -2 | $\mu \mathrm{A}$ |
| loss Zero-Gate-Voliage Drain Current | $V_{\text {OS }}=15 \mathrm{~V}, V_{\text {SS }}=0$, | See Nofs 2 | 2.5 8 | 25 | mA |
| $V_{\text {Gs ofin }}$ Gate-Source Cutoff Voltage | $V_{\text {DS }}=15 \mathrm{~V}, \mathrm{l}_{\mathrm{D}}=20 \mathrm{n}$ |  | -0.5 -5 | $-1 \quad-9$ | V |
| Small-Signal Common-Source Forward Iransfer Admittance | $V_{\text {DS }}=15 \mathrm{~V}, \quad V_{\text {ES }}=0$, | $f=1 \mathrm{kHz},$ <br> See Note 2 | 4000 | 4800 | $\mu \mathrm{mho}$ |
|  | $\begin{aligned} V_{D S} & =15 \mathrm{~V}, \\ \mathrm{I}_{\mathrm{D}} & =2 \mathrm{~mA}(71558) \\ \mathrm{I}_{\mathrm{D}} & =5 \mathrm{~mA}(\mathrm{~T} / 559) \end{aligned}$ | $\mathrm{f}=1 \mathrm{kHz}$ | 130022004000 | 230035005000 | $\mu \mathrm{mho}$ |
| $\begin{aligned} & \text { Small-Signal Common-Source } \\ & \text { Output Admiltance } \end{aligned}$ |  | $f=1 \mathrm{kHz}$ | 20 | 50 | $\mu \mathrm{mhog}$ |
| Ciss $^{\text {Common-Source Short- Circuit }}$ <br> Input Capactonce |  | $t=1$ mhz | 6 | 6 | pF |
| $\mathrm{C}_{\text {rut }}$ Common-Source Short-Girait <br> Reverse Transfer Capacitance |  | 1 = 1 mhz | 3 | 3 | pf |
| $\text { Re }\left(Y_{h}\right) \begin{aligned} & \text { Small-Signal Common-Sourte } \\ & \text { Forward Iransfer Conductonce } \end{aligned}$ |  | $t=100 \mathrm{mHz}$ | 1000 | 2000 | $\mu \mathrm{mhn}$ |

## PARAMETER COLOR-CODE INFORMATION

The TIS58 is furnished in color-coded loss brackets, each having a 2-to-1 spread as shown in Table 1.

$$
\begin{array}{lc}
\text { COLOR CODE } & \begin{array}{c}
\text { IDSs } B R A C K E T ~ \\
\\
\text { Yellow }
\end{array} \\
\text { Green } & 2.5 \mathrm{~mA}-5 \mathrm{~mA} \\
\text { G } & 4 \mathrm{~mA}-8 \mathrm{~mA}
\end{array}
$$

TABLE 1 - TISSB

The TIS59 is furnished in color-coded loss brackets, each having a 2.5 -to-1 spread as shown in Table 2.

| COLOR CODE | Joss $B R A C K E T$ |
| :---: | :---: |
|  | $V_{D S}=15 \mathrm{~V}, V_{G S}=0$, See Note 2 |
| Yellow | $6 \mathrm{~mA}-15 \mathrm{~mA}$ |
| Green | $10 \mathrm{~mA}-25 \mathrm{~mA}$ |

[^121]NOTE 2: These paramators must be measured using pelse rechniques. $t_{p} \approx 100 \mathrm{~ms}$, duty cycle $\leq 10 \%$.

# SILECT ${ }^{\dagger}$ TRANSISTORS $\ddagger$ <br> FOR APPLICATION IN AM-FM RECEIVERS AND GENERAL-PURPOSE HIGH-FREQUENCY AMPLIFIERS <br> TIS62A Features: 

- fT . . . 500 MHz Min
- Low rb'C ${ }^{\text {c }}$. . 20 ps Max
- F... 6 dB Max at 100 MHz

Rugged, One-Piece Construction with Standard TO-18 100-mil Pin Circle
mechanical data
These transistors are encapsulated in a plastic compound specifically designed for this purpose, using a highly mechanized process developed by Texas instruments. The case will withstand soldering temperatures without deformation. These devices exhibit stable characteristics under high-humidity conditions and are capable of meeting MIL-STD-202C, Method 106B. The transistors are insensitive to light.

absolute maximum ratings at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)
Collector-Base Voltage . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 30 V
Collector-Emitter Voltage (See Note 1) . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 12 V

NOTES: 1. This value applles wher the base-emitter diode is open-circuited.
2. Derate inearly to $150^{\circ} \mathrm{C}$ free-air temperature at the rate of $\mathbf{4 \mathrm { mW }} \mathbf{/}^{\circ} \mathrm{C}$.

[^122]USES CHIP N22

## TYPES TIS62A, TIS63A, TIS64A N-P-N SILICON TRANSISTORS

electrical characteristics at $25^{\circ} \mathrm{C}$ free-air temperature

| PARAMETER |  | TEST CONDITIONS | TIS62A |  | TIS63A |  | TIS64A |  | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | MJN | MAX | MIN | MAX | MIN | MAX |  |
| $\mathrm{V}_{\text {(BR) }} \mathrm{CBO}$ | Collector-Base Breakdown Voltage |  | $\mathrm{I}_{C}=100 \mu A, \quad I_{E}=0$ | 30 |  | 30 |  | 30 |  | V |
| $V_{\text {(BR) CEO }}$ | Collector-Emitter Breakdown Voltage | $I_{C}=4 \mathrm{~mA}, \quad I_{B}=0, \quad$ See Note 3 | 12 |  | 12 |  | 12 |  | $V$ |
| $V_{\text {(BR)EBO }}$ | Emitter-Base Breakdown Voltage | $\mathrm{I}_{\mathrm{E}}=100 \mu \mathrm{~A}, \quad \mathrm{I}_{\mathrm{C}}=0$ | 3 |  | 3 |  | 3 |  | V |
| ${ }^{1} \mathrm{CBO}$ | Collector Cutoff Current | $V_{C B}=10 \mathrm{~V}, \mathrm{I}_{\mathrm{E}}=0$ |  | 100 |  | 100 |  | 100 | nA |
| hfe | Static Forward Current Transfer Ratio | $\mathrm{V}_{C E}=10 \mathrm{~V}, \mathrm{I}^{\prime} \mathrm{C}=4 \mathrm{~mA}$ | 30 | 225 | 30 | 225 | 50 | 150 |  |
| Pfel | Small-Signal Common-Emitter Forward Current Transfer Ratio | $V_{C E}=10 \mathrm{~V}, \mathrm{I}_{\mathrm{C}}=4 \mathrm{~mA}, \quad f=455 \mathrm{kHz}$ |  |  | 27 |  |  |  | dB |
|  |  | $\mathrm{V}_{C E}=10 \mathrm{~V}, \mathrm{I}_{\mathrm{C}}=4 \mathrm{~mA}, \quad \mathrm{f}=10 \mathrm{MHz}$ |  |  | 27 |  |  |  |  |
|  |  | $\mathrm{V}_{\mathrm{CE}}=10 \mathrm{~V}, \mathrm{I} C=4 \mathrm{~mA}, \quad \mathrm{f}=100 \mathrm{MHz}$ | 5 | 18 | 5 | 18 | 5 | 18 |  |
| $C_{c b}$ | Collector-Base Capacitance | $\begin{array}{ll} V_{C B}=10 \mathrm{~V}, & I_{E}=0, \end{array} \quad \begin{aligned} & \mathrm{f}=1 \mathrm{MHz}, \\ & \\ & \text { See Note } 4 \end{aligned}$ | 0.4 | 1.3 | 0.4 | 1.3 | 0.4 | 1.3 | pF |
| ${ }^{6}{ }^{\prime} \mathrm{C}_{\mathrm{c}}$ | Collector-Base Time Constant | $\mathrm{V}_{C B}=10 \mathrm{~V}, \mathrm{I}_{\mathrm{E}}=-4 \mathrm{~mA}, f=79.8 \mathrm{MHz}$ |  | 20 |  | 20 |  | 20 | ps |

NOTES: 3. This parameter must be measured using pulse techniques, $t_{w}=300 \mu s$, duty cycle $\leqslant 2 \%$.
4. $C_{c b}$ measurement employs a three-terminal capacitance bridge incorporating a guard circuit. The emitter is connected to the guard terminal of the bridge.
operating characteristics at $25^{\circ} \mathrm{C}$ free-air temperature

| PARAMETER | TEST CONDITIONS |  |  |  | TIS62A |  | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  | TYP | MAX |  |
| F Spot Noise Figure | $V_{C E}=10 \mathrm{~V}$, | $1 \mathrm{C}=2 \mathrm{~mA}$, | $\mathrm{R}_{\mathrm{G}}=300 \Omega$, | $f=100 \mathrm{MHz}$ | 4 | 6 | dB |

THERMAL INFORMATION

DISSIPATION DERATING CURVE


FIGURE 1

# SILECT $\dagger$ FIELD-EFFECT TRANSISTORS $\ddagger$ <br> SUPPLIED AS MATCHED PAIRS 

## - High $\mathbf{y}_{\mathrm{ts}} / \mathbf{C}_{\mathrm{iss}}$ Ratio (High-Frequency Figure-of-Merit)

- Low Input Capacitance, $\mathrm{C}_{\text {iss }} \ldots .8 \mathrm{pF}$ Max
- Low Gafe Reverse Current Differential ... 10 nA Max at $T_{A}=100^{\circ} \mathrm{C}$
- Recommended for Low-Cost, Low-Level D-C Amplifiers, Sample-Hold Circuits, and Series-Shunt Choppers


## mechanical data

Each TIS69 or TIS70 comprises a matched pair of transistors. A clip is supplied with each transistor pair. These transistors are encapsulated in a plastic compound specifically designed for this purpose, using a highly mechanized process developed by Texas instruments. The case will withstand soldering temperatures without deformation. These devices exhibit stable characteristics under high-humidity conditions and are capable of meeting MIL-STD-202C, Method 106B. The transistors are insensitive to light.

absolute maximum ratings at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)


NOTE 1: Derate linearly to $150^{\circ} \mathrm{C}$ free-air temperature at the rate of $2.88 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$.
${ }^{\dagger}$ Trademark of Texas instruments
$\ddagger$ U. S. Patent No. 3,439,238
electrical characteristics at $\mathbf{2 5}{ }^{\circ} \mathrm{C}$ froe-air temperature (unloss otherwise noted)
individual triode characteristics

|  | PARAMETER | TEST CONDITIONS |  |  | MIN | MaX | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| less | Gate Reverse Current | $V_{G S}=-25 \mathrm{~V}$ | $V_{\text {DS }}=0$ |  |  | -1 | $\mu \mathrm{A}$ |
|  |  | $V_{\text {GS }}=-15 V_{1}$ | $V_{\text {DS }}=0$ |  |  | -2 | nA |
|  |  | $V_{\text {GS }}=-15 \mathrm{~V}$, | $V_{0 S}=0$, | $\mathrm{I}_{\mathrm{A}}=100^{\circ} \mathrm{C}$ |  | -2 | $\mu$ |
| $V_{\text {csiofl }}$ | Gate-Source Cutoff Voltage | $V_{\text {DS }}=15 \mathrm{~V}$, | $\mathrm{l}_{0}=2 \mathrm{nA}$ |  | -0.5 | -5 | $V$ |
| loss | Zero-Gote-Voltage Drain Current | $V_{\text {DS }}=15 \mathrm{~V}$, | $V_{G S}=0$, | See Note 2 | 0.5 | 8 | mA |
| $\left\|y_{t s}\right\|$ | Small-Slgnal Common-Source Forward Tronster Admittance | $V_{\text {OS }}=15 \mathrm{~V}$, | $V_{\text {Gs }}=0$, | $f=1 \mathrm{kHz}$ | 1 | 6 | mmho |
| \|Yos ${ }^{\text {a }}$ | Small-Signol Common-Source Output Admittance | $V_{D S}=15 \mathrm{~V}$, | $V_{\text {GS }}=0$, | $\mathrm{f}=1 \mathrm{kHz}$ |  | 35 | $\mu \mathrm{mho}$ |
| $C_{6}$ | Small-Signal Common-Source Input Capocitance | $V_{D S}=15 \mathrm{~V}$, | $V_{G S}=0$, | $\mathrm{f}_{\text {¢ }}=1 \mathrm{mhz}$ |  | 8 | pf |
| $\mathrm{Crss}^{\text {r }}$ | Small-Signol Common-Source Reverse Transter Capocitonce | $\mathrm{V}_{\mathrm{DS}}=15 \mathrm{~V}$, | $\mathbf{V}_{\mathbf{G s}}=0$, | $\mathrm{f}=\mathrm{I}$ M Mz |  | 4 | pf |
| $\left\|y_{s t}\right\|$ | Small-Signal Common-Source Forward Transfor Admittance | $V_{D S}=15 \mathrm{~V}$, | $V_{\text {SS }}=0$, | $f=100 \mathrm{mHz}$ | 0.8 |  | mmhe |

triode matching characteristics

| PARAMETER |  | TEST CONDITIONS | $\begin{gathered} \text { TIS69 } \\ \hline \text { MIN MAX } \\ \hline \end{gathered}$ | $\begin{array}{\|l\|} \hline 71570 \\ \hline \text { KIN MAX } \\ \hline \end{array}$ | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  | Gate-Reverse-Current Differentiol | $\begin{aligned} V_{G S}=-15 \mathrm{~V}, & V_{D S} \\ & =0 \\ T_{A} & =100^{\circ} \mathrm{C} \end{aligned}$ | 10 | 10 | nA |
| $\left\|V_{G S 1}-V_{G S 2}\right\|$ | Gate-Source-Voltage Differential | $V_{\text {DS }}=15 \mathrm{~V}, \quad \mathrm{I}_{\mathrm{D}}=50 \mu \mathrm{~A}$ | 16 | 32 | m ${ }^{\text {V }}$ |
|  |  | $V_{D S}=15 V_{1} \quad I_{D}=500 \mu \mathrm{~A}$ | 10 | 15 | mV |
| $\left.\mid \Delta V_{\text {SSI }}-V_{\text {ES }}\right)_{\Delta T_{A}} \mid$ | Gate-Source-Voltage Differential Change with Temperature | $\begin{array}{ll} \hline V_{D S}=15 \mathrm{~V}, & \mathrm{I}_{\mathrm{D}}=500 \mu \mathrm{~A}, \\ \mathrm{I}_{A(1)}=25^{\circ} \mathrm{C}, & \mathrm{I}_{A(2)}=-40^{\circ} \mathrm{C} \end{array}$ | 10 | 15 | ${ }^{m}$ |
|  |  | $\begin{array}{ll} V_{D S}=15 \mathrm{~V}, & I_{0}=500 \mu \mathrm{~A} \\ I_{A(1)}=25^{\circ} \mathrm{C}, & \mathrm{I}_{A(2)}=100^{\circ} \mathrm{C} \end{array}$ | 10 | 15 | mV |
| $\begin{array}{\|l\|l\|} \frac{\text { loss1 }}{l_{\text {loss2 }}} \\ \hline \end{array}$ | Zero-Gate-Voltage Droin Curront Ratio | $V_{D S}=15 \mathrm{~V}, \begin{aligned} & V_{G S}=0, \\ & \text { Soe Mote 3 } \end{aligned}$ | 0.9 J | 0.81 |  |
| $\frac{\left\|y_{k}\right\|_{1}}{\left\|y_{t}\right\|_{2}}$ | Small-Signol Common-Source Forward Trensier Admistance Ratio | $\begin{array}{ll} V_{D S}=15 V_{1} & V_{G S}=0 \\ 1=1 \mathrm{kHz}, & \text { See Note } 3 \end{array}$ | 0.91 | 0.81 |  |

NOTES: 2. This parameter must be measured using pulse techniques. $t_{w} \approx 100 \mathrm{~ms}$, duty evcle $\leq 10 \%$.
3. The fower of the two characteristic readings is taken as the numerator.

# SILECT $\dagger$ FIELD-EFFECT TRANSISTORS $\ddagger$ FOR HIGH-SPEED COMMUTATOR AND CHOPPER APPLICATIONS 

- Low $\mathrm{r}_{\text {dr(an) }}: \mathbf{2 5 \Omega}$ Max (TIS73)
- Low $I_{\text {D(off }}: 2$ nA Max
- Low Drain-Gate Capacitance ( $\mathrm{C}_{\text {res }}$ ): 8 pF Max
- Rugged, One-Piece Construction wifh Standard

T0-18 100-mil Pin-Circle

## mechanical data

These transistors are encapsulated in a plastic compound specifically designed for this purpose, using a highly mechanized process developed by Texas Instruments. The case will withstand soldering temperatures without deformation. These devices exhibit stable characteristics under high-humidity conditions and are capable of meeting MIL-STD-202C, Method 106B. The transistors are insensitive to light.

absolute maximum ratings at $25^{\circ} \mathrm{C}$ free-air temperature (unless othorwise noted)


MOTES: 1 . Derate linderly te $150^{\circ} \mathrm{C}$ troe-air temperature at the rate of $2.2 \mathrm{et} \mathrm{mW} / \mathrm{deg}$.

${ }^{\dagger}$ Trademark of Texes Inetruments
¥U. S. Patent No. 3,439,238

## TYPES TIS73, TIS74, TIS75 <br> N-CHANNEL SILICON JUNCTION FIELD-EFFECT TRANSISTORS

electrical characteristics of $25^{\circ} \mathrm{C}$ free-cir temperature (unless otherwise noted)

| PARAMETER <br> $V_{\text {(IE) }}$ \|sss Gate-Source Breakdown Voltage | TEST CONDITIONS | TiS73 | TIS74 | TiS75 | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | MIN MAX | MIN MAX | MIN MAX |  |
|  | $\mathrm{I}_{G}=-1 \mu \mathrm{~A}, V_{\text {dS }}=0$ | -30 | -30 | -30 | 1 |
| Gate Reverse Curront | $V_{G S}=-15 \mathrm{~V}, V_{\text {DS }}=0$ | -2 | -2 | -2 | nA |
|  | $V_{G S}=-15 V, V_{D S}=0, \quad T_{A}=100^{\circ} \mathrm{C}$ | -5 | -5 | -5 | $\mu \mathrm{A}$ |
| Drain Cutoff Current | $V_{\text {DS }}=15 \mathrm{~V}, \quad V_{G S}=-10 \mathrm{~V}$ | -2 | -2 | -2 | nA |
| $\mathrm{V}_{\text {SSIoffl }}$ Gate-Source | $V_{D S}=15 \mathrm{~V}, \quad V_{G S}=-10 \mathrm{~V}, \mathrm{~T}_{\mathrm{A}}=100^{\circ} \mathrm{C}$ | -5 | -5 | -5 | $\mu \mathrm{A}$ |
| loss $\quad$ Zero-Gate-Voltage Drain C | $V_{\text {DS }}=15 \mathrm{~V}, \mathrm{I}_{\mathrm{D}}=4 \mathrm{nA}$ | -4 $\quad-10$ | -2 -6 | $-0.8-4$ | V |
|  | $V_{D S}=15 V_{\text {d }} \quad V_{G S}=0, \quad$ See Note 3 | 50 | $20 \quad 100$ | 880 | mA |
| Drain-Sourte On-State Voltage | $\mathrm{I}_{\mathrm{D}}=20 \mathrm{~mA}, \quad V_{G S}=0$ | 0.75 |  |  | V |
|  | $\mathrm{T}^{\text {D }}=10 \mathrm{~mA}, \quad V_{G S}=0$ |  | 0.5 |  | $V$ |
|  | $\mathrm{I}_{0}=5 \mathrm{~mA}, \quad V_{G S}=0$ |  |  | 0.5 | $V$ |
| Idsion) On-State Resistance | $V_{G S}=0, \quad l_{\text {d }}=0, \quad f=1 \mathrm{kHz}$ | 25 | 40 | 60 | $\Omega$ |
| $\mathrm{C}_{\text {ise }} \quad \begin{aligned} & \text { Common-Source Shert-Circuif } \\ & \text { Input Capactance }\end{aligned}$ | $V_{\text {DS }}=0, \quad V_{G S}=-10 \mathrm{~V}, \mathrm{f}=1 \mathrm{mHz}$ | 18 | 18 | 18 | pF |
| $\mathbf{C}_{\text {ris }}$ Common-Source Short-Circuit <br> Reverse Trunsfar Copocitance | $V_{D S}=0, \quad V_{G S}=-10 \mathrm{~V}, \mathrm{f}=1 \mathrm{mHz}$ | 8 | 8 | 8 | pF |

switching characteristics at $25^{\circ} \mathrm{C}$ free-air temperature


HOTE 3: These perameters mest be meosured ssing pelse fochniques. $t_{p} \approx 100$ ms, duty cycle $\leq 10 \%$.
†These are nominal valoes, exact values vary slightly with transistor paremeters.

## PARAMETER MEASUREMENT INFORMATION



NOTES
The input woveforms are suppliad by a genarator with the foliowing characteristics: $l_{\text {ouf }}=50 \Omega$, duty cycle $\approx 2 \%$.
b. Waveforms are monitored on on oscilloscopa with the following characteristics: $t_{r} \leq 0.75 \mathrm{~ms}, \mathrm{R}_{\mathrm{in}} \geq 1 \mathrm{M} \Omega, \mathrm{c}_{\mathrm{in}} \leq 2.5 \mathrm{pF}$.

# HIGH-FREQUENCY SILECT $\dagger$ TRANSISTORS $\ddagger$ FOR TV TUNER AND IF APPLICATIONS <br> <br> Featuring Low-Feedhack Capacitance and Forward-AGC Characteristics <br> <br> Featuring Low-Feedhack Capacitance and Forward-AGC Characteristics <br> - TIS84 for Tuner RF Amplifiers <br> - TIS108 for IF Amplifiers (Replaces TIS85) 

## Rugged, One-Piece Construction with Standard T0-18 100-mil Pin Circle

## mechanical data

These transistors are encapsulated in a plastic compound specifically designed for this purpose, using a highly mechanized process developed by Texas Instruments. The case will withstand soldering temperatures without deformation. These devices exhibit stable characteristics under high-humidity conditions and are capable of meeting MIL-STD-202C, Method 106B. The transistors are insensitive to light.
Feedback capacitance is minimized by placing the emitter terminal between the base and collector terminals, thus optimizing compatability with advanced high-frequency design.

absolute maximum ratings at $25^{\circ} \mathrm{C}$ free-air temparature (unless otherwise noted)

$$
\text { Collector-Base Voltage . . . . . . . . . . . . . . . . . . . . . . . . . } 40 \text { V }
$$

Collector-Emitter Voltage (See Note 1) ..... 30 V
Emitter-Base Voltage ..... 4 V
Continuous Collector Current ..... 50 mA
Continuous Device Dissipation at (or below) $25^{\circ} \mathrm{C}$ Free-Air Temperature (See Note 2) ..... 500 mW
Storage Temperature Range . ..... $-65^{\circ} \mathrm{C}$ to $150^{\circ} \mathrm{C}$
Lead Temperature $\mathrm{K}_{6}$ Inch from Case for 10 Seconds ..... $260^{\circ} \mathrm{C}$
electrical characteristics at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

| PARAMETER |  | TEST CONDITIONS |  | TIS84 |  | TIS 108 |  | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | MIN | MAX | MIN | MAX |  |
| $V_{\text {(RX) }}$ | Collector-Base Breakdown Yolitige |  |  | $\mathrm{I}_{\mathrm{C}}=10 \mu \mathrm{~A}, \mathrm{I}_{\mathrm{E}}=0$ |  | 40 |  | 40 |  | $V$ |
|  | Collector-Emitter Breakdown Voltoge | $\mathrm{I}_{\mathrm{c}}=10 \mathrm{~mA}, \mathrm{I}_{\mathrm{I}}=0$, | See Note 3 | 30 |  | 30 |  | $V$ |
| lcro | Collector Cutoff Current | $V_{C I}=10 \mathrm{~V}, \mathrm{I}_{\mathrm{E}}=0$ |  |  | 50 |  | 50 | nA |
|  |  | $\mathrm{V}_{\mathrm{CI}}=10 \mathrm{~V}, \mathrm{I}_{\mathrm{E}}=0$, | $\mathrm{T}_{\mathrm{A}}=85^{\circ} \mathrm{C}$ |  | 5 |  | 5 | $\mu \mathrm{A}$ |
| $\mathrm{I}_{\text {Evo }}$ | Emitier Cutoff Current | $V_{E D}=4 \mathrm{~V}, \mathrm{l}_{\mathrm{c}}=0$ |  |  | 10 |  | 10 | $\mu \mathrm{A}$ |
| hre | Static Forward Current Tronster Ratio | $V_{C E}=10 \mathrm{~V}, \mathrm{I}_{C}=4 \mathrm{~mA}$ |  | 30 |  | 25 |  |  |
| $V_{\text {EE }}$ | Base-Emitter Voltage | $V_{C E}=10 \mathrm{~V}, \mathrm{I}_{\mathrm{C}}=4 \mathrm{~mA}$ |  |  | 0.84 |  | 0.84 | V |

NOTES: 1. This velue applies when the base-emitter diode is open-circuited.
2. Derate linearly to $150^{\circ} \mathrm{C}$ free-air temperature at the rate of $4 \mathrm{~mW} /^{\circ} \mathrm{C}$.
3. This parameter must be measured using pulse techniques. $t_{w}=300 \mu s$, duty cycle $\leqslant 2 \%$.

[^123]
## TYPES TIS84, TIS108 <br> N-P-N SILICON TRANSISTORS

-lectrical characteristics at $\mathbf{2 5}^{\circ} \mathrm{C}$ free-air temperature

| PARAMETER |  | TEST CONDITIONS | T1584 | 715108 | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  | Small-Signal Commen-Emiftier Forward Curment Transfer Rotio |  | MIN TYP MAX | MIN TYP MAX |  |
| $\left\|h_{60}\right\|$ |  | $V_{c t}=10 \mathrm{~V}, \mathrm{I}_{\mathrm{c}}=4 \mathrm{~mA}, f=100 \mathrm{mHz}$ | 3.56 .5 | $3.5 \quad 6.5$ |  |
| $\left\|y_{1}\right\|$ | Small-Sjenal Common-Emittior Forward Transfer Admitiance | $V_{C!}=10 V_{,} I_{c}=4 \mathrm{~mA}, f=200 \mathrm{mhz}$ | 6080 |  | mmho |
|  |  | $V_{C!}=10 V_{,} I_{C}=4 \mathrm{~mA}, i=45 \mathrm{miz}$ |  | $80 \quad 105$ |  |
|  | Phase Angle of Small-Stgnol CommonEmilter Forword Prenstor Admittonce | $V_{C!}=10 \mathrm{~V}, I_{C}=4 \mathrm{~mA}, 1=200 \mathrm{MHz}$ | $-50^{\circ}-60^{\circ}-60^{\circ}$ |  |  |
|  |  | $V_{C!}=10 \mathrm{~V}, \mathrm{I}_{\mathrm{c}}=4 \mathrm{~mA}, \mathrm{f}=45 \mathrm{mHz}$ |  | $-10^{\circ}-18^{\circ}-25^{\circ}$ |  |
| Cios | Poralici-Equivalent Common-Emitter Short-Circuit Input Capacitrance $\dagger$ | $V_{\mathrm{CI}}=10 \mathrm{~V}, \mathrm{I}_{\mathrm{c}}=4 \mathrm{~mA}, f=200 \mathrm{MHz}$ | 11 |  | pF |
|  |  | $V_{C E}=10 V_{1} I_{C}=4 \mathrm{~mA}, t=45 \mathrm{MHz}$ |  | 18 |  |
| $\mathrm{Cras}^{\prime}$ | Common-Emitter Shont-Circult Reverse Transfor Capocitanco $\dagger$ | $\begin{array}{r} V_{c i}=10 \mathrm{~V}, \\ \mathrm{I}_{\mathrm{c}}=1 \mathrm{~mA} \\ \mathrm{f}=0.1 \mathrm{MHz} \text { to } 1 \mathrm{mHz} \end{array}$ | 0.220 .4 | 0.220 .4 | pF |
| $C_{001}$ | Parallad-Equivalent Common-Emithor Short-Clrevit Output Capocitance $\dagger$ | $V_{C E}=10 \mathrm{~V}, I_{C}=4 \mathrm{~mA}, t=200 \mathrm{MHz}$ | 1.1 |  | pF |
|  |  | $V_{C I}=10 \mathrm{~V}, \mathrm{I}_{\mathrm{C}}=4 \mathrm{~mA}, \hat{1}=45 \mathrm{mmz}$ |  | 1.1 |  |
| Re( $\mathrm{h}_{\text {a }}$ ) | Real Port of Smali-Signel Common-Emitter Input Impedance | $V_{C E}=10 \mathrm{~V}, \mathrm{I}_{\mathrm{C}}=4 \mathrm{~mA}, \mathrm{I}=200 \mathrm{mHz}$ | $25 \quad 60$ |  | $\Omega$ |
|  |  | $V_{C E}=10 V_{1} I_{C}=4 \mathrm{~mA}, f=45 \mathrm{mhz}$ |  | 5080 |  |
| Re(yiol | Real Port of Small-Signal Common-Emither Input Admiltance | $V_{C E}=10 \mathrm{~V}, \mathrm{I}_{\mathrm{C}}=4 \mathrm{~mA}, f=200 \mathrm{mHz}$ | $14 \quad 40$ |  | mmho |
|  |  | $V_{C E}=10 \mathrm{~V}, \mathrm{I}_{\mathrm{C}}=4 \mathrm{~mA}, f=45 \mathrm{mHz}$ |  | 36 |  |
| Re(yool | Real Purt of Small-Signal Common-Emifter Output Admittonce | $V_{C E}=10 \mathrm{~V}, \mathrm{I}_{\mathrm{C}}=4 \mathrm{~mA}, f=200 \mathrm{mHz}$ | 0.20 .5 |  | mmho |
|  |  | $V_{C E}=10 \mathrm{~V}, \mathrm{I}_{C}=4 \mathrm{~mA}, i=45 \mathrm{mHz}$ |  | 0.050 .2 |  |


operating characteristics at $\mathbf{2 5}^{\mathbf{\circ}} \mathbf{C}$ free-air temperature

| Parameter |  | TEST CONDITIONS |  |  | T1584 |  |  | TIS108 |  |  | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| WF | Spof Noise Figure |  |  |  | MIN | TYP | MAX | MIN | TYP | MAX |  |
|  |  | $\begin{aligned} & V_{\text {cE }}=10 \mathrm{~V} \\ & f=200 \mathrm{MHz} \end{aligned}$ | $\mathrm{l}_{\mathrm{c}}=3 \mathrm{~mA}$, | $\mathrm{R}_{6}=50 \Omega$, |  | 2.8 |  |  |  |  | dB |
|  |  | $\begin{aligned} & V_{\text {CE }}=10 \mathrm{~V}, \\ & f=45 \mathrm{mHz} \\ & \hline \end{aligned}$ | $l_{c}=3 \mathrm{~mA}$, | $R_{G}=50 \Omega$, |  |  |  |  | 3 | 6 | $d B$ |
| $\mathbf{G p o}$ | Unneutrolized SmallSignal Common-Emittor Insertion Power Gain | $\begin{array}{\|l\|} \hline V_{c c}=12 \mathrm{~V} \\ R_{G^{\prime}}=150 \Omega \\ \text { See Figure } 1 \\ \hline \end{array}$ | $\begin{aligned} & I_{c} \approx 2.5 \mathrm{~mA}, \\ & R_{L}^{\prime}=1 \mathrm{k} \Omega_{1}, \end{aligned}$ | $\begin{aligned} & V_{B y}=2.1 v_{1} \\ & f=200 \mathrm{mHz}, \end{aligned}$ | 12 | 16 | 18 |  |  |  | dB |
|  |  | $\begin{array}{\|l} V_{c c}=12 \mathrm{~V} \\ R_{\mathrm{S}^{\prime}}=500 \Omega \\ \text { See Figure I } \\ \hline \end{array}$ | $\begin{aligned} & \mathrm{l}_{\mathrm{c}} \approx 4.5 \mathrm{~mA}, \\ & \mathrm{R}_{\mathrm{L}^{\prime}=250 \Omega}, \end{aligned}$ | $\begin{aligned} & V_{a b}=2.6 \mathrm{~V} \\ & \mathrm{f}=45 \mathrm{mHz}, \end{aligned}$ |  |  |  | 25 | 30 | 33 | dB |
| $V_{\text {buec }}$ | Gain-Control <br> Baso-Supply <br> Voliage | $\begin{aligned} & \mathrm{V}_{\mathrm{Cc}}=12 \mathrm{~V}, \\ & \Delta \mathrm{G}_{\mathrm{po}}=-30 \mathrm{~dB} \ddagger \end{aligned}$ | $\begin{aligned} & R_{s}^{\prime}=150 \Omega, \\ & f=200 \mathrm{mHz}, \end{aligned}$ | $R_{L}^{\prime}=1 \mathrm{k} \Omega,$ <br> See Figure 1 | 3.7 |  | 4.6 |  |  |  | V |
|  |  | $\begin{aligned} & V_{c c}=12 \mathrm{~V}, \\ & \Delta G_{p p}=-30 \mathrm{~dB} \ddagger \end{aligned}$ | $\begin{aligned} & R_{\boldsymbol{s}}^{\prime}=500 \Omega, \\ & \mathrm{f}=45 \mathrm{MHz}, \end{aligned}$ | $R_{L}^{\prime}=250 \Omega$ <br> See Figure 1 |  |  |  | 3.5 |  | 4.5 | V |



# TYPES TISE4, TIS108 <br> N-P-N SILICON TRANSISTORS 

## PARAMETER MEASUREMENT INFORMATION



FIGURE 1 - POWER-GAIN AND GAIN-CONTROL-VOLTAGE TEST CIRCUIT

## TYPICAL CHARACTERISTICS

TISe4
SPOT NOISE FIGURE COLLECTOR CURRENT


FIGURE 2

Tis84
RELATIVE SMALL-SIGNAL COMMON-EMITTER POWER GAIN vs


FIGURE 3


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If caanot assume ony raspensibility for ony cirtuils shown
of represent that they ore free tram polent infringamant.
texas msthuments mesteves the night to maxe thanges at any time in order to Improve design and to supply the best phoduct possible.

TEXAS INSTRUMENTS

# HIGH-FREQUENCY SILECT $\dagger$ TRANSISTORS $\ddagger$ DESIGNED FOR TV MIXER AND NON-AGC IF STAGES <br> Featuring Low Feedback Capacitance and Full Characterization to Simplify Circuit Design <br> - TIS86 for Mixer <br> - TIS87 for Non-AGC IF Amplifier <br> Rugged, One-Piece Construction with Standard T0-18 100-mil Pin Circle 

## mechanical data

These transistors are encapsulated in a plastic compound specifically designed for this purpose, using a highly mechanized process developed by Texas Instruments. The case will withstand soldering temperctures without deformation. These devices exhibit stable characteristics under high-humidity conditions and are capable of meeting MIL-STD-202C, Method 1068. The transistors are insensitive to light.
Feedback capacitance is minimized by placing the emitter terminal between the base and collector terminals, thus optimizing compatibility with advanced high-frequency design.

absolute maximum ratings at $25^{\circ} \mathrm{C}$ free-air temperature (unless othorwise noted)


MOTES: 1. This value applies when the bose-emilter diede is open-eircuited.
2. Derate lineariy to $150^{\circ} \mathrm{C}$ freo-air tumperature at the rate af $3.2 \mathrm{~mW} / \mathrm{deg}$.
3. Derate linearly to $150^{\circ} \mathrm{C}$ lead temperatere of the rate of $5.6 \mathrm{~mW} / \mathrm{deg}$. Lead temperature is measurod on the coliecter lead $1 / 16$ inch from the case.

## TYPES TIS86, TIS87 N-P-N SILICON TRANSISTORS

eloctrical characteristics at $25^{\circ} \mathrm{C}$ freo-air temperature (unless otherwise noted)

| PARAMETER |  | TEST CONDITIONS | 7586 | 11587 | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | MIN TYP MAX | MIN TYP MAX |  |
| $V_{\text {arajciol }}$ | Collector-Base Breakdown Vohtrge |  | $\mathrm{Ic}_{\mathrm{c}}=10 \mu \mathrm{l}_{1} \mathrm{l}_{\mathrm{E}}=0$ | 30 | 45 | $v$ |
| $V_{\text {(lu) }}$ | Collector-Emitter Breakdown Vothoge | $\mathrm{I}_{\mathrm{c}}=10 \mathrm{~mA}, \mathrm{I}_{\mathrm{E}}=0, \quad$ Soe Note 4 | 30 | 45 | V |
| leso | Collector Cutoff Current | $V_{C B}=15 \mathrm{~V}, \mathrm{I}_{\mathrm{E}}=0$ | 100 | 100 | $\underline{\mathrm{n}}$ |
|  |  | $V_{C B}=15 \mathrm{~V}, \mathrm{I}_{\mathrm{E}}=0, \quad \mathrm{~T}_{\mathrm{A}}=85^{\circ} \mathrm{C}$ | 10 | 10 | $\mu \mathrm{A}$ |
| $\mathrm{I}_{\mathrm{E}}$ | Emitter Cutofi Current | $V_{\text {Eti }}=4 \mathrm{~V}, \mathrm{I}_{\mathrm{c}}=0$ | 10 | 10 | $\mu A$ |
| $h_{\text {fe }}$ | Static Forword Current Trunsfer Ratio | $\mathrm{V}_{\mathrm{CE}}=10 \mathrm{~V}, \mathrm{I}_{\mathrm{C}}=4 \mathrm{~mA}$ | $40 \quad 200$ |  |  |
|  |  | $V_{C E}=12 \mathrm{~V}, \mathrm{I}_{\mathrm{C}}=12 \mathrm{~mA}$, See Mole 4 |  | $30 \quad 150$ |  |
| $V_{\text {ex }}$ | Bose-Emitite Yoltuge | $V_{C E}=12 \mathrm{~V}, \mathrm{I}_{\mathrm{c}}=15 \mathrm{~mA}$, See Mote 4 | 0.87 | 0.87 | $V$ |
| $\bar{V}_{\text {CEF }}$ | Collector-Emitter Saturation Voltoje | $\mathrm{I}_{3}=1.5 \mathrm{~mA}, \mathrm{l}_{\mathrm{c}}=15 \mathrm{~mA}$ |  | 0.5 | V |
| \|hiol | Smoll-Signol Common-Emitter Fonward Current Tronsfor Ratio | $V_{C E}=10 \mathrm{~V}, \mathrm{I}_{\mathrm{C}}=4 \mathrm{~mA}, t=100 \mathrm{mtz}$ | 5 |  |  |
|  |  | $\mathrm{V}_{\text {CE }}=12 \mathrm{~V}, \mathrm{l}_{C}=12 \mathrm{~mA}, \mathrm{f}=100 \mathrm{mHz}$ |  | 5 |  |
| $\left\|y_{\text {fol }}\right\|$ | Small-Signal Common-Emitter Forward Iransfor Admittonce | $Y_{C E}=10 \mathrm{~V}, \mathrm{l}_{\mathrm{C}}=4 \mathrm{~mA}, f=45 \mathrm{mmz}$ | 90115 |  | nimho |
|  |  | $V_{\text {CE }}=12 \mathrm{~V}, \mathrm{l}_{\mathrm{C}}=12 \mathrm{~mA} f=45 \mathrm{mmz}$ |  | $130 \quad 200$ |  |
| $\phi_{\text {y }}^{\text {re }}$ | Phase Angle of Small-Signal Common-Emittor Forward Tronsfor Admiftrance | $V_{C E}=10 \mathrm{~V}, \mathrm{I}_{\mathrm{C}}=4 \mathrm{~mA}, f=45 \mathrm{mmz}$ | $-7^{\circ}-15^{\circ}-20^{\circ}$ |  |  |
|  |  | $V_{\text {ce }}=12 \mathrm{~V}, \mathrm{t}_{\mathrm{c}}=12 \mathrm{~mA}, i=45 \mathrm{mHz}$ |  | $-18^{\circ}-25^{\circ}-35^{\circ}$ |  |
| Cos | Paralle-Equivalent Common-Emitter Short-Circuit Input Capactionces $\dagger$ | $V_{C E}=10 \mathrm{~V}, \mathrm{l}_{\mathrm{C}}=4 \mathrm{~mA}, f=200 \mathrm{mHz}$ | 9 |  | pf |
|  |  | $V_{C E}=12 \mathrm{~V}, \mathrm{I}_{\mathrm{C}}=12 \mathrm{~mA}, f=45 \mathrm{mHz}$ |  | 25 |  |
| Cros | Common-Emitter Short-Circuit Reverse Transier Capacitance $\dagger$ | $V_{C E}=10 \mathrm{~V}, \mathrm{I}_{\mathrm{c}}=1 \mathrm{~mA},$ | $0.33 \quad 0.45$ | 0.330 .45 | pF |
| Cor | Parallel-Equivalent Common-Emitter Short-Giruit Output Copaditoncet | $V_{C E}=10 \mathrm{~V}, \mathrm{I}_{\mathrm{C}}=4 \mathrm{mR}, 1=45 \mathrm{mhz}$ | 1.1 |  | pf |
|  |  | $V_{C E}=12 \mathrm{~V}, \mathrm{I}_{\mathrm{C}}=12 \mathrm{~mA}, i=45 \mathrm{mHz}$ |  | 1.1 |  |
| Re( $\mathrm{h}_{\text {iof }}$ ) | Real Part of Small-Signal Common-Emitter Input Impedance | $V_{C E}=10 \mathrm{~V}, \mathrm{~L}_{\mathrm{c}}=4 \mathrm{~mA}, 1=200 \mathrm{mHz}$ | $32 \quad 60$ |  | $\Omega$ |
|  |  | $V_{C E}=12 \mathrm{~V}, \mathrm{I}_{\mathrm{C}}=12 \mathrm{~mA}, 1=45 \mathrm{mmz}$ |  | $55 \quad 100$ |  |
| Re(yiol | Real Port of Smali-Signal Common-Emitter Input Adanittence | $V_{C E}=10 V_{,} I_{C}=4 \mathrm{~mA}, \quad f=200 \mathrm{MHz}$ | $8.5 \quad 30$ |  | mombo |
|  |  | $V_{C E}=12 \mathrm{~V}, \mathrm{I}_{\mathrm{C}}=12 \mathrm{mh}, 1=45 \mathrm{mHz}$ |  | $5 \quad 12$ |  |
| Re(yoce | Real Port of Small-Signol Common-Emitter OUtput Admittance | $V_{C E}=10 \mathrm{~V}, I_{C}=4 \mathrm{~mA}, \quad i=45 \mathrm{mHz}$ | $0.02 \quad 0.15$ |  | mmbe |
|  |  | $V_{C E}=12 \mathrm{~V}, \mathrm{I}_{\mathrm{C}}=12 \mathrm{~mA}, f=45 \mathrm{mHz}$ |  | $0.07 \quad 0.2$ |  |

MOTE 4: These parameters must be maasured using pulse techniques. $\mathrm{I}_{\mathrm{p}}=300 \mu \mathrm{~s}$, dety cycle $\leq \mathbf{2 \%}$.
$\dagger C_{i e s}, C_{\text {ress }}$ ond $C_{\text {oes }}$ are defined as the imeginary perts of thes smell-sigmol, commen-emither, shect-circcif edmittences divided by $\mathbf{2 \pi f}$.
operating characteristics of $25^{\circ} \mathrm{C}$ free-air temperafure

| PARAMETER | TEST CONDITIONS | TIS86 |  | UNIT |
| :---: | :---: | :---: | :---: | :---: |
|  |  | TYP | MAX |  |
| MF Spot Noise Figure | $V_{C E}=10 \mathrm{~V}, \mathrm{~T}_{\mathrm{c}}=4 \mathrm{~mA}, \mathrm{R}_{6}=50 \Omega, \mathrm{f}=200 \mathrm{NHz}$ | 2.5 | 5 | dB |



## SILECT $\dagger$ COMPLEMENTARY TRANSISTORS ${ }^{\ddagger}$ Available in Matched Complementary Pairs (TIS90M thru TIS93M) for Complementary-Symmetry or Other Class-B Audio-Amplifier Applications <br> - Supplied in Color-Coded $h_{\text {FE }}$ Brackets of 3-dB-Maximum Range <br> - I.6-W Rating af $25^{\circ} \mathrm{C}$ Case Temperature

## mechanical data

These transistors are encapsulated in a plastic compound specifically designed for this purpose, using a highly mechanized process developed by Texas Instruments. The case will withstand soldering temperatures without deformation. These devices exhibit stable characteristics under high-humidity conditions and are capable of meeting MIL-STD-202C, Method 106B. The transistors are insensitive to light.

absolute maximum ratings at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted) 8
Coilector-Base Voltage . . . . . . . . . . . . . . . . . . . . . . . . . 40 V
Collector-Emitter Voltage (See Note 1) . . . . . . . . . . . . . . . . . . . . 40 V
Emitter-Base Voltage . . . . . . . . . . . . . . . . . . . . . . . . . . 5 V
Continuous Collector Current . . . . . . . . . . . . . . . . . . . . . . 400 mA
Continuous Device Dissipation at (or below) $25^{\circ} \mathrm{C}$ Free-Air Temperature (See Note 2) . . . . 625 mW
Continuous Device Dissipation at (or below) $25^{\circ} \mathrm{C}$ Lead Temperature (See Note 3) . . . . . 1.25 W
Continuous Device Dissipation at (or below) $25^{\circ} \mathrm{C}$ Case-and-Lead Temperature (See Note 4) . . 1.6 W
Storage Temperature Range . . . . . . . . . . . . . . . . . . . $-65^{\circ} \mathrm{C}$ to $150^{\circ} \mathrm{C}$
Load Temperature $Y_{6}$ Inch from Case for 10 Seconds . . . . . . . . . . . . . . . $260^{\circ} \mathrm{C}$
NOTES: 1. This value appiles whan the base-emitter diode is open-circulted.
2. Derate linearly to $150^{\circ} \mathrm{C}$ free-air tempereture at the rate of $\mathrm{BmW} /^{\circ} \mathrm{C}$.
3. Derate linearly to $180^{\circ} \mathrm{C}$ lead tamperature at the rate of $10 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$

Leed temperature is measured on the callector leed 1/16 inch from the case.
4. This rating applies with the entira ease (Including the leads) maintained at $25^{\circ} \mathrm{C}$.
§ Voltages and currents apply to the n-p-n transletors. For the p-n-p transistors the values ine the same, but the polaritien are reversed.

## N-P-N TYPES TIS90, TISS0M, TIS92, TIS92M P-N-P TYPES TIS91, TIS91M, TIS93, TIS93W COMPLEMENTARY SILICON TRANSISTORS

electrical characteristics af $25^{\circ} \mathrm{C}$ free-air temperature

| PARAMETER |  | TEST CONDITIONS $\dagger$ | N-P-N |  |  | P-N-P | Unit |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | TIS90, TIS90M TIS92, TIS92M | $\begin{aligned} & \text { TiS91, TiS91M } \\ & \text { TIS93, } 1593 \mathrm{M} \end{aligned}$ |  |
|  |  | MIN | TYP | MAX | MIN TYP MAX |  |
| $V_{\text {(ax) }}$ | Collector-Base Breakdown Voltage |  | $\mathrm{I}_{\mathrm{c}}=100 \mu \mathrm{~A}, \mathrm{I}_{\mathrm{E}}=0$ | 40 |  |  | -40 | $V$ |
| $V_{\text {lerjceo }}$ | Collector-Emitter Breakdown Yoltage |  | $L_{c}=10 \mathrm{~mA}, I_{B}=0, \quad$ See Note 5 | 40 |  |  | -40 | $V$ |
|  | Emitter-Base Breakdown Voltage | $\mathrm{I}_{\mathrm{E}}=100 \mu \mathrm{~A}, \mathrm{I}_{\mathrm{C}}=0$ | 5 |  |  | -5 | $V$ |
| $\mathrm{I}_{\text {cmo }}$ | Collector Cutoff Current | $V_{C B}=20 V_{1} l_{E}=0$ |  |  | 100 | -100 | nA |
| $\mathrm{I}_{\text {EiOO }}$ | Emitter Culoft Current | $\mathbf{V}_{E l}=\mathbf{3} \mathbf{V}, \quad \mathbf{k}_{\mathrm{C}}=\mathbf{0}$ |  |  | 100 | -100 | nA |
| $h_{\text {fe }}$ | Static Forword Current Transfer Ratio | $V_{C E}=2 V_{1} \quad I_{C}=50 \mathrm{~mA}$, See Note 5 | 100 | 160 | 300 | $100 \quad 160 \quad 300$ |  |
| $V_{\text {VE }}$ | Base-Emitter Voltage | $V_{C E}=2 \mathrm{~V}, \quad \mathrm{I}_{\mathrm{C}}=50 \mathrm{~mA}$, See Note 5 | 0.6 | 0.77 | 1 | -0.6-0.76 -1 | $v$ |
|  |  | $\mathrm{Im}_{\mathrm{m}}=5 \mathrm{~mA}, \quad \mathrm{I}_{\mathrm{C}}=50 \mathrm{~mA}$, See Note 5 |  | 0.04 | 0.25 | $-0.06-0.25$ | $v$ |
| $V_{\text {cElsat) }}$ | Collector-Emitrer Saturation Voitrage | $\mathrm{I}_{\mathrm{B}}=20 \mathrm{~mA}, \quad \mathrm{I}_{\mathrm{c}}=200 \mathrm{~mA}$, See Note 5 |  | 0.17 |  | -0.23 | $V$ |

MOTE 5: Thase parameters must be measurod using pulse tochniques. $\mathrm{I}_{\mathrm{p}}=300 \mu \mathrm{~s}$, duty cycle $\leq 2 \%$.
†Test condition voltages and currents apply to the $n-p-n$ transistors. For the $p-n-p$ transistors the values are the same, but the polarities are reversed.

## PARAMETER COLOR-CODE INFORMATION

To facilitate matching and identification these transistors are color-coded in her brackets, each having a maximum spread of 3 dB as shown in the table below. No guaraniee is made as to distribution of $h_{\text {fe }}$ values, except that equal numbers of $n-p-n$ and $p-n-p$ devices will be shipped in any given brocket when motched tomplementory pairs are ordered.

| COLOR CODE | YELIOW | CREEN | BLUE | VIOLET | GRAY |
| :---: | :---: | :---: | :---: | :---: | :---: |
| $h_{\text {fe }}$ Range, $\left\|V_{C E}\right\|=2 V,\left\|\\|_{C}\right\|=50 \mathrm{~mA}$ | 100-125 | 115-150 | 140-190 | 170-235 | 215-300 |

ORDERING INFORMATION - To order matched complementary pairs, order the same quantity each of TIS90M and TIS91M or TIS92M and TIS93M. Devices may be ordered separately by specitying TIS90, TIS91, TIS92, or TIS93.

THERMAL INFORMATION


FICURE 1

## TYPES TIS94 THRU TIS99 N-P-N SILICON TRANSISTORS

# A COMPLETE FAMILY OF LOW-NOISE, LOW- TO MEDIUM-CURRENT SILECT ${ }^{\dagger}$ TRANSISTORS $\ddagger$ FOR USE IN HI-FI AUDIO AMPLIFIERS AND GENERAL PURPOSE LOW-FREQUENCY APPLICATIONS 

- High V (BR)CEO . . . 65 V Min (TIS96 and TIS99)
- Excellent hfe Linearity to $\mathbf{1 0 0} \mathbf{~ m A}$


## mechanical data

These transistors are encapsulated in a plastic compound specifically designed for this purpose, using a highly mechanized process developed by Texas Instruments. The case will withstand soldering temperatures without deformation. These devices exhibit stable characteristics under high-humidity conditions and are capable of meeting MIL-STD-202C, Method 106B. The transistors are insensitive to light.

absolute maximum ratings at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)


## TYPES TIS94 THRU TIS99 N-P-N SILICON TRANSISTORS

electrical characteristics at $\mathbf{2 5}^{\circ} \mathrm{C}$ free-air temperature


## operating characteristics at $25^{\circ} \mathrm{C}$ free-air temperature



NOTES: 4. These parameters must be measured using pulse techniques. $\mathrm{t}_{\mathbf{w}}=\mathbf{3 0 0} \mu$ s, duty cycle $<2 \%$.
5. $\mathrm{C}_{\mathrm{cb}}$ and $\mathrm{C}_{\mathrm{eb}}$ are measured using three-terminal masurement techniques with the third electrode (emitter or collector respectively) guardea.
6. Average Noise Figure is measured in an amplifier with response down 3 dB at 10 Hz and 10 kHz and a high-frequency rolloft of 6 dB /octave.
§The TIS96 and TIS99 are color-coded on $h_{F E}$ measured at $V_{C E}=5 \mathrm{~V}, I_{C}=100 \mathrm{~mA}$. Each $h_{\text {FE }}$ brackethas a 2-to-1 spread as follows: red, 55-110; orange, 90-180; yellow, 150-300. No particular hFE distribution is implied by this coding system.

## TYPES TIS100, TIS101 N-P-N SILICON TRANSISTORS

# HIGH-VOLTAGE SILECT ${ }^{\dagger}$ TRANSISTORS $\ddagger$ FOR VIDEO OUTPUT STAGES, AGC AMPLIFIERS, AND BURST AMPLIFIERS 

- High V(BR)CEO . . . 180 V Min (TIS100)
- Low Ccb . . . 3 pF Max


## mechaniceal data

These transistors are encapsulated in a plastic compound specifically designed for this purpose, using a highly mechanized process developed by Texas Instruments. The case will withstand soldering temperatures without daformation. These devices exhibit stable characteristics under high-humidity conditions and are capable of meeting MIL-STD-202C, Method 106B. The transistors are insensitive to light.
absolute maximum ratings at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

| Collector-Base Voltage . <br> Collector-Emitter Voltage (See Note 1) |  | $\begin{aligned} & \text { TIS100 } \\ & 180 \mathrm{~V} \end{aligned}$ | $\begin{aligned} & T 15101 \\ & 150 \mathrm{~V} \end{aligned}$ |
| :---: | :---: | :---: | :---: |
|  |  | 180 V | 150 |
| Emitter-Base Voltage |  | 5 V | 5 V |
| Continuous Collector Current . . . . . . . . . . . . . . . . . . . $\longleftarrow 100 \mathrm{~mA} \longrightarrow$ |  |  |  |
| Continuous Device Dissipation at (or below) $25^{\circ} \mathrm{C}$ Free-Air Temperature (See Note 2) $\longleftarrow<625 \mathrm{~mW}$ |  |  |  |
| Continuous Device Dissipation at (or below) $25^{\circ} \mathrm{C}$ Lead Temperature (See Note 3) |  |  |  |
| Continuous Device Dissipation of (or below) $25^{\circ} \mathrm{C}$ Case-and-Lead |  |  |  |
| Temperature (See Note 4) |  |  |  |
| orage Temperature Range . | - - . . . . . . . . . . . |  |  |
| mperature Kı Inch from Case for | Seconds |  |  |

WOTES: I. Thase values epply betwem 0 and 10 mA coilecter cerront when the base-smilter diede is open-circuitod.

3. Derate lineserly $10150^{\circ} \mathrm{C}$ lead tampereture of the relo of $10 \mathrm{mw} / \mathrm{deg}$. Loed temporeture is meosured on the collector lead $1 / 16$ inch from the cass.


# TYPES TIS100, TIS101 N-P-N SILICON TRANSISTORS 

olectrical charactoristics at $\mathbf{2 5}{ }^{\circ} \mathrm{C}$ free-air temperature

| PARAMETER |  | TEST CONDITIONS |  |  | TIS100 |  | 715101 |  | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | MII | TYP MAX | MIN | TYP MAX |  |
| $V_{\text {(m) }}$ cio | Collector-Base Breakdown Voltage |  |  |  | $l_{c}=100 \mu A$, | $4=0$ |  | 18 |  | 150 |  | $V$ |
| $\mathbf{V}_{\text {(m) }}$ ciso | Collector-Emitter Braekdown Voltage | $\mathrm{I}_{c}=10 \mathrm{ma}$, | $\mathrm{I}_{1}=0$, | See Nots 5 | 180 |  | 150 |  | V |
| $\mathrm{I}_{\text {cio }}$ | Collactor Cutoff Current | $V_{C B}=75 \mathrm{~V}$, | $i n_{1}=0$ |  |  | 50 |  | 50 | ni |
| T100 | Emitter Cutofi Current | $V_{8 i}=5 \mathrm{~V}$, | $\mathrm{I}_{6}=0$ |  |  | 100 |  | 100 | $\mu \mathrm{A}$ |
| $h_{\text {m }}$ | Static forward Current Transier Ratio | $V_{C i}=10 V_{\text {, }}$ | $\mathrm{I}_{C}=1 \mathrm{~mA}$, |  | 2 |  | 20 |  |  |
|  |  | $V_{C I}=10 \mathrm{~V}$, | $\mathrm{l}_{6}=\mathbf{2 5} \mathrm{mA}$, | See Note 5 | 3 |  | 30 |  |  |
| $V_{\text {clant }}$ | Collector-Emither Saturation Voltage | $\mathrm{l}_{\mathrm{g}}=2.5 \mathrm{~mA}$ | $\mathrm{l}_{\mathrm{c}}=25 \mathrm{~mA}$, | See Note 5 |  | 1 |  | 1 | V |
| $\left\|h_{\text {fol }}\right\|$ | Small-Signal Common-Emilttor Forward Curtent Transter Ratio | $V_{C E}=50 \mathrm{~V}$, | $\mathrm{Ic}_{c}=2.5 \mathrm{~mA}$, | $f=20 \mathrm{MHz}$ |  |  | 3 |  |  |
|  |  | $V_{C I}=15 V_{1}$ | $\mathrm{I}_{6}=25 \mathrm{~mA}$, | f=20 M ${ }^{\text {miz }}$ |  |  | 4 |  |  |
| Cobo | Common-Base Open-Clrailt Output Capacitance | $V_{C I}=20 \mathrm{~V}$, | $\mathrm{I}_{1}=0$ | $f=1 \mathrm{MHz},$ <br> See Note 6 |  | 2.8 |  | 2.8 | pf |
| $C_{\text {cb }}$ | Collector-Bose Capositance | $\mathrm{V}_{\mathrm{ct}}=20 \mathrm{~V}$, | $1=0$, | $\begin{aligned} & f=1 \mathrm{MHz}, \\ & \text { Soe Note } 6 \end{aligned}$ |  | 1.73 |  | 1.73 | pF |
| $C_{b}$ | Emitter-Base Capacitance | $V_{\text {E }}=1 \mathrm{~V}$, | $\mathrm{I}_{\mathrm{c}}=\mathrm{v}$, | $f=1 \text { mhzz }$ <br> Soe Note 6 |  | 13 |  | 13 | pf |

MOTES: 5. Thase parametors must be meesured uing pulse tachniques. $\mathrm{t}_{\mathrm{p}}=300 \mu$, duly cyclo $\leq \mathbf{2 \%}$.
 nactod to the guard terminal of the bridge. $C_{\text {obe }}$ meesuraments are made with the third terminal Hoating.

## THERMAL INFORMATION



NOTE 7: The collector lead is soldered to the middle of an edge of - square heat sink made of 2 -ounce copper bonded to 1/16-Inch-thick $\times \times \times P$ Bakalite ${ }^{\dagger}$
${ }^{\dagger}$ Trademark of Union Carbide Corporation

# HIGH-FREQUENCY SILECT ${ }^{\dagger}$ TRANSISTOR $\ddagger$ DESIGNED FOR TV MIXERS AND NON-AGC IF STAGES Full Characterization to Simplify Circuit Design 

## - Low Feedback Capacitance

- hFE Linearity over Wide Current Range Minimizes Intermodulation Distortion
- Rugged, One-Piece Construction with Standard TO-18 100-mil Pin Circle
- 1.25 W Rating at $25^{\circ} \mathrm{C}$ Lead Temperature


## mechanical data

This transistor is encapsulated in a plastic compound specifically designed for this purpose, using a highly mechanized process developed by Texas Instruments. The case will withstand soldering temperatures without deformation. This device exhibits stable characteristics under high-humidity conditions and is capable of meeting MIL-STD-202C, Method 106B. The transistor is insensitive to light.

absolute maximum ratings at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)
Collector-Base Voltage . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 45 V

Collector-Emitter Voltage (See Note 1) . . . . . . . . . . . . . . . . . . . . . . . . . . . . 45 V
Emitter-Base Voltage . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . $4 V$
Continuous Collector Current . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 50 mA
Continuous Device Dissipation at (or below) $25^{\circ} \mathrm{C}$ Free-Air Temperature (See Note 2) . . . . . . . . . 625 mW
Continuous Device Dissipation at (or below) $25^{\circ} \mathrm{C}$ Lead Temperature (See Note 3) . . . . . . . . . . 1.25 W
Storage Temperature Range . . . . . . . . . . . . . . . . . . . . . . . . . . . $-65^{\circ} \mathrm{C}$ to $150^{\circ} \mathrm{C}$
Lead Temperature $\mathbf{1 / 1 6}$ Inch from Case for 10 Seconds . . . . . . . . . . . . . . . . . . . . . $260^{\circ} \mathrm{C}$
NOTES: 1. This value applies when the base-emitter diode is open-circuited.
2. Derate linearly to $150^{\circ} \mathrm{C}$ free-air temperature at the rate of $5 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$.
3. Derate Hnearly to $150^{\circ} \mathrm{C}$ lasd temperature at the rate of $10 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$. Lead ternperature is measured on the collector lead $1 / 16$ inch from the case.
$\dagger$ Trademark of Texas Instruments
$\ddagger$ U.S. Patent No. 3,439,238

## TYPE TIS105 <br> N-P-N SILICON TRANSISTOR

electrical characteristics at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

| PARAMETER |  | TEST CONDITIONS |  | MIN | TYP | MAX | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| $V_{\text {(BR) }}$ CBO | Collector-Base Breakdown Voltage | $\mathrm{I}_{\mathrm{C}}=10 \mu \mathrm{~A}, \mathrm{I}^{2}=0$ |  | 45 |  |  | V |
| $V_{\text {(BR) }}$ | Collector-Emitter Breakdown Voltage | $\mathrm{I}_{\mathrm{C}}=10 \mathrm{~mA}, \mathrm{I}_{\mathrm{B}}=0$, | See Note 4 | 45 |  |  | V |
| ICBO | Collector Cutoff Current | $\mathrm{V}_{C B}=30 \mathrm{~V}, \mathrm{I}_{\mathrm{E}}=0$ |  |  |  | 50 | nA |
|  |  | $V_{C B}=30 \mathrm{~V}, I_{E}=0$, | $\mathrm{T}_{\mathrm{A}}=85^{\circ} \mathrm{C}$ |  |  | 10 | $\mu \mathrm{A}$ |
| IEBO | Emitter Cutoff Current | $V_{E B}=4 \mathrm{~V}, 1 \mathrm{I}=0$ |  |  |  | 10 | $\mu \mathrm{A}$ |
| hFE | Static Forward Current Transfer Ratio | $V_{C E}=15 \mathrm{~V}, \mathrm{I} \mathrm{C}=10 \mathrm{~mA}$ | See Note 4 | 30 |  | 150 |  |
|  |  | $V_{C E}=15 \mathrm{~V}, \mathrm{I} \mathrm{C}=30 \mathrm{~mA}$ |  | 30 |  | 150 |  |
| $V_{\text {BE }}$ | Base-Emitter Voitage | $V_{C E}=15 \mathrm{~V}, 1 \mathrm{C}=10 \mathrm{~mA}$, See Note 4 |  |  |  | 0.8 | V |
| $V_{\text {CE }}$ sat) | Callector-Emitter Saturation Voltage | $\mathrm{J}_{\mathrm{B}}=1 \mathrm{~mA}, \quad \mathrm{I}_{\mathrm{C}}=20 \mathrm{~mA}$ |  |  |  | 0.5 | $V$ |
| Thfel | Small-Signal Common-Emitter Forward Current Transfer Ratio | $V_{C E}=15 \mathrm{~V}, \mathrm{l}=10 \mathrm{~mA}, \quad \mathrm{f}=100 \mathrm{MHz}$ |  | 3 | 6.5 |  |  |
| $\frac{f_{T}(2)}{T T(1)}$ | Ratio of Transition Frequencies | $\begin{aligned} & \mathrm{V}_{\mathrm{CE}}=15 \mathrm{~V}, \mathrm{I}_{\mathrm{C}}(1)=10 \mathrm{~mA}, \mathrm{I}_{\mathrm{C}}(2)=20 \mathrm{~mA}, \\ & \text { See Note } 5 \end{aligned}$ |  | 0.75 |  |  |  |
| \|Vfe| | Small-Signal Common-Emitter Forward Transfer Admittance | $V_{C E}=15 \mathrm{~V}, I_{C}=10 \mathrm{~mA},$ | $\mathrm{f}=45 \mathrm{MHz}$ |  | 240 |  | mmho |
| 9yfe | Phase Angle of Small-Signal Common-Emitter Forward Transfer Admittance | $V_{C E}=15 \mathrm{~V}, \mathrm{IC}=10 \mathrm{~mA}$, | $f=45 \mathrm{MHz}$ | $40^{\circ}$ |  |  |  |
| $\mathrm{c}_{\mathrm{cb}}$ | Collector-Base Capacitance | $V_{C B}=10 \mathrm{~V}, I_{E}=0$. | $f=1 \mathrm{MHz},$ <br> See Note 6 |  | 0.7 | 1 | pF |
| Cies | Parallel-Equivalent Common-Emitter Short-Circuit Input Capacitance ${ }^{\dagger}$ | $V_{C E}=15 \mathrm{~V}, \mathrm{I}^{\prime}=10 \mathrm{~mA}$. | $\mathrm{f}=\mathbf{4 5} \mathbf{M H z}$ |  | 32 |  | pF |
| $\mathrm{C}_{\text {oes }}$ | Parallel-Equivalent Common-Emitter Short-Circuit Output Capacitance ${ }^{\dagger}$ | $V_{C E}=15 \mathrm{~V}, \mathrm{IC}=10 \mathrm{~mA}$, | $\mathrm{f}=45 \mathrm{MHz}$ |  | 2.4 |  | pF |
| Re( $\mathrm{y}_{\mathrm{ie}}$ ) | Real Part of Small-Signal <br> Common-Emitter Input Admittance | $V_{C E}=15 \mathrm{~V}, 1 \mathrm{C}=10 \mathrm{~mA}$, | $f=45 \mathrm{MHz}$ |  | 11 |  | mmho |
|  |  | $V_{C E}=15 \mathrm{~V}, 1 \mathrm{C}=10 \mathrm{~mA}$, | $f=200 \mathrm{MHz}$ |  | 25 |  |  |
| Rely oe) | Real Part of Small-Signal Common-Emitter Output Admittance | $V_{C E}=15 \mathrm{~V}, \mathrm{IC}=10 \mathrm{~mA}$, | $\mathrm{f}=45 \mathrm{MHz}$ |  | 0.15 |  | mmho |

NOTES: 4. These parameters must be measured using pulse techniques. $t_{w}=300 \mu \mathrm{~s}$, duty cycle $\leqslant 2 \%$.
5. To obtain $f_{T}$, the $h_{\text {fe }} \mid$ response is extrapolated at the rate of -6 dB per octave from $\mathrm{f}=100 \mathrm{MHz}$ to the frequency at which $h_{f e} \mid=1$.
6. $C_{c b}$ measurement employs a three-terminal capacitance bridge incorporating a guard circuit. The emitter is connected to the guard terminal of the bridge.
${ }^{\dagger} C_{\text {ies }}$ and $C_{\text {oes }}$ are defined as the imaginary parts of the small-signal, common-emitter, short-circuit admittances divided by $2 \pi{ }^{\boldsymbol{\pi}}$.

## operating characteristics at $\mathbf{2 5}{ }^{\circ} \mathrm{C}$ free-air temperature

| PARAMETER | TEST CONDITIONS |  | TYP | MAX | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: |
| Mixer Spot Noise Figure | $V_{C C}=18 \mathrm{~V}, \quad I^{\prime} \mathrm{C} \approx 6.5 \mathrm{~mA}$, | $f_{\text {RF }}=200 \mathrm{MHz}, \quad \mathrm{f}_{\text {LO }}=245 \mathrm{MHz}$, | 5.5 | 7 | dB |
| Conversion Gain | Bandwidth $=4.5 \mathrm{MHz}$, | See Figure 3 | 22 |  | dB |

## TYPE TIS105

## N-P-N SILICON TRANSISTOR

TYPICAL CHARACTERISTICS


TRANSITION FREQUENCY
COLLECTOR CURRENT

NOTE 5: To obtain $f_{T}$, the $h_{f e}$ |response is extrapolated at the rate -6 dB per octave from $f=100 \mathrm{MHz}$ to the frequency at which $\boldsymbol{h}_{\mathrm{fe}} /=1$.

## PARAMETER MEASUREMENT INFORMATION



MIXER SPOT NOISE FIGURE AND CONVERSION GAIN TEST CIRCUIT
ficure 3


MEASUREMENT INFORMATION FOR FIGURE 2
FIGURE 4

# HICH-FREQUENCY SILECT $\dagger$ TRANSISTORS $\dagger$ <br> FOR TV TUNER AND IF APPLICATIONS <br> <br> Featuring Low-Feedback Capacitance and Forward-ACC Characteristics <br> <br> Featuring Low-Feedback Capacitance and Forward-ACC Characteristics <br> <br> - TISEA for Tuner RF Amplifiers <br> <br> - TISEA for Tuner RF Amplifiers <br> <br> - TISI08 for IF Amplifiers (Replaces TIS85) <br> <br> - TISI08 for IF Amplifiers (Replaces TIS85) <br> <br> Rugged, One-Piece Construction with Stendard T0-18 100-mil Pin Circle 

 <br> <br> Rugged, One-Piece Construction with Stendard T0-18 100-mil Pin Circle} mechanical data

These transistors are encapsulated in a plastic compound specifically designed for this purpose, using a highly mechanized process developed by Texas Instruments. The case will withstand soldering temperatures without deformation. These devices exhibit stable characteristics under high-humidity conditions and are capable of meeting MIL-STD-202C, Method 106B. The transistors are insensitive to light.
Feedback capacitance is minimized by placing the emitter terminal between the base and collector terminals, thus optimizing compatability with advanced high-frequency design.

absolute maximum ratings at $25^{\circ} \mathrm{C}$ free-air temperafure (unless otherwise noted)
Collector-Base Vohage . . . . . . . . . . . . . . . . . . . . . . . . . 40 V
Collector-Emitter Voltage (See Note 1) . . . . . . . . . . . . . . . . . . . . 30 V
Emitter-Base Voltage . . . . . . . . . . . . . . . . . . . . . . . . . . 4 V
Continuous Collector Current . . . . . . . . . . . . . . . . . . . . . . 50 mA
Continuous Device Dissipation at (or below) $25^{\circ} \mathrm{C}$ Free-Air Temperature (See Note 2) . . . . 500 mW
Storage Temperature Range . . . . . . . . . . . . . . . . . . . . $-65^{\circ} \mathrm{C}$ to $150^{\circ} \mathrm{C}$
Lead Temperature $\mathrm{K}_{6}$ Inch from Case for 10 Seconds . . . . . . . . . . . . . . . $260^{\circ} \mathrm{C}$
electrical characteristics at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

| PARAMETER |  | TEST CONDITIONS |  | TIS84 |  | TIS108 |  | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | MIN | MAX | MIN | MAX |  |
| $V_{\text {(0x) }}$ | Collector-Base Ereakdown Voltage |  |  | $\mathrm{I}_{\mathrm{c}}=10 \mu \mathrm{~A}, \mathrm{l}_{\mathrm{E}}=0$ |  | 40 |  | 40 |  | $V$ |
| $V_{\text {(R) }}$ Ceo | Collector-Emitter Breakdown Voltage | $\mathrm{I}_{\mathrm{c}}=10 \mathrm{~mA}, \mathrm{I}_{\mathrm{s}}=0$, | See Note 3 | 30 |  | 30 |  | $V$ |
| Icso | Collector Cutoff Current | $\mathrm{V}_{\mathrm{CB}}=10 \mathrm{~V}, \mathrm{I}_{\mathrm{E}}=0$ |  |  | 50 |  | 50 | nh |
|  |  | $V_{c s}=10 V_{\text {c }} \mathrm{l}_{\mathrm{E}}=0$, | $r_{A}=85^{\circ} \mathrm{C}$ |  | 5 |  | 5 | $\mu \mathrm{A}$ |
| $\mathrm{J}_{\text {E10 }}$ | Emitter Cutofl Current | $V_{6 s}=4 \mathrm{~V}, \mathrm{I}_{\mathrm{c}}=0$ |  |  | 10 |  | 10 | $\mu A$ |
| $h_{\text {fe }}$ | Static Forward Current Tronsfer Ratio | $V_{C E}=10 \mathrm{~V}, \mathrm{Ic}_{\mathrm{C}}=4 \mathrm{~mA}$ |  | 30 |  | 25 |  |  |
| $V_{\text {EE }}$ | Bose-Emitter Volitage | $V_{C E}=10 V_{1} I_{C}=4 \mathrm{~mA}$ |  |  | 0.84 |  | 0.84 | V |

NOTES: 1. This value applies when the base-emitter diode is open-circuited.
2. Derate linearly to $150^{\circ} \mathrm{C}$ free-air temperature at the rate of $4 \mathrm{~mW} / \mathrm{C}$.
3. This parameter must be measured using pulse techniques. $t_{w}=300 \mu \mathrm{~s}$, duty cycle $\leqslant 2 \%$.

[^124]ҰU. S. Patent No. 3,439,238

## TYPES TIS84, TIST08 N-P-N SILICON TRANSISTORS

electrical characteristics at $25^{\circ} \mathrm{C}$ free-air temperature

| PARAMETER |  | TEST CONDITIONS | 71584 | TIS108 | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | MIN TYP MAX | MIN TYP MAX |  |
| $\left\|h_{\text {fol }}\right\|$ | Small-Signal Common-Emitter Forword Current Ironsfer Ratio |  | $V_{C E}=10 \mathrm{~V}, I_{c}=4 \mathrm{~mA}, \mathrm{f}=100 \mathrm{mHz}$ | 3.56 .5 | 3.56 .5 |  |
| \| $\mathrm{rbo}_{\text {o }}$ \| | Small-Signal Common-Emitter Forward Transfer Admittance | $V_{C E}=10 \mathrm{~V}, \mathrm{I}_{\mathrm{C}}=4 \mathrm{~mA}, \mathrm{f}=200 \mathrm{mHz}$ | $60 \quad 80$ |  | mmho |
|  |  | $\mathrm{V}_{C E}=10 \mathrm{~V}, \mathrm{I}_{C}=4 \mathrm{~mA}, \mathrm{f}=45 \mathrm{mHz}$ |  | $80 \quad 105$ |  |
| $\phi_{\text {y }}{ }_{0}$ | Phase Angle of Small-Signol CommonEmitter Forward Transior Admittance | $V_{\text {CE }}=10 \mathrm{~V}, i_{C}=4 \mathrm{~mA}, f=200 \mathrm{mHz}$ | $-50^{\circ}-60^{\circ}-80^{\circ}$ |  |  |
|  |  | $V_{C E}=10 \mathrm{~V}, \mathrm{I}_{C}=4 \mathrm{~mA}, \mathrm{f}=45 \mathrm{mHz}$ |  | $-10^{\circ}-18^{\circ}-25^{\circ}$ |  |
| $C_{\text {ces }}$ | Parollel-Equivalent Common-Emitter Short-Gircuit Input Copocitance $\dagger$ | $V_{C E}=10 \mathrm{~V}, \mathrm{I}_{\mathrm{C}}=4 \mathrm{~mA}, \mathrm{f}=200 \mathrm{MHz}$ | 11 |  | pF |
|  |  | $V_{C E}=10 \mathrm{~V}, \mathrm{I}_{\mathrm{C}}=4 \mathrm{~mA}, \mathrm{I}=45 \mathrm{mHz}$ |  | 18 |  |
| $C_{\text {res }}$ | Common-Emither Short-Circuit Reverse Transfer Capacitance $\dagger$ | $\begin{aligned} \mathrm{V}_{\mathrm{cE}}=10 \mathrm{~V}, & \mathrm{I}_{\mathrm{c}}=1 \mathrm{~mA} \\ \mathrm{f} & =0.1 \mathrm{MHz}_{10} 1 \mathrm{mHz} \end{aligned}$ | 0.220 .4 | 0.220 .4 | pf |
| $C_{008}$ | Parallel-Equivalent Common-Emitter Short-Circuit Output Capacitance $\dagger$ | $V_{C E}=10 \mathrm{~V}, I_{\mathrm{C}}=4 \mathrm{~mA}, f=200 \mathrm{mHz}$ | 1.1 |  | pF |
|  |  | $V_{C E}=10 \mathrm{~V}, \mathrm{I}_{\mathrm{C}}=4 \mathrm{~mA}, 1=45 \mathrm{mHz}$ |  | 1.1 |  |
| $\mathrm{Re}\left(\mathrm{h}_{\mathrm{i}}{ }^{\text {e }}\right.$ ) | Real Port of Small-Signol Common-Emitter Input Impedance | $V_{\text {CE }}=10 \mathrm{~V}, \mathrm{I}_{\mathrm{C}}=4 \mathrm{~mA}, \mathrm{f}=200 \mathrm{mHz}$ | $25 \quad 60$ |  | $\Omega$ |
|  |  | $\mathrm{V}_{C E}=10 \mathrm{~V}, \mathrm{I}_{\mathrm{C}}=4 \mathrm{~mA}, f=45 \mathrm{MHz}$ |  | $50 \quad 80$ |  |
| Re(y col $^{\text {a }}$ | Real Part of Small-Signal Common-Emitter Input Admittonce | $V_{C E}=10 \mathrm{~V}, \mathrm{I}_{\mathrm{C}}=4 \mathrm{~mA}, \mathrm{f}=200 \mathrm{MHz}$ | $14 \quad 40$ |  | mmho |
|  |  | $V_{C E}=10 \mathrm{~V}, I_{C}=4 \mathrm{~mA}, f=45 \mathrm{MHz}$ |  | 3 |  |
| $\operatorname{Re}\left(Y_{08}\right)$ | Real Part of Small-Signal Common-Emitter Output Admittance | $\mathrm{V}_{\text {CE }}=10 \mathrm{~V}, \mathrm{I}_{\mathrm{C}}=4 \mathrm{~mA}, \mathrm{f}=200 \mathrm{MHz}$ | 0.20 .5 |  | mmho |
|  |  | $\mathrm{V}_{\mathrm{CE}}=10 \mathrm{~V}, \mathrm{I}_{\mathrm{c}}=4 \mathrm{~mA}, \mathrm{I}=45 \mathrm{mHz}$ |  | $0.05 \quad 0.2$ |  |

$\dagger \mathrm{C}_{\mathrm{iss}}, \mathrm{C}_{\text {ress }}$, ond $\mathrm{C}_{\text {coss }}$ are defined as the imaginary patts of the small-signol, cormmon-amilter, short-circuit odmittances divided by $\mathbf{2 x t}$.
operating characteristics at $25^{\circ} \mathrm{C}$ free-air temperature

| PARAMETER |  | TEST CONDITIONS |  |  | T1584 |  |  | TIS108 |  |  | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | MIN | TYP | MAX | MIN | TYP | MAX |  |
| NF | Spot Moise Figure |  |  |  | $\begin{aligned} & V_{C E}=10 \mathrm{~V}, \\ & \mathrm{f}=200 \mathrm{MHz} \end{aligned}$ | $\mathrm{l}_{\mathrm{c}}=3 \mathrm{~mA}$, | $\mathrm{R}_{\mathrm{G}}=50 \Omega$, |  | 2.8 | 3.3 |  |  |  | dB |
|  |  | $\begin{aligned} & V_{\text {CE }}=10 \mathrm{~V}, \\ & i=45 \mathrm{MHz} \end{aligned}$ | $\mathrm{Ic}_{\mathrm{c}}=3 \mathrm{~mA}$, | $\mathrm{R}_{6}=50 \Omega$, |  |  |  |  | 3 | 6 | dB |
| $\mathbf{G}_{\boldsymbol{p}}$ | Unneutrolized SmallSignal Common-Emitter Insertion Power Gain | $\begin{aligned} & V_{\mathrm{CC}}=12 \mathrm{~V} \\ & \mathrm{R}_{\mathrm{G}}^{\prime}=150 \Omega, \\ & \text { See }^{\prime} \text { Figure } 1 \\ & \hline \end{aligned}$ | $\begin{aligned} & I_{c} \approx 2.5 \mathrm{~mA} \\ & R_{L}^{\prime}=1 \mathrm{k} \Omega_{1} \end{aligned}$ | $\begin{aligned} & V_{B B}=2.1 \mathrm{~V} \\ & \mathrm{f}=200 \mathrm{mHz}, \end{aligned}$ | 12 | 16 | 18 |  |  |  | d8 |
|  |  | $\begin{aligned} & V_{c c}=12 \mathrm{~V}, \\ & R_{c^{\prime}}=500 \Omega, \\ & \text { See Figure } 1 \\ & \hline \end{aligned}$ | $\begin{aligned} & I_{C} \approx 4.5 \mathrm{~mA}, \\ & R_{L^{\prime}}=250 \Omega_{1} \end{aligned}$ | $\begin{aligned} & V_{\mathrm{BB}}=2.6 \mathrm{~V} \\ & \mathrm{f}=45 \mathrm{mHz} \end{aligned}$ |  |  |  | 25 | 30 | 33 | dB |
| $V_{B r\|c c\|}$ | Gain-Control Base-Supply Voltage | $\begin{aligned} & V_{c c}=12 \mathrm{~V}, \\ & \Delta G_{p o}=-30 \mathrm{~d} \ddagger \ddagger \end{aligned}$ | $\begin{aligned} & R_{G}^{\prime}=150 \Omega, \\ & f=200 \mathrm{MHz}, \end{aligned}$ | $R_{L^{\prime}}=1 \mathrm{k} \Omega,$ <br> See Figure 1 | 3.7 |  | 4.6 |  |  |  | $v$ |
|  |  | $\begin{aligned} & \mathrm{V}_{\mathrm{cc}}=12 \mathrm{~V}, \\ & \Delta \mathrm{G}_{\mathrm{pt}}=-30 \mathrm{~dB} \ddagger \end{aligned}$ | $\begin{aligned} & R_{G}^{\prime}=500 \Omega, \\ & I=45 \mathrm{MHz}, \end{aligned}$ | $R_{L}^{\prime}=250 \Omega,$ <br> See Figure 1 |  |  |  | 3.5 |  | 4.5 | V |

$\ddagger \Delta 6_{p o}$ is detined as the change in $G_{p e}$ from the yolue of $V_{6 B}=2.1 \mathrm{~V}$ of 200 MHz or from the value at $\mathbf{Y}_{\mathrm{si}}=2.6 \mathrm{~V}$ at 45 MHz .

# TYPES TIS84, TIS108 N-P-N SILICON TRANSISTORS 

## PARAMETER MEASUREMENT INFORMATION



FIGURE 1 - POWER-GAIN AND GAIN-CONTROL-VOLTAGE TEST CIRCUIT

## TYPICAL CHARACTERISTICS



NOTE 3: This parameter must be measured using pulse techniques. $t_{w}=300 \mu s$, duty cycle $<\mathbf{2 \%}$
$\ddagger \Delta G_{p e}$ is defined ws the change in $G_{p e}$ from the value at $V_{B B}=2.1 \mathrm{~V}$ at 200 MHz or from the value at $\mathrm{V}_{\mathrm{BB}}=2.6 \mathrm{~V}$ at 45 MHz ,

## SILECT ${ }^{\dagger}$ TRANSISTORS $\ddagger$ <br> DESIGNED FOR HIGH-SPEED, MEDIUM-POWER SWITCHING AND GENERAL PURPOSE AMPLIFIER APPLICATIONS featuring <br> - High fT . . . . 350 MHz typ at $10 \mathrm{~V}, 20 \mathrm{~mA}$ <br> - Low VCE(sat) .... 0.13 V typ at 150 mA

- High Maximum IC . . . . 800 mA
- A5T2222 Electrically Similar to 2N2222, 2N3116, and 2N4952
- TIS109 Processing Includes Operational Aging at 300 mW for 24 Hours
- TIS110 Electrically Similar to 2N4400
- TIS111 Electrically Similar to 2N4401


## mechanical data

These transistors are encapsulated in a plastic compound specifically designed for this purpose, using a highly mechanized process developed by Texas instruments. The case will withstand soldering temperatures without deformation. These devices exhibit stable characteristics under high-humidity conditions and are capable of meeting MIL-STD-202C, Method 106B. The transistors are insensitive to light.

absolute maximum ratings at $\mathbf{2 5}$ 鱼 free-air temperature (unless otherwise noted)


NOTES: 1. These values apply between 0 and 10 mA coliector current when the base-emitter diode is open-circulted.
2. Derate linearly to $150^{\circ} \mathrm{C}$ free-alir temperature at the rate of $5 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$.
3. Derate Inearly to $150^{\circ} \mathrm{C}$ lead temperature at the rate of $10 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$. Lead temperature is measured on the collector lead $1 / 16$ inch from the case.
${ }^{\dagger}$ Trademerk of Texas Instruments
FU.S. Patent No. 3,439,238.

## TYPES A5T2222, TIS109, TIS110, TISH1 N-P-N SILICON TRANSISTORS

## A5T2222, TIS109

electrical characteristics at $\mathbf{2 5}{ }^{\circ} \mathbf{C}$ free-air temperature (unless otherwise noted)

| PARAMETER |  | TEST CONDITIONS |  | A5T2222 | T18100 | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | MIN MAX | MHN MAX |  |
| $V_{\text {(BR) }}$ CBO | Collector-Base Breakdown Vol tage |  |  | $I_{C}=10 \mu A, \quad I E=0$ |  | 60 | 60 | V |
| V(BR)CEO | Collector-Emitter Breakdown Voltage | $I_{C}=10 \mathrm{~mA}, \mathrm{I}_{\mathrm{B}}=0$, | See Note 4 | 30 | 30 | $V$ |
| V(BR)EBO | Emitter-Base Breakdown Voltege | $\mathrm{IE}_{\mathrm{E}}=10 \mu \mathrm{~A}, \quad \mathrm{IC}=0$ |  | 5 | 5 | V |
| 1 CBO | Collector Cutoff Current | $V_{C B}=20 \mathrm{~V}, I_{E}=0$ |  |  | 100 | nA |
|  |  | $V_{C B}=50 \mathrm{~V}, \mathrm{I}_{\mathrm{E}}=0$ |  | 10 |  | nA |
|  |  | $V_{C B}=50 \mathrm{~V}, \mathrm{IE}_{\mathrm{E}}=0$, | $\mathrm{TA}=100^{\circ} \mathrm{C}$ | 3 | 3 | $\mu \mathrm{A}$ |
| IEBO | Emitter Cutoff Current | $V_{E B}=3 \mathrm{~V}, \quad I_{C}=0$ |  | 10 | 10 | nA |
| hfe | Static Forward Current Transfer Ratio | $V_{C E}=10 \mathrm{~V}, I^{\prime}=100 \mu \mathrm{~A}$ |  | 35 | 20 |  |
|  |  | $V_{C E}=10 \mathrm{~V}, \mathrm{I}^{\prime} \mathrm{C}=1 \mathrm{~mA}$ |  | 50 | 30 |  |
|  |  | $\begin{aligned} & V_{C E}=10 \mathrm{~V}, I_{C}=10 \mathrm{~mA} \\ & V_{C E}=10 \mathrm{~V}, I_{C}=160 \mathrm{~mA} \\ & \hline \end{aligned}$ | See Note 4 | 75 | 40 |  |
|  |  |  |  | 100300 | $100 \quad 400$ |  |
|  |  | $V_{C E}=10 \mathrm{~V}, I_{C}=500 \mathrm{~mA}$ |  | 30 | 20 |  |
|  |  | $\mathrm{V}_{C E}=1 \mathrm{~V}, \mathrm{I}_{\mathrm{C}}=150 \mathrm{~mA}$ |  | 50 | 35 |  |
| VBE | Base-Emitter Voltage | $\mathrm{I}_{B}=16 \mathrm{~mA}, \mathrm{I}_{C}=150 \mathrm{~mA}$ | See Note 4 | 1.3 | 1.3 | V |
|  |  | $\mathrm{I}_{B}=50 \mathrm{~mA}, I_{C}=500 \mathrm{~mA}$ |  | 2.6 | 2.6 | V |
| $V_{C E}($ sat) | Collector-Emitter Saturation Voltage | $I_{B}=15 \mathrm{~mA}, \quad I_{C}=150 \mathrm{~mA}$ | See Note 4 | 0.4 | 0.4 | V |
|  |  | $\mathrm{I}_{\mathrm{B}}=50 \mathrm{~mA}, \mathrm{I}^{2}=500 \mathrm{~mA}$ |  | 1.6 | 1.6 | V |
| $\left\|h_{f e}\right\|$ | Small-Signal Common-Emitter Forward Current Transfer Ratio | $V_{C E}=10 \mathrm{~V}, I^{\prime}=20 \mathrm{~mA}$, | $f=100 \mathrm{MHz}$ | 2.5 | 2.5 |  |
| fT | Transition Frequency | $V_{C E}=10 \mathrm{~V}, I_{C}=20 \mathrm{~mA}$, | See Note 5 | 250 | 250 | MHz |
| Cobo | Common-Base Open-Circuit Output Capacitance | $V_{C B}=10 \mathrm{~V}, \mathrm{I}_{\mathrm{E}}=0$, | $f=1 \mathrm{MHz}$ | 8 | 10 | pf |
| Cibo | Common-Base Open-Circuit Input Capecitance | $V_{E B}=0.5 \mathrm{~V}, \mathrm{IC}=0$. | $\mathrm{f}=1 \mathrm{MHz}$ | 26 | 25 | pF |
| Re( $h_{\text {ie }}$ ) | Real Part of Small-Signal Common-Emitter Input Impedance | $V_{C E}=10 \mathrm{~V}, \mathrm{I}^{\prime}=20 \mathrm{~mA}$, | $f=300 \mathrm{MHz}$ | 60 | 60 | $\Omega$ |

NOTES: 4. These parameters must be measured using puise techniques. $t_{w}=\mathbf{3 0 0} \mu$, duty eycle $<2 \%$.
 frequency at which $\left|h_{f o}\right|=1$.

## switching characteristics at $\mathbf{2 5}{ }^{\circ} \mathrm{C}$ free-air temperature

| PARAMETER | TEST CONDITIONSt |  | TVP | UNIT |
| :---: | :---: | :---: | :---: | :---: |
| $\mathrm{t}_{\mathrm{d}}$ Delay Time | $V_{C C}=30 \mathrm{~V}$, $I_{C}=150 \mathrm{~mA}$, <br> $\mathrm{I}_{\mathrm{B}(1)}=15 \mathrm{~mA}$,  <br> $V_{\text {BE (off) }}=-0.5 \mathrm{~V}$, See Figure 1 |  | 5 | ns |
| tr Aise Time |  |  | 15 | ns |
| $t_{5}$ Storage Time |  |  | 190 | ns |
| $t_{+}$Fall Time |  |  | 23 | ns |

[^125]
## TYPES A5T2222, TIS109, TIS110, TIST11 <br> N-P-N SILICON TRANSISTORS

## PARAMETER MEASUREMENT INFORMATION




FIGURE 1-DELAY AND RISE TIMES


FIGURE 2--STORAGE AND FALL TIMES

NOTES: 8 . The input waveforms have the following characteristics: for figure 1 , $t_{r} \leqslant 2$ ns, $t_{w} \leqslant 200$ ns, duty cycle $\leqslant 2 \% ;$ for figure 2 , $t_{f} \leqslant 5 \mathrm{~ns}, t_{w} \approx 100 \mu \mathrm{~s}$, duty cycle $\leqslant 17 \%$.
b. All waveforms are monitored on an oscilloscope with the following characteristics: $t_{r} \leqslant 5 \mathrm{~ns}, \mathrm{R}_{\mathrm{in}}>100 \mathrm{k} \Omega, \mathrm{C}_{\mathrm{in}} \leqslant 12 \mathrm{pF}$,

TIS109 OPERATIONAL AGING
All TIS109 transistors are aged for a minimum of 24 hours in the circuit shown at the right. Total device dissipation is approximately $\mathbf{3 0 0} \mathrm{mW}$. All static characteristics are tested prior to and after aging. Dynamic characteristics are tested as necessary to guarantee the specified limits after aging.

NOMINAL CONDITIONS

$$
\begin{aligned}
& V_{C E}=20 \mathrm{~V} \\
& \mathrm{I}_{E}=-15 \mathrm{~mA} \\
& T_{A}=25^{\circ} \mathrm{C}
\end{aligned}
$$



## TIS110, TIS111

## electrical characteristics at $25^{\circ} \mathrm{C}$ free-air temperature



NOTES: 4. These parameters must be measured using pulse techniques. $t_{w}=\mathbf{3 0 0} \mu \mathrm{s}$, duty cycle $<\mathbf{2 \%}$.
5. To obtain ${ }^{f} T$, the $\left.\right|_{h_{f e}} \mid$ response with frequency is extrapolated at the rate of -6 dB per octave from $\mathrm{f}=100 \mathrm{MHz}$ to $\mathbf{~ t h e ~}$ frequency at which $\left|h_{f e}\right|=1$.
6. $\mathrm{C}_{\mathrm{cb}}$ and $\mathrm{C}_{\mathrm{eb}}$ measurements employ a three-terminal capacitance bridge incorporating a guard circuit. The third electrode (emitter or collector, respectively) is connected to the guard terminal of the bridge.

# TYPES A5T2222, TIS109, TIS110, TISm <br> N-P-N SILICON TRANSISTORS 

## TIS110, TIS111

switching characteristics at $\mathbf{2 5}{ }^{\circ} \mathrm{C}$ free-air temperature

| PARAMETER | TEST CONDITIONS ${ }^{\text { }}$ |  | MAX | UNIT |
| :---: | :---: | :---: | :---: | :---: |
| $t_{\text {d }}$ Delay Time | $\mathrm{V}_{\mathrm{CC}}=\mathbf{3 0 V}$, | $\mathrm{I}_{\mathrm{C}}=150 \mathrm{~mA}, \mathrm{I}_{\mathrm{B}(1)}=15 \mathrm{~mA}$, | 15 | ns |
| $t_{r}$ Rise Time | $V_{\text {BE }}(\mathrm{fff})=-2 \mathrm{~V}$, | See Figure 3 | 20 | ns |
| $t_{5}$ Storage Time | $\mathrm{VCC}=30 \mathrm{~V}$. | $\mathrm{I}_{\mathrm{C}}=150 \mathrm{~mA}, \mathrm{I}_{\mathrm{B}(1)}=15 \mathrm{~mA}$, | 230 | ns |
| $t_{f}$ Fall Time | $I_{B(2)}=-15 \mathrm{~mA}$, | See Figure 4 | 60 | ns |

tVoltage and current values shown are nominal; exact values vary slightly with transistor parameters.
PARAMETER MEASUREMENT INFORMATION


TEST CIRCUIT


VOLTAGE WAVEFORMS

FIGURE 3-DELAY AND RISE TIMES


FIGURE 4-STORAGE AND FALL TIMES

NOTES: a. The input waveforms have the following characteristics: for figure 3, $t_{r} \leqslant 2 \mathrm{~ns}, \mathrm{t}_{\mathrm{w}} \leqslant 10 \mu \mathrm{~s}$, duty eycle $\leqslant 2 \%$; for figure 4 $t_{f} \leqslant 5 \mathrm{~ns}, \mathrm{t}_{\mathrm{w}} \approx 10 \mu \mathrm{~s}$, duty cycle $\leqslant 2 \%$.
b. All waveforms are monitored on an oscilloscope with the following characteristics: $t_{r} \leqslant 5 \mathrm{~ns}, R_{\text {in }} \geqslant 100 \mathrm{k} \Omega, \mathrm{C}_{\mathrm{in}} \leqslant 12 \mathrm{pF}$.

## SILECT ${ }^{\dagger}$ TRANSISTORS $\ddagger$ <br> DESIGNED FOR HIGH-SPEED, MEDIUM-POWER SWITCHING AND GENERAL PURPOSE AMPLIFIER APPLICATIONS

- A5T2907, A5T3644, and A5T3645 Electrically Similar to 2N2907, 2N3644, and 2N3645
- TIS112 Processing Includes Operational Aging at $\mathbf{3 0 0} \mathbf{~ m W}$ for $\mathbf{2 4}$ Hours


## mechanical data

These transistors are encapsulated in a plastic compound specifically designed for this purpose, using a highly mechanized process developed by Texas Instruments. The case will withstand soldering temperatures without deformation. These devices exhibit stable characteristics under high-humidity conditions and are capable of meeting MIL-STD-202C, Method 106B. The transistors are insensitive to light.

absolute maximum ratings at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)


NOTES: 1. This value applies between 0 and 600 mA collector current when the base-emitter diode is open-circuited.
2. Derate linearly to $150^{\circ} \mathrm{C}$ free-air temperature at the rate of $5 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$.
3. This rating applies with the entire case (including the leads) maintained ot $25^{\circ} \mathrm{C}$. Derate linearly to $150^{\circ} \mathrm{C}$ case-and-iead temperature at the rate of $12.8 \mathrm{~mW} / f^{\circ} \mathrm{C}$.
${ }^{\dagger}$ Trademark of Texas Instruments
$\ddagger$ U. S. Patent No. 3,439,238

## TVPES A5T2907, TIS112 P-N-P SILICON TRANSISTORS

electrical characteristics at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)


NOTE 4: These parameters must be measured using pulse techniques. $\boldsymbol{t}_{\mathbf{w}}=\mathbf{3 0 0} \mu \mathrm{s}$, dury eycle $\leq \mathbf{2 \%}$.
switching characteristics at $25^{\circ} \mathrm{C}$ free-air temperature

| PARAMETER | TEST CONDITIONS ${ }^{\text {t }}$ | A5T2907 | TIS112 | UNIT |
| :---: | :---: | :---: | :---: | :---: |
|  |  | MAX | MAX |  |
| $t_{\text {d }}$ Delay Time | $\begin{array}{ll} I_{C}=-150 \mathrm{~mA}, & I_{B(1)}=-15 \mathrm{~mA}, \\ R_{L}=200 \Omega, & V_{B E(\text { off })}=0, \\ & \text { See Figure } 1 \end{array}$ | 10 | 10 | ns |
| $\mathrm{tr}_{\mathbf{r}} \quad$ Rise Time |  | 40 | 40 | ns |
| $\mathrm{t}_{\text {on }}$ Turn-On Time |  | 45 | 45 | ns |
| $\mathrm{t}_{\mathbf{s}} \quad$ Storage Time | $\begin{array}{ll} I^{\prime} C=-150 m A, & I_{B}(1)=-13 \mathrm{~mA}, \\ \mathrm{R}_{\mathrm{L}}=37 \Omega, & \mathrm{I}_{\mathrm{B}(2)}=17 \mathrm{~mA}, \\ \text { See Figure } 2 \end{array}$ | 80 | 80 | ns |
|  |  | 30 | 70 | ns |
| toff Turn-Off Time |  | 100 | 140 | ns |

'Voltage and current values shown are nominal; exact values vary slightly with transistor parameters.

# TYPES A5T2907, TIS112 P-N-P SILICON TRANSISTORS 



## TIS112 OPERATIONAL AGING

All TIS112 transistors are aged for a minimum of 24 hours in the circuit shown below. Total device dissipation is approximately $\mathbf{3 0 0} \mathbf{m W}$. All static characteristics are tested prior to and after aging. Dynamic characteristics are tested as necessary to guarantee the specified limits after aging.


NOMINAL CONDITIONS

$$
\begin{aligned}
& V_{C E}=-30 \mathrm{~V} \\
& \mathrm{I}_{E}=10 \mathrm{~mA} \\
& T_{A}=25^{\circ} \mathrm{C}
\end{aligned}
$$

# HIGH-FREQUENCY SILECT ${ }^{\dagger}$ TRANSISTORS $\ddagger$ DESIGNED FOR COMMON-BASE VHF APPLICATIONS 

## - Low Feedback Capacitance, $\mathrm{C}_{\mathrm{ct}}$

- Specified Forward-AGC Characteristics


## Rugged, One-Piece Construction with Standard TO-18 100-mil Pin Circle

## mechanical data

This transistor is ancapsulated in a plastic compound specifically designed for this purpose, using a highly mechanized process developed by Texas Instruments. The case will withstand soldering temperatures without deformation. This device exhibits stable characteristics under high-humidity conditions and is capable of meeting MIL-STD-202C, Method 106B. The transistor is insensitive to light.


NOTES: A. Lead diameter is not controlled in this area.
B. Leads having maximum diameter ( 0.019 ) shall be within 0.007 of their true positions messured in the gaging piane 0.054 below the eeating piane of the device relative to a maximum-diameter package.
C. All dimenslons are in inches.

## absolute maximum ratings at $\mathbf{2 5}{ }^{\circ} \mathbf{C}$ free-air temperature (unless otherwise noted)

Collector-Base Voltage . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 40 V
Collector-Emitter Voltage (See Note 1) . . . . . . . . . . . . . . . . . . . . . . . . . . . . 30 V
Emitter-Base Voltage . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 4 V
Continuous Collector Current . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 50 mA
Continuous Device Dissipation at (or below) $\mathbf{2 5}^{\circ} \mathrm{C}$ Free-Air Temperature (See Note 2) . . . . . . . . . 250 mW
Storage Temperature Range . . . . . . . . . . . . . . . . . . . . . . . . . . . $-65^{\circ} \mathrm{C}$ to $150^{\circ} \mathrm{C}$
Lead Temperature $1 / 16$ Inch from Case for 10 Seconds . . . . . . . . . . . . . . . . . . . . . $260^{\circ} \mathrm{C}$
electrical characteristics at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

| PARAMETER | TEST CONDITIONS | MIN MAX | UNIT |
| :---: | :---: | :---: | :---: |
| $\mathrm{V}_{\text {(BR)CBO }}$ Collector-Base Breakdown Voltage | $\mathrm{I}_{\mathrm{C}}=10 \mu \mathrm{~A}, \quad \mathrm{IE}_{\mathrm{E}}=0$ | 40 | V |
| V(BR)CEO Collector-Emitter Breakdown Voltage | $I^{\prime} C=10 \mathrm{~mA}, I_{B}=0, \quad$ See Note 3 | 30 | V |
| Collector Cutoff Current | $V_{C B}=10 \mathrm{~V}, \mathrm{IE}^{=}=0$ | 50 | nA |
|  | $V_{C B}=10 \mathrm{~V}, \mathrm{I}_{\mathrm{E}}=0, \quad \mathrm{TA}=85^{\circ} \mathrm{C}$ | 5 | $\mu \mathrm{A}$ |
| IE8O Emitter Cutoff Current | $V_{E B}=4 V, I_{C}=0$ | 10 | $\mu \mathrm{A}$ |
| hFE Static Forward Current Transfer Ratio | $V_{C E}=10 \mathrm{~V}, \mathrm{I} C=4 \mathrm{~mA}$ | 30 |  |
| VBE Base-Emitter Voltage | $V_{C E}=10 \mathrm{~V}, \mathrm{I}_{C}=4 \mathrm{~mA}$ | 0.8 | V |
| hfel Small-Signal Common-Emitter Forward Current Transfer Ratio | $V_{C E}=10 \mathrm{~V}, I_{C}=4 \mathrm{~mA}, \quad f=100 \mathrm{MHz}$ | 4.5 |  |
| $\mathrm{C}_{\text {ce }} \quad$ Collector-Emitter Capacitance | $V_{C E}=10 \mathrm{~V}, I_{B}=0, \quad f=1 \mathrm{MHz},$ <br> See Note 4 | 0.3 | pF |

NOTES: 1. This value applies when the bsse-amitter diode is open-circuited.
2. Derate linearly to $150^{\circ} \mathrm{C}$ free-air temporature at the rate of $2 \mathrm{mw} /{ }^{\circ} \mathrm{C}$.
3. This parameter must be measured using pulse techniques. $t_{w}=300 \mu s$, duty cyele $<\mathbf{2 \%}$.
4. $\mathrm{C}_{\mathrm{ca}}$ measuremont employs a three-terminal capacitance bridge incorporating a guard eircuit. The base is connected to the guard terminal of the bridge.
${ }^{\dagger}$ Trademark of Texas Instruments
$\ddagger$ U.S. Patent No. 3,439,238

## TYPE TIS125 <br> N-P-N SILICON TRANSISTOR

## operating characteristics at $25^{\circ} \mathrm{C}$ free-air temperature

| PARAMITEA | TEST CONDITIONS | MIN MAX | UNIT |
| :---: | :---: | :---: | :---: |
| F Spot Noise Figure | $\begin{aligned} & \hline \text { VCC }=10 \mathrm{~V}, \mathrm{IC}=3 \mathrm{~mA}, \quad \mathrm{RG}_{\mathrm{G}}=80 \Omega, \\ & f=200 \mathrm{MHz}, \text { See Fiqure } 1 \end{aligned}$ | 3.6 | dB |
| $\boldsymbol{O}_{\text {pb }}$ Unnoutralized Small-8ignal Common-Bave Inwrtion Powor Guin | $\begin{aligned} & V_{C C}=10 \mathrm{~V}, \mathrm{IC}=3 \mathrm{~mA}, \quad f=200 \mathrm{MHz}, \\ & \text { Sce Eiqure } 1 \end{aligned}$ | $17 \quad 23$ | dB |
| Ic Collector Current for 30-dB Gain Reduction | $V_{C C}=10 \mathrm{~V}, f=200 \mathrm{MHz},$ $\Delta G_{p b}=-30 \mathrm{~dB} \dagger, \quad \text { Set Figure } 1$ | 87.6 | mA |

${ }^{\dagger} \Delta \omega_{p b}$ io defined as the change in $\Theta_{p b}$ from the value ot $\mathrm{Ic}=3 \mathrm{~mA}$.

## PARAMETER MEASUREMENT INFORMATION



L1: 6 T \#16, $\%$ inch ID, tapped 3/4 turn from end nearer VCC.
FIGURE 1-200 MHz POWER GAIN, NOISE FIGURE, AND GAIN CONTROL TEST CIRCUIT

## TYPICAL CHARACTERISTICS

## SMALL-SIGNAL COMMON-BASE INSERTION POWER GAIN <br> vs <br> COLLECTOR CURRENT



Figure 2

TYPE TIS126

# HIGH-FREQUENCY SILECT $\dagger$ TRANSISTOR $\ddagger$ FOR USE IN VHF MIXERS AND NON.AGC IF AMPLIFIERS 

- High fT . . . 600 MHz Min
- Specified $\mathrm{f} T$ vs IC Characteristic
- Low Ccb . . . 0.36 pF Max
- Rugged, One-Piece Construction with Standard TO-18 100-Mil Pin Circle


## mechanical data

This transistor is encapsulated in a plastic compound specifically designed for this purpose, using a highly mechanized process developed by Texas Instruments. The case will withstand soldering temperatures without deformation. This device exhibits stable characteristics under high-humidity conditions and is capable of meeting MIL-STD-202C, Method 106B. The transistor is insensitive to light.

Feedback capacitance is minimized by placing the emitter terminal between the base and collector terminals, thus optimizing compatibility with advanced high-frequency design.


## absolute maximum ratings at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

> Collector-Base Voltage
> 45 V
> Collector-Emitter Voltage (See Note 1)
> 40 V
> Emitter-Base Voltage
> Continuous Collector Current . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 50 mA
> Continuous Device Dissipation at (or below) $25^{\circ} \mathrm{C}$ Free-Air Temperature (See Note 2) . . . . . . . . . 400 mW
> Continuous Device Dissipation at (or below) $25^{\circ} \mathrm{C}$ Lead Temperature (See Note 3) . . . . . . . . . . 700 mW
> Storage Temperature Range . . . . . . . . . . . . . . . . . . . . . . . . . . . $-65^{\circ} \mathrm{C}$ to $150^{\circ} \mathrm{C}$
> Lead Temperature $\mathbf{1 / 1 6}$ Inch from Case for 10 Seconds . . . . . . . . . . . . . . . . . . . . . $260^{\circ} \mathrm{C}$
> NOTES: 1. This value spplies when the base-emitter diode is open-circuited.
> 2. Derate Ilnearly to $150^{\circ} \mathrm{C}$ free-air temperature at the rate of $3.2 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$.
> 3. Derate lineorly to $150^{\circ} \mathrm{C}$ lead temperature at the rate of $5.6 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$. Lead temparature is measured on the collector lead 1/16 inch from the case.
${ }^{\dagger}$ Trademark of Texas Instruments
$\ddagger$ U.S. Patent No, 3,439,238
electrical characteristics at $25^{\circ} \mathrm{C}$ free-air temperature

| PARAMETER | TEST CONDITIONS |  |  | MIN | MAX | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| $V_{\text {(BR)CBO }}$ Collector-Base Breakdown Voltage | ${ }^{\prime} \mathrm{C}=100 \mu \mathrm{~A}$, | $I_{E}=0$ |  | 45 |  | V |
| $V_{\text {(BR)CEO }}$ Collector-Emitter Breakdown Voltage | ${ }^{1} \mathrm{C}=1 \mathrm{~mA}$, | $\mathrm{I}_{\mathrm{B}}=0$, | See Note 4 | 40 |  | V |
| V(BR)EBO Emitter-Base Breakdown Voltage | $\mathrm{I}_{\mathrm{E}}=100 \mu \mathrm{~A}$, | $\mathrm{I}_{\mathrm{C}}=0$ |  | 4 |  | V |
| IC8O Collector Cutoff Current | $\mathrm{V}_{\mathrm{CB}}=30 \mathrm{~V}$. | $\mathrm{I}_{\mathrm{E}}=0$ |  |  | 50 | nA |
| hFE Static Forward Current Transfer Ratio | $V_{C E}=15 \mathrm{~V}$, | $1 \mathrm{C}=10 \mathrm{~mA}$, | See Note 4 | 25 |  |  |
| $V_{\text {CE }}$ (sat) Collector-Emitter Soturation Voltage | $\mathrm{I}_{B}=3 \mathrm{~mA}$, | $I_{C}=30 \mathrm{~mA}$, | See Note 4 |  | 0.5 | V |
| \|hfelSmall-Signal Common-Emitter <br> Forward Current Transfer Ratio | $\mathrm{V}_{\text {CE }}=15 \mathrm{~V}$, | $I_{C}=10 \mathrm{~mA}$, | $f=100 \mathrm{MHz}$ | 6 |  |  |
| $\frac{\mathrm{f}}{\mathbf{T}(2)} \quad$ ( $\mathbf{T}(1) \quad$ Ratio of Transition Frequencies | $V_{C E}=15 \mathrm{~V}$ <br> See Note 5 | $\mathrm{I}(1)=15 \mathrm{~m}$ | $\mathrm{IC}(2)=20 \mathrm{~mA}$, | 0.65 |  |  |
| $\mathrm{C}_{\text {cb }} \quad$ Collector-Base Capacitance | $V_{C B}=10 \mathrm{~V} .$ <br> See Note 6 | $I_{E}=0,$ | $\mathrm{f}=\mathbf{1 M H z}$, |  | 0.36 | pF |
| $r_{b}{ }^{\prime} \mathrm{C}_{\mathrm{c}} \quad$ Collector-8ase Time Constant | $\mathrm{V}_{C B}=15 \mathrm{~V}$, | $\mathrm{I}_{\mathrm{E}}=-4 \mathrm{~mA}$, | $\mathrm{f}=79.8 \mathrm{MHz}$ |  | 10 | ps |

NOTES: 4. These parameters must be measured using pulse techniques. $\tau_{w}=\mathbf{3 0 0} \mu \mathrm{s}$, duty cycle $\leqslant 2 \%$.
5. To obtain $f_{T}$, the $\boldsymbol{h}_{\text {fe }} \mid$ response is extrapolated at the rate of -6 dB per octave from $\mathrm{f}=100 \mathrm{MHz}$ to the frequency at which $\left|h_{f e}\right|=1$.
6. $C_{C b}$ measurement emplays a three-terminal capacitance bridge incorporating a guard circuit. The emitter is connected to the guard terminal of the bridge.
operating characteristics at $25^{\circ} \mathrm{C}$ free-air temperature

| PARAMETER |  | TEST CONDITIONS |  |  | MIN | MAX | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| F | Spot Noise Figure | $\begin{aligned} & V_{C E}=15 \mathrm{~V} \\ & f=200 \mathrm{MHz} \end{aligned}$ | $I_{C}=4 \mathrm{~mA},$ | $\mathrm{R}_{\mathrm{G}}=50 \Omega$, |  | 5 | dB |
| $G_{\text {pe(conv) }}$ | Small-Signal Conversion Power Gain | $\mathrm{V}_{\mathrm{CC}}=15 \mathrm{~V}$, | $\mathrm{I}_{\mathrm{C}}=10 \mathrm{~mA}$, | $\mathrm{fLO}^{\text {¢ }} \mathbf{2 4 5} \mathrm{MHz}$, | 24 |  | dB |
| B | Bandwidth | ${ }^{\ddagger}{ }^{\text {RF }}$ = 200 MHz , | See Figure 3 |  | 6 |  | MHz |
| $\mathrm{G}_{\mathrm{pe}}$ | Small-Signal Common-Emitter Insertion Power Gain | $v_{C C}=15 \mathrm{~V} .$ <br> See Figure 4 | $\mathrm{IC}=10 \mathrm{~mA}$. | $f=45 \mathrm{MHz}$, | 30 |  | dB |
| B | Bandwidth |  |  |  | 6 |  | MHz |

## TYPICAL CHARACTERISTICS

SMALL-SIGNAL COMMON-EMITTER

SMALL-SIGNAL CONVERSION POWER GAIN
vs
COLLECTOR CURRENT


INSERTION POWER GAIN
vs
COLLECTOR CURRENT



C1: Lesdiess disc ceramic, 0.001 pF
L1: 8T \#26 close wound, 3/32-inch ID, air core
L2: 7 T \#30 wound on coil form 7/32-inch 10, aluminum core 5/16-inch long
T1: Primary: 20T \#30 close wound
Secondary: 4T \#30 ctose wound and centered on primary
7/32-inch-1D paper form, ferrite core
FIGURE 3-200-MHz-to-45-MHz CIRCUIT FOR CONVERSION POWER GAIN


CIRCUIT COMPONENT INFORMATION
C1, C2: Leadiass disc ceramic, $0.001 \mu \mathrm{~F}$
C3: Arco 427 (or equivalent), 55-300 pF
T1: Primary: 8T \#26 double spaced
Secondary: 2T \#26 double spaced
Core: Ferrite torroid, 5/16-inch OD, 5/32-inch ID
FIGURE 4-45-MHZ POWER GAIN TEST CIRCUIT

BULLETIN NO. DL-S 7312005, MARCH 1973

## SILECTT VHF/UHF TRANSISTOR $\ddagger$ WITH FORWARD-AGC CHARACTERISTICS DESIGNED FOR COMMON-BASE AMPLIFIER APPLICATIONS

- Low C $\mathrm{C}_{\mathrm{ce}}$. . . 0.3 pF Max
- Low Noise at 850 MHz . . . 6.5 dB Max
- High Power Gain at $\mathbf{8 5 0} \mathbf{~ M H z ~ . ~ . ~} \mathbf{1 0}$ dB Min


## mechanical data

This transistor is encapsulated in a plastic compound specifically designed for this purpose, using a highly mechanized process developed by Texas Instruments. The case will withstand soldering temperatures without deformation. This device exhibits stable characteristics under high-humidity conditions and is capable of meeting MIL-STD-202C, Method 106 B . The transistor is insensitive to light.

absolute maximum ratings at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)
Collector-Base Voltage . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . - 60 V
Collector (See Note 1) . . . . . . . . . . . . . . . . . . . . . . . . . . . -45 V
Collector-Emitter Voltage (See Note 1) . . . . . . . . . . . . . . . . . . . . . . . . . . . . . $\mathbf{- 4} \mathbf{V}$
Emitter-Base Voltage . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . - 30 mA
Continuous Collector Current a (or below) $25^{\circ} \mathrm{C}$ Free-Air Temperature (See Note 2) $\because . . .2$.

Storage Temperature Range . . . .
Lead Temperature $1 / 16$ Inch from Case for 10 Seconds
electrical characteristics at $25^{\circ} \mathrm{C}$ free-air temperature


NOTES: 1. This value applies when the base-emitter diode is open-circuited.
2. Derate linearly to $160^{\circ} \mathrm{C}$ free-alr temperature at the rate of $\mathbf{2 ~ m W} /{ }^{\circ} \mathrm{C}$.
3. This parameter must be measured using pulse techniques. $\mathrm{t}_{\mathrm{w}}=300 \mu \mathrm{~s}$, duty cycle $\leq 2 \%$.
4. $\mathrm{C}_{\text {ce }}$ maasurement employs a three-terminal capacitance brldge incorporating a guard circult. The base he connected to the guard terminal of the bridge.
${ }^{\dagger}$ Tradomark of Texas Instruments
$\ddagger$ U.S. Patent No. 3,439,238
operating characteristics at $\mathbf{2 5}{ }^{\circ} \mathrm{C}$ free-air temperature

${ }^{\dagger} \Delta G_{p b}$ is defined as the change in $G_{p b}$ from the value at $t_{C}=-2 \mathrm{~mA}$

## PARAMETER MEASUREMENT INFORMATION



CIRCUIT COMPONENT INFORMATION
L1: Silver-plated brass $1 / 32^{\prime \prime}$ th ick, $1 / 2^{\prime \prime}$ wide, $1^{\prime \prime}$ lo ng
C1: 0.8-10 pF, Johansen \#4642, or equivalent
FIGURE 1-850-MHz POWER GAIN, NOISE FIGURE, AND GAIN-CONTROL TEST CIRCUIT

## TYPICAL CHARACTERISTICS

SMALL-SIGNAL COMMON-EMITTER FORWARD CURRENT TRANSFER RATIO vs


SMALL-SIGNAL COMMON-BASE INSERTION POWER GAIN vs COLLECTOR CURRENT

figure 3

## TYPE TIS129 <br> N-P-N SILICON TRANSISTOR

BULLETIN NO. DL-S 7312007, JUNE 1973

## SILECT ${ }^{\dagger}$ VHF/UHF TRANSISTOR $\ddagger$ <br> DESIGNED FOR COMMON-BASE OSCILLATOR AND AMPLIFIER APPLICATIONS <br> - Low Cce . . 0.3 pF Max <br> - High fT . . . $\mathbf{8 0 0} \mathbf{~ M H z ~ M i n ~}$ <br> - Specified fT Ratio <br> - Low rb ${ }^{\prime} \mathrm{C}_{\mathrm{c}} \ldots 9$ ps Max

## mechanical data

This transistor is encapsulated in a plastic compound specifically designed for this purpose, using a highly mechanized process developed by Texas Instruments. The case will withstand soldering temperatures without deformation. This device exhibits stable characteristics under high-humidity conditions and is capable of meeting MIL-STD-202C, Method 106B. The transistor is insensitive to light.


## absolute maximum ratings at $\mathbf{2 5} \mathbf{}{ }^{\mathbf{C}} \mathbf{C}$ free-air temperature (unless otherwise noted)

Collector-Base Voltage . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 40 V

Collector-Emitter Voltage (See Note 1) . . . . . . . . . . . . . . . . . . . . . . . . . . . . 25 V
Emitter-Base Voltage . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 40
Continuous Collector Current a (or below) $25^{\circ} \mathrm{C}$ Free-Air Temperature (See Note 2)
Continuous Device Dissipation at
30 mA
Continuous Device Dissipation at (or below) $\mathbf{2 5}{ }^{\circ} \mathrm{C}$ Free-Air Temperature (See Note 2) . . . . . . . . . 250 mW
Storage Temperature Range $-65^{\circ} \mathrm{C}$ to $150^{\circ} \mathrm{C}$
Lead Temperature $1 / 16$ Inch from Case for 10 Seconds
$260^{\circ} \mathrm{C}$
electrical characteristics at $25^{\circ} \mathrm{C}$ free-air temparature


NOTES: 1. This value applies when the base-emitter diode is open-circuited.
2. Derate linearly to $150^{\circ} \mathrm{C}$ free-air temperature at the rate of $2 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$.
3. This parameter must be measured using pulse techniques. $t_{w}=300 \mu \mathrm{~s}$, duty cycle < $2 \%$,
. To ${ }^{2}$. ${ }^{2}$, $\left|h_{t+1}\right|=1$.
6. $\mathrm{C}_{\mathrm{cb}}$ and $\mathrm{C}_{\mathrm{ce}}$ measurements employ a throe-terminal capacitance bridge or base, respectivaly) is connected to the guard termi
$\ddagger$ Trademark of Texas instruments
$\ddagger$ U.S. Patent No. $3,439,238$

USES CHIP N30

## TYPE TIS129

N-P-N SILICON TRANSISTOR
operating characteristics at $25^{\circ} \mathrm{C}$ free-air temperature


PARAMETER MEASUREMENT INFORMATION


CIRCUIT COMPONENT INFORMATION
L1: Sliver-plated brass $1 / 32^{\prime \prime}$ thick, $1 / \mathbf{2}^{\prime \prime}$ wide, $1^{\prime \prime}$ long
C1: 0.8-10 PF, Johansen \#4642, or equivalent
FIBURE $1-850-\mathrm{MHz}$ POWER-GAIN TEST CIRCUIT

## TYPICAL CHARACTERISTICS



FIOURE 2


# TYPES TIS133 THRU TIS136 N-P-N SILICON TRANSISTORS 

# SILECT ${ }^{\dagger}$ TRANSISTORS $\ddagger$ <br> FAST, HIGH-VOLTAGE, HIGH-CURRENT CORE DRIVERS (Replacements for TIS113 thru TIS116) 

- TIS133 Electrically Similar to 2N3724
- TIS135 Electrically Similar to 2N3725
- hFE Guaranteed from 10 mA to 1 A
- Guaranteed Switching Times at $\mathbf{5 0 0} \mathbf{~ m A}$


## mechanical data

These transistors are encapsulated in a plastic compound specifically designed for this purpose, using a highly mechanized process developed by Texas Instruments. The case will withstand soldering temperatures without deformation. These devices exhibit stable characteristics under high-humidity conditions and are capable of meeting MIL-STD-202C, Method 106B. The transistors are insensitive to light.

absolute maximum ratings at $25^{\circ} \mathbf{C}$ free-air temperature (unless otherwise noted)


NOTES: 1. These values apply when the base-emitter alode is open-circulted
2. This value applies for equart-wave pulees. ${ }^{\prime} w<300 \mu$, duty cycle $\leqslant 2 \%$.

4. Derate linearly to $150^{\circ} \mathrm{C}$ laed temperature at the rate 0 石 $\mathrm{mW} /{ }^{\circ} \mathrm{C}$. Lead temperature it measured on the collector lead $1 / 18$ inch from the case. $20^{\circ} \mathrm{C}$. Derate linearly to $180^{\circ} \mathrm{C}$ amse-and-lead
8. This rating appllet with the $8 \mathrm{~mW} / \mathrm{C}_{\mathrm{C}}$
$\dagger$ Trademark of Texas Instrument
$\ddagger$ U.s. Patent Number 3,439,238
UsES CHIP N13

## TYPES TIS133 THRU TIS136 <br> N-P-N SILICON TRANSISTORS

electrical characteristics at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)


NOTE 6: These perameters must be measured using pulse techniques. ${ }_{w}=300 \mu \mathrm{~s}$, dutv cycle $\leqslant 2 \%$.

# TYPES TIS133 THRU TIS136 N-P-N SILICON TRANSISTORS 

switching characteristics at $25^{\circ} \mathrm{C}$ free-air temperature

| PARAMETER | TEST CONDITIONS ${ }^{\text { }}$ |  | TIS133 | TIS134 | TIS135 | TIS136 | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  | MAX | MAX | MAX | MAX |  |
| $t_{\text {d }}$ Delay Time | $\begin{aligned} & V_{\mathrm{CC}}=30 \mathrm{~V}, \\ & \mathrm{l}_{\mathrm{B}(1)}=50 \mathrm{~mA}, \\ & \text { See Figure } 1 \end{aligned}$ | $\begin{aligned} & \mathrm{I} \mathrm{C}=500 \mathrm{~mA}, \\ & \mathrm{~V}_{\mathrm{BE}(\mathrm{off})}=-3.8 \mathrm{~V} \end{aligned}$ | 10 | 10 | 10 | 10 | ns |
| $t_{r}$ Rise Time |  |  | 30 | 30 | 30 | 30 | ns |
| $\mathrm{t}_{\text {on }}$ Turn-On Time |  |  | 35 | 35 | 35 | 35 | ns |
| $\tau_{s}$ Storage Time | $\begin{aligned} & V_{C C}=30 \mathrm{~V} \\ & I_{B(1)}=50 \mathrm{~mA} . \end{aligned}$ <br> See Figure 1 | $\begin{aligned} & I^{\prime}=500 \mathrm{~mA}, \\ & I_{B(2)}=-50 \mathrm{~mA}, \end{aligned}$ | 50 | 50 | 50 | 50 | ns |
| $t_{f}$ Fall Time |  |  | 25 | 25 | 30 | 30 | ns |
| toff Turn-Off Time |  |  | 60 | 60 | 60 | 60 | ns |

${ }^{\dagger}$ Voltege and current values shown are nominal; exact values vary slightly with transistor parameters.

## PARAMETER MEASUREMENT INFORMATION



## FIGURE 1-SWITCHING TIMES

NOTES: a. The input waveforms are supplied by a genarator with the following characteristics: $Z_{\text {out }}=50 \Omega, t_{r} \leqslant 1 \mathrm{~ns}, t_{f} \leqslant 1 \mathrm{~ns}, \mathrm{t}_{\mathrm{w}} \approx 1 \mu \mathrm{~s}$, duty cycle $<\mathbf{2 \%}$.
b. The output waveforms are monitored on an oscilloscope with the following characteristics: $\mathrm{t}_{\mathrm{r}} \leqslant 1 \mathrm{~ns}, \mathrm{R}_{\mathrm{in}} \geqslant 100 \mathrm{k} \Omega, \mathrm{C}_{\mathrm{in}} \leqslant 7 \mathrm{pF}$.

## SILECT ${ }^{\dagger}$ TRANSISTORS $\ddagger$ RECOMMENDED AS LOW-NOISE DESIGN REPLACEMENTS FOR GERMANIUM DRIFT TRANSISTORS IN:

## - AM Radio RF and IF Converter Applications

- TV Video and AGC Amplifiers, Sync Amplifiers and Separators, and Emitter Followers


## mechanical data

These transistors are encapsulated in a plastic compound specifically designed for this purpose, using a highly mechanized process developed by Texas Instruments. The case will withstand soldering temperatures without deformation. These devices exhibit stable characteristics under high-humidity conditions and are capable of meeting MIL-STD-202C, Method 106B. The transistors are insensitive to light.

absolute maximum ratings at $\mathbf{2 5}{ }^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)


NOTES: 1. This value epplies when the base-emitter diode is open-circuited.
2. Derate linearly to $150^{\circ} \mathrm{C}$ free-air temperature at the rate of $5 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$.

Trademerk of Texas instruments
$\ddagger$ U.S. Patent No. 3,438,238

# TYPES TIS37, TIS38, TIS137, TIS138 P-N-P SILICON TRANSISTORS 

electrical characteristics at $25^{\circ} \mathrm{C}$ free-air temperature

operating characteristics at $25^{\circ} \mathrm{C}$ free-air temperature

| PARAMETER | TEST COMDITIONS | $\begin{aligned} & \hline \text { TIS37 } \\ & \text { TIS137 } \end{aligned}$ | UNIT |
| :---: | :---: | :---: | :---: |
|  |  | TYP |  |
|  | $\mathrm{V}_{C E}=-9 \mathrm{~V}, \mathrm{I}_{\mathrm{C}}=-1 \mathrm{~mA}, \mathrm{R}_{\mathrm{G}}=75 \Omega, f=1 \mathrm{MHz}$ | 2.5 | dB |
| NF Spot Noise Figure | $V_{C E}=-9 \mathrm{~V}, \mathrm{I}^{\prime}=-1 \mathrm{~mA}, \mathrm{R}_{\mathrm{G}}=1 \mathrm{k} \Omega, \mathrm{f}=1 \mathrm{MHz}$ | 1 | dB |

## TYPICAL CHARACTERISTICS AT TA $\mathbf{= 2 5}{ }^{\circ} \mathrm{C}$

TIS37, TIS137
STATIC FORWARD CURRENT TRANSFER RATIO vs
COLLECTOR CURRENT


IC-Collector Current-mA
FIGURE 1

TIS37, TIS137
STATIC FORWARD CURRENT TRANSFER RATIO


NOTES: 3. This parameter must be measured uaing pulee techniques. $t_{w}=300 \mu$, duty cycle $<\mathbf{2 \%}$.
f $T$, the tha at which $\left|\mathrm{hfo}_{\mathrm{f}}\right|=1$.
5. $\mathrm{C}_{\mathrm{cb}}$ messurement employs a three-terminal capacitance bridge incorporating a guard circuit. The amitter is connected to the guard terminal of the bridge.
$4-549$
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## Transistor Chip Characterization

## TRANSISTOR CHIP CHARACTERIZATION

This section contains chip-characterization data for over fifty transistor-chip families. These data are applicable to all transistors types which have a chip reference in the lower right-hand corner of the first page of the data sheet. (Example: "USES CHIP N19" means that the types listed on that data sheet are made with chips of the N19 family.) Some data sheets do not have a chip reference. In general, these are either bar-type transistors (example: grown-junction devices) or chip-type transistors where the observed values of the characteristics of the basic chips are not applicable because of highly selective screening or special diffusions.

The characterization data are separated from the data sheets for several reasons:

- Redundant curves which would otherwise have to be repeated for many different types were eliminated. In this way one reference may apply to many type numbers.
- The amount of pertinent data for many type numbers is increased. Otherwise, each would have less characterization information because of space limitations.
- The user has more guidance in estimating whather to screan from off-the-shelf TI transistors for certain low-volume applications.
- The user now has adequate information about the distribution of transistor characteristic values to consider having TI do his screening for him on special order when the standard types do not quite fulfil the application needs.

However, the following points should be kept in mind:

- The high and low observed values, shown do not modify guaranteed limits for specific devices and, in the case of breakdown voltages, do not justify operation in excess of absolute maximum ratings.
- Measurement of characteristics at high power levels is applicable only for devices rated for those power levels.
- Distribution of characteristic values for any particular lot of transistors is not guaranteed.
- The distributions and ranges of values are not fixed. (TI reserves the right to improve the products and modify the distributions without notice.)

Some notes on the data follow:

- "LOW TYP HIGH"-The "TYP" column heading should require no explanation other than saying that it is typical for the chip family. However, the "LOW" and "HIGH" deserve some definition. These values represent the approximate extremes (excluding distribution "freaks") observed in recent production history. These extremes may be purely distributional in nature (a tailing off of the "normal" curve) or wholaly intentional (limits imposed on the chip-selection or transistor-screening steps).
- Since most of the families are aggregations of several subfamilies (usually modifications of diffusion profiles) the range of extreme values shown might seem usually broad.
- References to the availability of the chips in certain packages apply only to types listed in this book; many other chip-package combinations are available on special order.

For referencing to standard types using each of these chips, see Transistor Selection Guides, Section 2.
Chip-family classes are as follows:

JN - Junction field-effect transistors, $N$-channel
JP - Junction field-effect transistors, P-channel
MN - Insulated-gate (MOS) field-effect transistors, N-channel
MP - Insulated-gate (MOS) field-effect transistors, P-channel
$\mathrm{N}-\mathrm{N} \cdot \mathrm{P} \cdot \mathrm{N}$ multijunction transistors
P - P-N-P multijunction transistors
U - Unijunction transistors (chip type only) and programmable unijunction transistors

- JN51 is a $17 \times$ 17-mil, epitaxial, planar, expanded-contact chip
- Available in TO-18, TO-71, TO-72, a short-can version of TO-78, and Silect ${ }^{\dagger}$ packages
- For use in low-noise amplifier, mixer, switching, and chopper circuits



## electrical and operating characteristics at $\mathbf{2 5}{ }^{\circ} \mathbf{C}$ free-air temperature

| PARAMETER |  | CONDITIONS |  |  | OBSERVED VALUES |  |  | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | LOW | TYP | HIOH |  |
| V(BA)Oss | Gete-Source Breakdown Voltage |  |  |  | $10=-1 \mu A$, | $V_{D S}=0$ |  | $-30^{*}$ | -75 | -100 | $V$ |
| IGss | Gate Reverse Current | $V_{C S}=-15 V_{1}$ | $V_{D S}=0$ |  |  | -<0.1 | -2 | nA |
| $V_{\text {GS(0ff) }}$ | Gate-Source Cutoff Voltege | $V_{D S}=15 \mathrm{~V}$, | $I_{D}=0.5 n$ |  | -0.35 | -3.8 | -9 | V |
| $V_{\text {GS }}$ | Gate-Source Voltage | $V_{D S}=18 V_{\text {, }}$ | $I_{D}=100$ |  | -0.25 | -3 | -8 | $V$ |
| IDSs | Zero-Gate-Voltage Drain Current | $V_{D S}=15$. | $V_{G S}=0$, | See Note 1 | 0.6 | 10 | 24 | mA |
| 'dasion) | Small-Signel Drain-Source On-State Resistance | $V_{\text {DS }}=0$, | ${ }^{\prime} \mathrm{D}=0$, | $\mathrm{f}=1 \mathrm{kHz}$ | 100 | 200 | 2000 | $\Omega$ |
| $\left\|\mathrm{Vf}_{\mathrm{s}}\right\|$ | Small-Signal Common-Source Forward Transfer Admittance | $V_{\text {DS }}=0$, | $V_{G S}=0$. | $\mathbf{f = 1} \mathbf{k H z}$ | 2 | 4.8 | 7 | mmho |
| Hos1 | Small-Signal Common-Source Output Admittance |  |  |  |  | 25 | 70 | $\mu \mathrm{mho}$ |
| $C_{\text {iss }}$ | Common-Source Short-Circuit Input Capacitance | $\begin{aligned} & V_{D S}=15 \mathrm{~V} \\ & \text { See Note } 2 \end{aligned}$ | $V_{G S}=0$, | $\mathrm{f}=1 \mathrm{MHz}$, | 3.5 | 4.7 | 6 | pF |
| $C_{\text {rss }}$ | Common-Source Short-Circuit Reverse Transfer Capecitance |  |  |  | 0.9 | 1.4 | 2 | pF |
| gis | Small-Signal Common-Source Input Conductance | $\mathrm{V}_{\text {DS }}=15 \mathrm{~V}$, | $V_{G S}=0$, | $f=100 \mathrm{MHz}$ |  | 90 | 250 | $\mu \mathrm{mho}$ |
| 9fs | Small-Signal Common-Source <br> Forward Transfer Conductance |  |  |  | 1 | 4 | 7 | mmho |
| 808 | Small-Signal Common-Source Output Conductance |  |  |  |  | 60 | 160 | $\mu \mathrm{mho}$ |
| $\mid \mathrm{Yfz}$ | Small-Signal Common-Source Forward Transfer Admittance | VDS $=15 \mathrm{~V}$, | $V_{G S}=0$, | $f=200 \mathrm{MHz}$ | 2 | 4 |  | mmho |
| 9 is | Small-Signal CommonSource Input Conductance |  |  |  |  | 0.5 | 1 | mmho |
| 901 | Small-Signal Common-Soure Output Conductance |  |  |  |  | 0.15 | 0.3 | mmho |
| $F$ | Spot Noise Figure | $\begin{aligned} & V_{D S}=16 \mathrm{~V} \\ & \mathrm{R}_{\mathrm{G}}=1 \mathrm{mn} \end{aligned}$ | $V_{G S}=0,$ | $f=10 \mathrm{~Hz},$ |  | 4.5 | 5 | $d 8$ |
|  |  | $\begin{aligned} & V_{D S}=18 V \\ & R_{G}=1 \mathrm{Mn} \\ & \hline \end{aligned}$ | Ves $=0$ | $\mathrm{f}=1 \mathrm{kHz}$, |  | 0.2 | 2 |  |
|  |  | $\begin{aligned} & V_{D S}=15 \mathrm{~V}, \\ & R_{G}=1 \mathrm{k} \Omega \end{aligned}$ | $\mathbf{V G S}=0$, | $\mathrm{f}=100 \mathrm{MHz}$ |  | 3 | 5 |  |
| $V_{n}$ | Equivalent Input Noise Voltage | $V_{D S}=16 \mathrm{~V}$, | $V_{G S}=0$ | $t=10 \mathrm{~Hz}$ |  | 170 | 300 | $n \mathrm{~V} / \sqrt{\mathrm{Hz}_{2}}$ |
|  |  |  |  | f=1 kHz |  | 15 | 100 |  |

[^126]

FIGURE 1

Correlation of
$\mathbf{Y f s}_{\mathrm{s}} \mid$ and IDSs with $\mathbf{V}_{\mathbf{G S}}(100 \mu \mathrm{~A})$


FIGURE 4


FIGURE 7

ID vs VGS


FIGURE 2

Normalized ID
vs


FIGURE 5

Correlation of
|Vos/with IDSS


FIGURE 8


FIGURE 3


FIGURE 6

$\ddagger$ Data is for devices heving indicated value of $l_{D S S}$ at $V_{D S}=15 \mathrm{~V}, \mathrm{~V}_{\mathrm{GS}}=0, \mathrm{~T}_{\mathrm{A}}=25^{\circ} \mathrm{C}$. NOTE 1: This parameter was measured using pulse techniques. $t_{w}-300 \mu s$, dury cycle $<2 \%$.

# CHIP TYPE JN51 N-CHANNEL SILICON JUNCTION FIELD-EFFECT TRANSISTORS 

## TYPICAL CHARACTERISTICS



FIGURE 10





FIGURE 14

## CHIP TYPE JN51 <br> N-CHANNEL SILICON JUNCTION FIELD-EFFECT TRANSISTORS

TYPICAL CHARACTERISTICS


FIGURE 15


FIGURE 17

F ws $f$


Figure 16


FIGURE 18

[^127]
## CHIP TYPE JN51 N-CHANNEL SILICON JUNCTION FIELD-EFFECT TRANSISTORS

## TYPICAL CHARACTERISTICS


$\ddagger$ Data is for devices having the indicated value of $I_{D S S}$ at $V_{D S}=15 \mathrm{~V}, \mathrm{~V}_{G S}=0, T_{A}=25^{\circ} \mathrm{C}$.
$\delta_{V_{n t}}=\sqrt{V_{n} 2+4 k T_{0} B R_{G}}$ where $k$ is Boltzmann's constant $=1.38 \times 10^{-23} \mathrm{~J} / K, B$ is bandwidth $=1 \mathrm{~Hz}$.

## CHIP TYPE JN52 <br> N-CHANNEL SILICON JUNCTION FIELD-EFFECT TRANSISTORS

- JN52 is a $19 \times 19-m i l$, epitaxial, planar, expanded-contact chip
- Available in TO-18 and Silect ${ }^{\dagger}$ packages
- For use in chopper, commutator, and other switching circuits
- Lower-IDSS devices also recommended for low-noise amplifier circuits

electrical and operating characteristics at $\mathbf{2 5}{ }^{\circ} \mathbf{C}$ free-air temperature

| PARAMETER |  | CONDITIONS |  |  | OBSERVED VALUES |  | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | LOW TYP | HIGH |  |
| $V_{\text {(BR) }}$ GSS | Gate-Source Breakdown Voltage |  |  |  | $\mathrm{I}_{\mathrm{G}}=-1 \mu \mathrm{~A}$, | $V_{\text {DS }}=0$ |  | $-30^{*}-45$ |  | V |
| IGSS . | Gate Reverse Current | $\mathrm{V}_{\mathrm{GS}}=-20 \mathrm{~V}$, | $V_{D S}=0$ |  | $-<0.01$ | -2 | nA |
| $V_{\text {GS( }}$ (off) | Gate-Source Cutoff Voltage | $V_{\text {DS }}=15 \mathrm{~V}$, | $\mathrm{I}_{\mathrm{D}}=1 \mathrm{nA}$ |  | -0.5 -4.5 | -12 | V |
| $\mathrm{V}_{\text {GS }}$ | Gate-Source Voltage | $V_{D S}=15 \mathrm{~V}$, | $I_{D}=100 \mu \mathrm{~A}$ |  | -0.5 -4.0 | -10 | V |
| IDSS | Zero-Gate-Voltage Drain Current | $V_{\text {DS }}=15 \mathrm{~V}$, | $V_{G S}=0$, | See Note 1 | 880 | 200 | mA |
| $\left\|\mathrm{Vfs}_{\text {f }}\right\|$ | Small-Signal Common-Source <br> Forward Transfer Admittance | $\mathrm{V}_{\mathrm{DS}}=15 \mathrm{~V}$ <br> See Note 2 | $\mathrm{V}_{\mathrm{GS}}=0,$ | $f=1 \mathrm{kHz}$ | 2030 | 40 | mmho |
| rds(on) | Small-Signal Drain-Source On-State Resistance | $\mathrm{V}_{\mathbf{G S}}=0$, | $I_{\text {D }}=0$, | $\mathrm{f}=1 \mathrm{kHz}$ | 1023 | 60 | $\Omega$ |
| $C_{\text {iss }}$ | Common-Source Short-Circuit Input Capacitance | $V_{G S}=-10 \mathrm{~V},$ <br> See Note 3 | $\mathrm{V}_{\text {DS }}=0$, | $f=1 \mathrm{MHz}$, | 8 | 15 | pF |
| $\mathrm{C}_{\text {rss }}$ | Common-Source Short-Circuit Reverse Transfer Capacitance | $V_{\mathrm{GS}}=-10 \mathrm{~V}$ <br> See Note 3 | $V_{D S}=0,$ | $f=1 \mathrm{MHz},$ | 3.2 | 6 | pF |
| $t_{d}(\mathrm{on})$ | Turn-On Delay Time |  |  | 2N4856 | 3 |  |  |
| ${ }_{t}{ }_{r}$ | Rise Time | $V_{D D}=10 \mathrm{~V}$, | $V_{G S(o n)}=0$, | Data | 1 |  |  |
| ${ }^{\text {t }}$ (loff) | Turn-Off Delay Time | $V_{G S(0 f f)}=-10 \mathrm{~V}$, $\mathrm{R}^{\prime}$ | $R_{L}=1 \mathrm{k} \Omega$ | Sheet | 10 |  | ns |
| $t_{f}$ | Fall Time |  |  | Circuit | 20 |  |  |

additional characteristics at $\mathbf{2 5}{ }^{\circ} \mathbf{C}$ free-air temperature of devices having IDSS $<\mathbf{4 0} \mathbf{m A}$

| PARAMETER |  | CONDITIONS |  |  | OBSERVED VALUES |  |  | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | LOW | TYP | HIGH |  |
| IDSS | Zero-Gate-Voltage Drain Current |  |  |  | $\mathrm{V}_{\text {DS }}=15 \mathrm{~V}$, | $V_{G S}=0$, | See Note 1 | 8 | 30 | 40 | mA |
| Vosi | Small-Signal Common-Source Output Admittance | $V_{D S}=15 \mathrm{~V}$ <br> See Note 2 | $V_{G S}=0$, | $\mathrm{f}=1 \mathrm{kHz}$, |  | 70 | 125 | $\mu \mathrm{mho}$ |
| $V_{n}$ | Equivalent Input Noise Voltage | $\mathrm{V}_{\text {DS }}=15 \mathrm{~V}$, | $\mathrm{I}_{\mathrm{D}}=1 \mathrm{~mA}$, | $\mathrm{f}=1 \mathrm{kHz}$ |  | 1.5 |  | $n \mathrm{~V} / \sqrt{\mathrm{Hz}}$ |
|  |  | $V_{\text {DS }}=15 \mathrm{~V}$, | $1 \mathrm{D}=1 \mathrm{~mA}$, | $f=10 \mathrm{~Hz}$ |  | 5 |  | $n \mathrm{~V} / \sqrt{\mathrm{Hz}}$ |

[^128]
## CHIP TYPE JN52 N-CHANNEL SILICON JUNCTION FIELD-EFFECT TRANSISTORS

TYPICAL CHARACTERISTICS


NOTES: 1. Thls parameter wes measured using pulse rechniques. $t_{w}=300 \mu s$, duty cycle $\leqslant 2 \%$.
2. To avoid overheating the transistor, these parameters were measured with bias conditions applled for less than five seconds. ${ }^{+}$Date is for devices having the indicated value of $I_{D S S}$ at $V_{D S}=15 \mathrm{~V}, \mathrm{~T}_{A}=25^{\circ} \mathrm{C}$.

## CHIP TYPE JN52 <br> N-CHANNEL SILICON JUNCTION FIELD-EFFECT TRANSISTORS

TYPICAL CHARACTERISTICS


FIGURE 8
$C_{\text {ras }}$ v VDs

$V_{n}$ vil



FIGURE 12
$V_{O}(\mathrm{av}) \neq \mathrm{vs} \mathrm{tr}_{\mathrm{r}}$ and $\mathrm{t}_{\mathrm{f}}$


FIGURE 13
$V_{O}(\mathrm{av}) \ddagger$ vs $f$


FIGURE 14


TEST CIRCUIT


INPUT VOLTAGE WAVEFORM

FIGURE 15-MEASUREMENT INFORMATION FOR FIGURES 13 and 14
NOTES: 2. To avold overheating the transistor, these parameters were measured with blas conditions applied for less then five seconds.
3. Capacitance measuremente were made uving chlpe mounted in TO-18 packages.
4. These measurements were made in the switehing circuit of Figure 1 of the 2 N 4858 dsta sheet verying $\mathrm{R}_{\mathrm{L}}$ from $100 \Omega$ to $10 \mathrm{k} \Omega$. $t_{w w}=1 \mu_{s}$, duty cycle $<2 \%$.
Voltmeter input resistance $R_{\text {In }}>10 \mathrm{M} \Omega$.
Fin the circult of Figure 15, averege output voltage results from capacitive feed-through of the gate-drive algnal.

## CHIP TYPE JN63 N-CHANNEL SILICON JUNCTION FIELD-EFFECT TRANSISTORS

- JN53 is a $15 \times 16$-mil, epitaxial, planar, expanded-contact chip
- Available in TO.72 and Silect ${ }^{\dagger}$ packages
- For use in VHF/UHF amplifier, oscillator, and mixer circuits requiring low noise characteristics

electrical and operating characteristics at $\mathbf{~} 5^{\circ} \mathrm{C}$ free-air temperature

| PARAMETER |  | CONDITIONS |  |  | OB8ERVED VALUES |  |  | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | LOW | TYP | HICH |  |
| $V$ (BR) CSS | Gate-Source Breakdown Voltage |  |  |  | $\mathrm{I}_{\mathrm{G}}=-1 \mu \mathrm{~A}$, | $V_{D S}=0$ |  | $-30^{*}$ | -45 | $-80$ | $V$ |
| IGSS | Gate Reverse Current | $\mathrm{V}_{\mathbf{G S}}=-20 \mathrm{~V}$, | $V_{D S}=0$ |  |  | <0.01 | -1 | nA |
| VGS(off) | Gate-Source Cutoff Voltege | $V_{D S}=15 \mathrm{~V}$, | $I_{D}=1 \mathrm{nA}$ |  | -0.5 | -3 | -8 | V |
| $V_{\text {GS }}$ | Gate-Source Voltage | $V_{D S}=15 \mathrm{~V}$, | $l_{D}=100 \mu A$ |  | -0.3 | -2.5 | -7 | V |
| IDSS | Zero-Gate-Voltage Drain Current | $V_{D S}=15 \mathrm{~V}$, | $V_{G S}=0$, | See Note 1 | 1 | 10 | 24 | mA |
| \|Vfs| | Small-Signal Common-Source Forward Transfer Admittance | $V_{D S}=15 \mathrm{~V}$, | $V_{G S}=0$, | $\mathrm{f}=1 \mathrm{kHz}$ | 3 | 6 | 7 | mmho |
| \|Yos| | Small-Signal Common-Source Output Admittance |  |  |  | 1 | 35 | 85 | $\mu \mathrm{mho}$ |
| $\mathrm{C}_{\text {iss }}$ | Common-Source Short-Circuit Input Capacitance | $\begin{aligned} & V_{D S}=15 \mathrm{~V} \\ & \text { See Note } 2 \end{aligned}$ | $V_{G S}=0$, | $\mathrm{f}=1 \mathrm{MHz}$, |  | 4 | 5 | pF |
| $C_{\text {rss }}$ | Common-Source Short-Circuit Reverse Transfer Capacitance |  |  |  |  | 0.8 | 1 | pF |
| Coss | Common-Source Short-Circuit Output Capacitance |  |  |  |  | 1 | 2 | pF |
| 9 is | Small-Signal Common-Source Input Conductance | $V_{\text {DS }}=15 \mathrm{~V}$, | $V_{G S}=0$ | $f=100 \mathrm{MHz}$ |  | 0.07 | 0.1 | mmho |
| $b_{\text {is }}$ | Small-Signal Common-Source Input Susceptance |  |  |  |  | 2.5 | 3 | mmho |
| gfs | Small-Signal Common-Source <br> Forward Transfer Conductance |  |  |  | 3 | 6 | 7 | mmho |
| 908 | Smatl-Signal Common-Source Output Conductance |  |  |  |  | 0.01 | 0.1 | mmho |
| $\mathrm{b}_{08}$ | Small-Signal CommonSource Output Susceptance |  |  |  |  | 0.7 | 1 | mmho |
| $\theta_{\text {is }}$ | Small-Signal Common-Source Input Conductance | $V_{D S}=15 \mathrm{~V}$ | $V_{\mathbf{G S}}=0$, | $f=400 \mathrm{MHz}$ |  | 0.25 | 1 | mmho |
| $\mathrm{b}_{\text {is }}$ | Small-Signal Common-Source Input Susceptance |  |  |  |  | 8 | 12 | mmho |
| Ofs | Small-Signal Common-Source <br> Forward Transfer Conductance |  |  |  | 2.5 | 5.5 | 7 | mmho |
| Sos | Small-Signal Common-Source Output Conductance |  |  |  |  | 0.06 | 0.15 | mmho |
| $\mathrm{b}_{\mathbf{o s}}$ | Small-Signal Common-Source Output Susceptance |  |  |  |  | 3 | 4 | mmho |
| F | Spot Noise Figure | $\begin{aligned} & V_{D S}=15 \mathrm{~V}, \\ & R_{G}=1 \mathrm{k} \Omega \end{aligned}$ | $I_{D}=5 \mathrm{~mA}$, | $f=100 \mathrm{MHz}$ $f=400 \mathrm{MHz}$ |  | 1 | $\begin{array}{r} 2 \\ -\quad 4 \end{array}$ | dB |

[^129]Correlation of

${ }^{+}$Dats is for devices having the indicated values of ${ }^{\text {DSS }}$ at $V_{D S}=15 \mathrm{~V}, \mathrm{~V}_{G S}=0, \mathrm{~T}_{\mathrm{A}}=25^{\circ} \mathrm{C}$.
NOTE 1: This parameter was messured using puise techniquas. $\mathrm{t}_{\mathrm{w}}=\mathbf{3 0 0} \mu$ s, duty cycle ${ }^{*} 2 \%$.

# CHIP TYPE JN53 N-CHANNEL SILICON JUNCTION FIELD-EFFECT TRANSISTORS 

## TYPICAL CHARACTERISTICS


${ }^{\dagger}$ Oata is for devices having the indicated values of $I_{D S S}$ at $V_{D S}=15 \mathrm{~V}, \mathrm{~V}_{G S}=0, T_{A}=25^{\circ} \mathrm{C}$.

TYPICAL CHARACTERISTICS


FIGURE 11
gres brs vs $f$


Figure 13


FigURE 12

FIGURE 14

## TYPICAL CHARACTERISTICS



## CHIP TYPE JN54

## N-CHANNEL SILICON JUNCTION FIELD-EFFECT TRANSISTORS

- JN54 is a $26 \times 26$-mil, epitaxial, expanded-contact chip
- Available in TO-39 and Silect ${ }^{\dagger}$ packages
- For use in high-voltage amplifier circuits

electrical and operating characteristics at $25^{\circ} \mathrm{C}$ free-air temperature

| PARAMETER |  | CONDITIONS |  |  | OBSERVED VALUES |  |  | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | LOW | TYP | HIGH |  |
| $V_{\text {(BR) }}$ GSS | Gate-Source Breakdown Voltage |  |  |  | $\mathrm{I}_{\mathrm{G}}=-10 \mu \mathrm{~A}$, | $\mathrm{V}_{\text {DS }}=0$ |  | $-250{ }^{*}$ | $-350$ |  | $V$ |
| IGSO | Gate Reverse Current | $\mathrm{V}_{\mathrm{GS}}=-75 \mathrm{~V}$, | $I^{\prime}=0$ |  |  | -<1 | -3 | nA |
| IGSS | Gate Reverse Current | $\mathrm{V}_{\mathrm{GS}}=-40 \mathrm{~V}$. | $V_{D S}=0$ |  |  | -<1 | -2 | nA |
| IDGO | Drain Reverse Current | $V_{D G}=200 \mathrm{~V}$. | IS $=0$ |  |  | <1 | 100 | nA |
| $V_{\text {GS }}$ (off) | Gate-Source Voltage | $\mathrm{V}_{\mathrm{DS}}=30 \mathrm{~V}$. | $\mathrm{I}_{\mathrm{D}}=4 \mathrm{nA}$ |  | -2 | -9 | -20 | V |
| IDSS | Zero-Gate-Voltage Drain Current | $V_{D S}=30 \mathrm{~V}$, | $\mathrm{V}_{\mathbf{G S}}=0$, | See Note 1 | 1 | 5.5 | 15 | mA |
| rds(on) | Small-Signal Drain-Source On-State Resistance | $V_{G S}=0$, | $I_{D}=0$, | $\mathrm{f}=1 \mathrm{kHz}$ |  | 1.0 | 2 | $\mathrm{k} \Omega$ |
| $\left\|\mathrm{Vfs}_{\text {f }}\right\|$ | Small-Signal Common-Source Forward Transfer Admittance | $V_{D S}=30 \mathrm{~V}$, | $V_{G S}=0$. | $f=1 \mathrm{kHz}$ | 0.75 | 1.0 | 3 | mmho |
| Nos | Small-Signal Common-Source Output Admittance |  |  |  |  | 27 | 100 | $\mu \mathrm{mho}$ |
| $\mathrm{C}_{\text {iss }}$ | Common-Source Short-Circuit Input Capacitance | $V_{D S}=30 \mathrm{~V}$ <br> See Note 2 | $V_{G S}=0$, | $f=1 \mathrm{MHz}$, |  | 7.5 | 10 | pF |
| Crss | Common-Source Short-Circuit Reverse Transfer Capacitance |  |  |  |  | 3.5 | 5 | pF |
| $V_{n}$ | Equivalent Input <br> Noise Voltage | $V_{D S}=30 \mathrm{~V}$ | $\mathrm{V}_{\mathrm{GS}}=0$, | $f=1 \mathrm{kHz}$ | 0.25 |  |  | $\frac{\mu V}{\sqrt{H z}}$ |

[^130]
## CHIP TYPE JN54 N-CHANNEL SILICON JUNCTION FIELD-EFFECT TRANSISTORS

TYPICAL CHARACTERISTICS


NOTE 1: This parameter was masurad using pulse techniques. $t_{w}=300 \mu s$, duty cycle $\leqslant 2 \%$.
$t_{\text {Data }}$ is for devices having the indicated value of loss at $V_{O S}=30 \mathrm{~V}, \mathrm{~T}_{A}=25^{\circ} \mathrm{C}$.

## CHIP TYPE JN54 <br> N-CHANNEL SILICON JUNCTION FIELD-EFFECT TRANSISTORS

## TYPICAL CHARACTERISTICS



[^131]$\dagger_{\text {Data }}$ is for devices having the indicated value of $I_{D S S}$ at $V_{D S}=30 \mathrm{~V}, T_{A}=25^{\circ} \mathrm{C}$.

- JN55 is a $19 \times 19$-mil, epitaxial, planar, expanded-contact chip
- Available in TO-72 packages
- For extremely low-noise preamplifier and amplifier circuits

electrical and operating characteristics at $25^{\circ} \mathrm{C}$ free-air temperature

| PARAMETER |  | CONDITIONS |  |  | OBSERVED VALUES |  |  | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | LOW | TYP | HIGH |  |
| $\mathrm{V}_{\text {(BR)GSS }}$ | Gate-Source Breakdown Voltage |  |  |  | $\mathrm{I}_{\mathrm{G}}=-1 \mu \mathrm{~A}$, | $V_{\text {DS }}=0$ |  | -20 | -35 |  | $V$ |
| IGSS | Gate Reverse Current | $\mathrm{V}_{\mathrm{GS}}=-10 \mathrm{~V}$, | $V_{D S}=0$ |  |  | $-<0.1$ | -0.5 | nA |
| $V_{\text {GS }}$ (off) | Gate-Source Cutoff Voltage | $V_{D S}=10 \mathrm{~V}$, | $\mathrm{I}_{\mathrm{D}}=0.5 \mathrm{nA}$ |  | -0.5 |  | -5 | V |
| 'DSS | Zero-Gate-Voltage Drain Current | $V_{D S}=10 \mathrm{~V}$, | $\mathrm{V}_{\mathrm{GS}}=0$, | See Note 1 | 5 |  | 50 | mA |
| $\left\|V_{f s}\right\|$ | Smail-Signal Common-Source Forward Transfer Admittance | $V_{D S}=10 \mathrm{~V}$, | ${ }^{\prime} \mathrm{D}^{\prime}=5 \mathrm{~mA}$, | $\mathrm{f}=1 \mathrm{kHz}$ | 15 | 20 | 30 | mmho |
| VosI | Small-Signal Common-Source Output Admittance | $V_{D S}=10 \mathrm{~V}$, | ${ }^{\prime} \mathrm{D}=5 \mathrm{~mA}$, | $\mathrm{f}=1 \mathrm{kHz}$ |  |  | 75 | $\mu \mathrm{mho}$ |
| $C_{\text {iss }}$ | Common-Source Short-Circuit Input Capacitance | $\begin{aligned} & V_{D S}=10 \mathrm{~V} \\ & \text { See Note } 2 \end{aligned}$ | $I_{D}=5 \mathrm{~mA}$, | $f=1 \mathrm{MHz}$, |  | 15 | 25 | pF |
| $\mathrm{C}_{\text {rss }}$ | Common-Source Short-Circuit Reverse Transfer Capacitance | $\mathrm{V}_{\mathrm{DS}}=10 \mathrm{~V}$ <br> See Note 2 | $l^{\prime}=5 \mathrm{~mA}$, | $f=1 \mathrm{MHz}$, |  | 3.5 | 5 | pF |
| F | Spot Noise Figure | $\begin{aligned} & V_{D S}=10 \mathrm{~V}, \\ & f=10 \mathrm{~Hz} \end{aligned}$ | $\mathrm{I}_{\mathrm{D}}=5 \mathrm{~mA}$, | $\mathrm{R}_{\mathrm{G}}=10 \mathrm{k} \Omega$, |  | 0.25 | 2.5 | dB |
|  |  |  |  | $f=10 \mathrm{~Hz}$ |  | 3 | 10 | $n \mathrm{~V} / \sqrt{\mathrm{Hz}}$ |
| $V_{n}$ | Equivalent Input Noise Voitage | $V_{D S}=10 \mathrm{~V}$, | $\mathrm{I}^{\prime}=5 \mathrm{~mA}$ | $\mathrm{f}=1 \mathrm{kHz}$ |  | 1.5 | 8 | nv/ ${ }^{\text {Hz }}$ |

[^132]
## CHIP TYPE JN55 <br> N-CHANNEL SILICON JUNCTION FIELD-EFFECT TRANSISTORS

TYPICAL CHARACTERISTICS

${ }^{\dagger}$ Data is for devices having the indicated value of $I_{D S S}$ at $V_{D S}=10 \mathrm{~V}, \mathrm{~V}_{G S}=0$, and $T_{A}=25^{\circ} \mathrm{C}$
NOTES: 1. This parameter was measured using pulse techniques. $\mathbf{t}_{w}=300 \mu$ s, duty cycle $\leqslant 2 \%$. 2. Capacitance measurements were made using chips mounted in TO-72 packages.

## CHIP TYPE JP71 P-CHANNEL SILICON JUNCTION FIELD-EFFECT TRANSISTORS

- JP71 is a $17 \times 17$-mil, epitaxial, planar, expanded-contact chip
- Available in TO-5, TO-18, TO-72, and Silect ${ }^{\dagger}$ packages
- For use in low-noise amplifier circuits

electrical and operating characteristics at $25^{\circ} \mathrm{C}$ free-air temperature

| PARAMETER |  | CONDITIONS |  |  | OBSERVED VALUES |  |  | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | LOW | TYP | HIGH |  |
| V(BR)GSS | Gate-Source Breakdown Voltage |  |  |  | $\mathrm{I}_{\mathrm{G}}=10 \mu \mathrm{~A}$, | $V_{\text {DS }}=0$ |  | $30^{*}$ | 50 |  | V |
| IGSS | Gate Reverse Current | $\mathrm{V}_{\text {GS }}=15 \mathrm{~V}$, | $V_{D S}=0$ |  |  | <0.1 | 2 | nA |
| $\mathbf{V}_{\mathbf{G S}}$ | Gate-Source Voltage | $\mathrm{V}_{\text {DS }}=-15 \mathrm{~V}$, | $I_{D}=-100$ |  | 0.5 | 3 | 9 | V |
| IDSS | Zero-Gate-Voitage Drain Current | $\mathrm{V}_{\text {DS }}=-15 \mathrm{~V}$, | $\mathrm{V}_{\mathrm{GS}}=0$, | See Note 1 | -0.3 | -6 | -15 | mA |
| $\mathrm{ras}^{(0 n)}$ | Small-Signal Drain-Source On-State Resistance | VDS $=0$, | $V_{G S}=0$, | $\mathrm{f}=1 \mathrm{kHz}$ |  | 300 | 2000 | $\Omega$ |
| \| ffs | | Small-Signal Common-Source Forward Transfer Admittance | $\mathrm{V}_{\mathrm{DS}}=-15 \mathrm{~V}$ | $V_{G S}=0$, | $\mathrm{f}=1 \mathrm{kHz}$ | 1 | 3 | 4 | mmho |
| \|Yos 1 | Small-Signal Common-Source Output Admittance |  |  |  |  | 7 | 75 | $\mu \mathrm{mho}$ |
| $\mathrm{C}_{\text {iss }}$ | Common-Source Short-Circuit Input Capacitance | $\int V_{D S}=-15 \mathrm{~V},$ <br> See Note 2 | $\mathbf{V G S}_{\mathbf{G S}}=0$, | $\mathrm{f}=\mathbf{1} \mathrm{MHz}$, | 3.5 | 5.5 | 7 | pF |
| Crss | Common-Source Short-Circuit Reverse Transfer Capacitance |  |  |  |  | 1.2 | 2 | pF |
| F | Spot Noise Figure | $\begin{aligned} & V_{D S}=-15 \mathrm{~V}, \\ & \mathrm{f}=1 \mathrm{kHz} \end{aligned}$ | $V_{G S}=0$, | $\mathrm{R}_{\mathrm{G}}=1 \mathrm{M} \Omega$, |  | 0.3 | 2 | dB |
| $V_{n}$ | Equivalent Input Noise Voltage | $\mathrm{V}_{\text {DS }}=-15 \mathrm{~V}$, | $\mathrm{V}_{\mathrm{GS}}=0$, | $\mathrm{f}=1 \mathrm{kHz}$ |  | 35 | 100 | $\mathrm{nV} / \sqrt{\mathrm{Hz}}$ |

[^133]
## CHIP TYPE JP7 <br> P-CHANNEL SILICON JUNCTION FIELD-EFFECT TRANSISTORS

## 


figure 1

Correlation of
$\left|Y_{\text {fs }}\right|$ and $I_{\text {DSS }}$ with $\mathbf{V}_{\mathbf{G S}}(100 \mu \mathrm{~A})$


FIGURE 4

Correlation of


FIGURE 7

TYPICAL CHARACTERISTICS


FIGURE 2
Normalized ID
vs
Normalized VGS
(Devices Having loss Greater than 3 mA )

figure 5


FIGURE 8
$I_{D} \mathbf{w} V_{G S}$


FIGURE 3

Normalized $\left|\mathrm{F}_{\mathrm{f}}\right|$

Normalized VGS

figure 6


FIGURE 9

[^134]
# CHIP TYPE JPT <br> P-CHANNEL SILICON JUNCTION FIELD-EFFECT TRANSISTORS 

TYPICAL CHARACTERISTICS

t Deta is for devices having the Indicated value of loss at $V_{D S}=-15 \mathrm{~V}, V_{G S}=0, T_{A}=25^{\circ} \mathrm{C}$.
NOTE 2: Capecitance masaurements were made using chips mounted in Silect packeges.

## CHIP TYPE JP72

P-CHANNEL SILICON JUNCTION FIELD-EFFECT TRANSISTORS

- JP72 is a $19 \times 19$-mil, epitaxial, planar, expanded-contact chip
- Available in TO-72 packages
- For use in commutator and chopper circuits

electrical characteristics at $25^{\circ} \mathrm{C}$ free-air tamperature


[^135]
## P-CHANNEL SILICON JUNCTION FIELD-EFFECT TRANSISTORS

TYPICAL CHARACTERISTICS


NOTES: 2. To obtain reproducible results, these parameters were measured with bias conditions applied for less than five seconds 3. Cspacitance messurements were mada using chips mounted in TO-72 packages.

- MN81 is a $19 \times 19$-mil, epitaxial, planar, expanded-contact chip which has integrated back-to-back diodes between the gates and the source and substrate


## - Available in TO-72 packages

- For use in VHF amplifier and mixer circuits requiring low noise, low feedback capacitance, and very high gain

electrical characteristics at $\mathbf{2 5}{ }^{\circ} \mathbf{C}$ free-air temperature

| PARAMETER |  | CONDITIONS |  |  | OBSERVED VALUES |  |  | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | LOW | TYP | HIGH |  |
| V(BR)DS | Drain-Source Breakdown Voltage |  |  |  | $l^{\prime}=10 \mu A$, | $\mathrm{V}_{\mathbf{G 1 S}}{ }^{\text {w }} \mathrm{V}_{\mathbf{G 2 S}}=-5 \mathrm{~V}$ |  | 25* | 28 |  | V |
| V(BR)G1SSF | Gate-One-Source Forward Breakdown Voltage | $\mathrm{IG}_{\mathrm{G}}=10 \mathrm{~mA}$. | $V_{G 2 S}=V_{\text {DS }}=0$, | See Note 1 | 6 | 12 | 30 | V |
| $V_{\text {(BR) }}$ G1SSR | Gate-One-Source Reverse Breakdown Voltage | $\mathrm{IG}_{\mathrm{I}}=\mathbf{- 1 0 m A}$ | $V_{G 2 S}=V_{D S}=0$, | See Note 1 | $-6{ }^{*}$ | -12 | -30 | V |
| $V_{\text {(BR) }}$ G2SSF | Gate-Two-Source Forward Breakdown Voltage | $\mathrm{I}_{\mathrm{G} 2}=10 \mathrm{~mA}$, | $\mathbf{V}_{\mathbf{G I S}}=\mathrm{V}_{\mathrm{DS}}=0$, | See Note 1 | 6 | 12 | 30 | V |
| $\mathbf{V}_{(B R)}$ G2SSR | Gate-Two-Source Reverse Breakdown Voltage | $\mathrm{I}_{\mathrm{G2}}=-10 \mathrm{~mA}$, | $V_{G 1 S}=V_{D S}=0$, | See Note 1 | -6* | -12 | -30 | $V$ |
| 'G1SSF | Gate-One-Terminal <br> Forward Current | $\mathrm{V}_{\mathrm{G1S}}=5 \mathrm{~V}$, | $V_{G 2}=V_{D S}=0$ |  |  | $<0.01$ | 10 | nA |
| 'G1SSR | Gate-One-Terminal Reverse Current | $\mathrm{V}_{\mathrm{G1S}}=-5 \mathrm{~V}$, | $V_{G 2}=V_{\text {DS }}=0$ |  |  | $-<0.01$ | -10 | nA |
| IG2SsF | Gate-Two-Terminal Forward Current | $\mathrm{V}_{\mathbf{G 2 S}}=5 \mathrm{~V}$, | $V_{G 1 S}=V_{D S}=0$ |  |  | $<0.01$ | 10 | nA |
| IG2SSR | Gate-Two-Terminal Reverse Current | $\mathrm{V}_{\mathrm{G} 2 \mathrm{~S}}=-5 \mathrm{~V}$, | $V_{G 1 S}=V_{\text {DS }}=0$ |  |  | -<0.01 | -10 | nA |
| IDS | Zero-Gate-One-Voltage Drain Current | $\mathrm{V}_{\mathrm{DS}}=15 \mathrm{~V} .$ <br> See Note 2 | $V_{G 1 S}=0,$ | $\mathrm{V}_{\mathrm{G} 25}=4 \mathrm{~V}$. | 3 | 10 | 30 | mA |
| $\mathrm{V}_{\mathrm{G} 1 \mathrm{~S} \text { (off) }}$ | Gate-One-Source Cutoff Voltage | $V_{D S}=15 \mathrm{~V}$, | $\mathbf{V G 2 S}^{\text {G }}=\mathbf{4} \mathbf{V}$. | $I_{D}=20 \mu \mathrm{~A}$ | -0.5 | -1.8 | -4 | V |
| $V_{\text {G2S }}$ (off) | Gate-Two-Source Cutoff Voltage | $V_{D S}=15 \mathrm{~V}$, | $\mathrm{V}_{\mathrm{G1S}}=0$. | $I_{D}=20 \mu \mathrm{~A}$ | -0.2 | -1.4 | -4 | V |
| $\left\|y_{f s}\right\|$ | Small-Signal Common-Source <br> Forward Transfer Admittance | $\begin{aligned} & \mathrm{V}_{\text {DS }}=15 \mathrm{~V}, \\ & \mathrm{f}=1 \mathrm{kHz}, \end{aligned}$ | $V_{\mathrm{G} 1 \mathrm{~S}}=0,$ <br> See Note 3 | $\mathrm{V}_{\mathrm{G2S}}=4 \mathrm{~V}$, | 7 | 15 | 22 | mmho |
| $\mathrm{C}_{\text {iss }}$ | Common-Source Short-Circuit Input Capacitance | $\begin{aligned} & V_{D S}=15 \mathrm{~V}, \\ & f=1 \mathrm{MHz} . \end{aligned}$ | $\mathrm{V}_{\mathrm{G} 1 \mathrm{~S}}=0,$ <br> See Notes 3 and 4 | $\mathbf{V G 2 S}^{\text {a }} \mathbf{4} \mathbf{V}$, |  | 5 |  | pF |
| $\mathrm{C}_{\text {oss }}$ | Common-Source Short-Circuit Output Capacitance | $\begin{aligned} & V_{D S}=15 \mathrm{~V}, \\ & f=1 \mathrm{MHz}, \end{aligned}$ | $V_{G 1 S}=0,$ <br> See Notes 3 and 4 | $\mathbf{V}_{\text {G2S }}=4 \mathrm{~V}$. |  | 2 |  | pF |
| Crss | Common-Source Short-Circuit Reverse Transfer Capacitance | $\begin{aligned} & V_{D S}=15 \mathrm{~V}, \\ & f=1 \mathrm{MHz} \end{aligned}$ | $V_{G 2 S}=4 V$ <br> See Note 4 | $I_{\text {d }}=10 \mathrm{~mA}$, | 0.005 | $<0.1$ | 0.03 | pF |

These values do not modify guaranteed limits for specific devices and do not justify operation in excess of absolute maximum ratings.
NOTES: 1. To ensure thet the protective diodes are functionig properis,
NOTES: 1. To ensure that the protective diodes are functioning properly, this voltage is maasured while the device is conducting rated forvara gate current.
2. This parameter was measured using pulse tech niques. $t_{w}=300 \mu \mathrm{~s}$, duty cycle $\leqslant \mathbf{2 \%}$.
3. To avoid overhesting the transistor, these parameters must be measured with bias conditions applied for less than five seconds.
4. Capacitance measurements were made using chips mounted in TO-72 packages.

# CHIP TYPE MN81 <br> N-CHANNEL DUAL-GATE DEPLETION-TYPE INSULATED-GATE FIELD-EFFECT TRANSISTORS 

TYPICAL CHARACTERISTICS AT TA $\mathbf{= 2 5}{ }^{\circ} \mathrm{C}$

${ }^{\dagger}$ Date is for devices having the indicated value of $\mathrm{IDS}_{\mathrm{DS}}$ at $\mathrm{V}_{\mathrm{DS}}=15 \mathrm{~V}, \mathrm{~V}_{\mathrm{G} 1 \mathrm{~S}}=0, \mathrm{~V}_{\mathrm{G2S}}=4 \mathrm{~V}$.
NOTE 2: This parameter was measured using pulse techniques. $t_{w}=300 \mu \mathrm{~s}$, duty cycle $\leqslant \mathbf{2 \%}$.

## TYPICAL CHARACTERISTICS AT TA $\mathbf{=} \mathbf{2 5}^{\circ} \mathrm{C}$




FIGURE 7
$\boldsymbol{g}_{\mathrm{os}} \mathrm{vs} \mathrm{V}_{\mathbf{G} 2 \mathrm{~S}}$


FIGURE 9
$b_{f s} \mathbf{v s} V_{G 2 S}$


FIGURE 8
$g_{o s}$ vs VDS

$t^{\text {Data }}$ is for devices having the indicated value of ${ }^{\mathrm{DS}}$ at $\mathrm{V}_{\mathrm{DS}}=15 \mathrm{~V}, \mathrm{~V}_{\mathrm{G} 1 \mathrm{~S}}=0, \mathrm{~V}_{\mathrm{G} 2 \mathrm{~S}}=4 \mathrm{~V}$.

## TYPICAL CHARACTERISTICS AT TA $\mathbf{~ 2 5}^{\circ} \mathrm{C}$



[^136]
## CHIP TYPE MN81 <br> N-CHANNEL DUAL-GATE DEPLETION-TYPE <br> INSULATED-GATE FIELD-EFFECT TRANSISTORS

TYPICAL CHARACTERISTICS AT TA $=\mathbf{2 5}^{\circ} \mathbf{C}$



FIGURE 18


FIGURE 18


FIBURE 20

- MN82 is a $19 \times 19$-mil, epitaxial, planar, expanded-contact MOS silicon chip
- Available in TO-72 packages
- For use in VHF amplifier circuits

electrical and operating characteristics at $25^{\circ} \mathrm{C}$ free-air temperature

| PARAMETER |  | CONDITIONS |  |  | OBSERVED VALUES |  |  | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | LOW | TYP | HFGH |  |
| $V_{\text {(BR) }}$ DSV | Drain-Source Breakdown Voltage |  |  |  | $I_{D}=10 \mu A$, | $V_{G S}=-8 \mathrm{~V}$ |  | $20^{*}$ | 28 |  | $V$ |
| IGSSF | Forward Gate-Terminal Current | $\mathrm{V}_{\mathrm{GS}}=8 \mathrm{~V}$, | $V_{\text {DS }}=0$ |  |  | $<1$ |  | pA |
| IGSSR | Reverse Gate-Terminal Current | $\mathrm{V}_{\text {GS }}=-8 \mathrm{~V}$, | $V_{D S}=0$ |  |  | -<1 | -50 | PA |
| $V_{\text {GS }}$ (off) | Gate-Source Cutoff Voltage | $\mathrm{V}_{\text {DS }}=15 \mathrm{~V}$, | $\mathrm{I}^{1} \mathrm{D}=50 \mu \mathrm{~A}$ |  | -0.8 | -1.5 | -8 | V |
| IDSS | Zero-Gate-Voltage Drain Current | $V_{D S}=15 \mathrm{~V}$, | $\mathrm{V}_{\mathbf{G S}}=0$, | See Note 1 | 5 | 10 | 30 | mA |
| \|Vfsi | Small-Signal Common-Source Forward Transfer Admittence | $V_{D S}=15 \mathrm{~V}$, | $I_{D}=5 \mathrm{~mA}$, | $\mathrm{f}=1 \mathrm{kHz}$ | 5 | 10 | 12 | mmho |
| \|Yos| | Small-Signal Common-Source Output Admittance |  |  |  |  | 0.25 |  | mmho |
| $C_{\text {iss }}$ | Cormmon-Source Short-Circuit Input Capacitance | $V_{D S}=15 \mathrm{~V},$ <br> See Note 2 | ${ }^{\prime} D^{\prime}=5 \mathrm{~mA}$, | $f=1 \mathrm{MHz}$, | 4 |  |  | pF |
| $C_{\text {rss }}$ | Common-Source Short-Circuit Reverse Transfer Capecitance |  |  |  |  | 0.3 | 0.35 | pF |
| $C_{\text {css }}$ | Common-Source Short-Circuit Output Capecitance |  |  |  |  | 1.6 |  | pF |
| gis | Small-Signal Common-Source Input Conductance | $V_{D S}=15 \mathrm{~V}$, | $I_{D}=5 \mathrm{~mA}$, | $f=\mathbf{2 0 0 ~ M H z}$ |  | 0.2 |  | mmho |
| $b_{\text {is }}$ | Small-Signal Common-Source Input Susceptance |  |  |  |  | 4.5 |  |  |
| 9f8 | Small-Signal Common-Source Forward Transfer Conductance |  |  |  |  | 10 |  | mmho |
| $b_{\text {fis }}$ | Small-Signal Common-Source Forward Transfer Susceptance |  |  |  |  | -2 |  |  |
| 9rs | Small-Signal Common-Source Reverse Transfer Conductance |  |  |  |  | 0.05 |  | mmho |
| brs | Small-Signal Common-Source Reverse Transfer Susceptance |  |  |  | -0.4 |  |  |  |
| gos | Small-Signal Common-Source Output Conductance |  |  |  | 0.25 |  |  | mmho |
| $b_{0: 3}$ | Small-Signal Common-Source Output Susceptance |  |  |  | 2 |  |  |  |
| F | Spot Noise Figure | $V_{\text {DS }}=15 \mathrm{~V}$, | $10=5 \mathrm{~mA}$, | $f=200 \mathrm{MHz}$ |  |  | 5 | d8 |

This velue does not modify guaranteed limite for specific devices and does not justify operation in excess of absolute maximum reings. CAUTION: The measurement of $V_{(B R) D S V}$ may be destructive.
NOTES: 1. This paramatar was measured using pulee techniques. $t_{w}=300 \mu s$, duty cycle $<2 \%$.
2. Capacitance measurements were made using chlps mounted In TO-72 packages.

TYPICAL CHARACTERISTICS


[^137]
# CHIP TYPE MN82 <br> N-CHANNEL DEPLETION-TYPE INSULATED-GATE FIELD-EFFECT TRANSISTORS 

TYPICAL CHARACTERISTICS


## CHIP TYPE MN82

## N-CHANNEL DEPLETION-TYPE

 INSULATED-GATE FIELD-EFFECT TRANSISTORSTYPICAL CHARACTERISTICS


NOTE 2: Capacitance measurements were made using chips mounted in TO-72 packages.

## CHIP TYPE MN83 <br> N-CHANNEL ENHANCEMENT-TYPE INSULATED-GATE FIELD-EFFECT TRANSISTORS

- MN83 is a $21 \times 21$-mil, epitaxial, planar, expanded-contact MOS silicon chip
- Available in TO-72 packages
- For use in switching and chopper circuits

electrical and operating characteristics at $25^{\circ} \mathrm{C}$ free-air temperature

| PARAMETER |  | CONDITIONS |  |  | OBSERVED VALUES |  |  | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | LOW | TYP | HIGH |  |
| $V_{\text {(BR) }}$ DSS | Drain-Source Breakdown Voltage |  |  |  | ${ }^{1} \mathrm{D}=10 \mu \mathrm{~A}$, | $V_{G S}=0$ |  | $25^{*}$ | 40 |  | V |
| IGSSF | Forward Gate-Terminal Current | $\mathrm{V}_{\text {GS }}=35 \mathrm{~V}$, | $V_{\text {DS }}=0$ |  |  | $<1$ | 10 | pA |
| IGSSR | Reverse Gate-Terminal Current | $V_{\text {GS }}=-35 \mathrm{~V}$, | $V_{D S}=0$ |  |  | -<1 | -10 | pA |
| ldss | Zero-Gate-Voltage Drain Current | $V_{D S}=10 \mathrm{~V}$, | $\mathrm{V}_{\mathrm{GS}}=0$ |  |  | <1 | 10 | nA |
| $\mathrm{V}_{\mathrm{GS}}(\mathrm{th})$ | Gate-Source Threshold Voltage | $V_{D S}=10 \mathrm{~V}$, | $\mathrm{I}_{\mathrm{D}}=10 \mu \mathrm{~A}$ |  | 0.5 | 1 | 3 | V |
| ID(on) | On-State Drain Current | $V_{D S}=10 \mathrm{~V}$, | $\mathrm{V}_{\text {GS }}=10 \mathrm{~V}$, | See Note 1 | 10 | 150 | 400 | mA |
| Tds(on) | Small-Signal Drain-Source On-State Resistance | $\mathrm{V}_{\mathbf{G S}}=10 \mathrm{~V}$, | $\mathrm{I}_{\mathrm{D}}=0$, | $f=1 \mathrm{kHz}$ |  | 15 | 200 | $\Omega$ |
| $C_{\text {iss }}$ | Common-Source Short-Circuit Input Capacitance | $V_{D S}=10 \mathrm{~V}$ <br> See Note 2 | $V_{G S}=0$, | $\mathrm{f}=1 \mathrm{MHz}$, |  | 4.5 | 6 | pF |
| $\mathrm{C}_{\text {rss }}$ | Common-Source Short-Circuit Reverse Transfer Capaciatnce | $V_{D S}=0,$ <br> See Note 2 | $\mathbf{V G S}_{\mathbf{G S}}=0$, | $f=1 \mathrm{MHz}$, |  | 1.1 | 1.5 | pF |
| $t_{\text {d }}$ (on) | Turn-On Delay Time | $\left\{\begin{array}{l} V_{D D}=10 \mathrm{~V} \\ V_{G S(\text { on })}=10 \mathrm{~V}, \end{array}\right.$ | $\begin{aligned} & I_{D}(o n) \approx 10 \mathrm{~mA}, \\ & V_{G S(o f f)}=0, \end{aligned}$ | $\mathrm{R}_{\mathrm{L}}=800 \Omega$ <br> Figure 1 Circuit |  | 1 |  | ns |
| $\mathrm{t}_{\mathbf{r}}$ | Rise Time |  |  |  |  | 2 |  |  |
| $t_{\text {d }}$ (off) | Turn-Off Delay Time |  |  |  |  | 3 |  |  |
| $\mathrm{t}_{\mathrm{f}}$ | Fall Time |  |  |  |  | 12 |  |  |

This value does not modify guaranteed limits for specific devices and does not justify operation in excess of absolute maximum ratings. CAUTION: The measurement of $V_{(B R) O S S}$ may be destructive.
NOTES: 1. This parameter was measured using pulse techniques. $t_{w}=300 \mu \mathrm{~s}$, dutv cycle $\leqslant 2 \%$.
2. Capacitance measurements were made using chips mounted in TO-72 packages.

PARAMETER MEASUREMENT INFORMATION


TEST CIRCUIT


VOLTAGE WAVEFORMS

NOTES: a. The input waveform is supplied by a generator with the following characteristics: $Z_{\text {out }}=50 \Omega$, duty $\mathbf{c y c}=\leqslant \mathbf{1 \%}, \mathrm{t}_{\mathrm{r}} \leqslant \mathbf{0 . 3 3} \mathbf{n s}$, $t_{f}<0.33 \mathrm{~ns}, t_{w} \approx 100 \mathrm{~ns}$.
b. Waveforms are monitored on an oscilloscope with the following characteristics: $\mathrm{t}_{\mathrm{r}} \leqslant \mathbf{0 . 4} \mathrm{ns}, \mathrm{R}_{\mathrm{in}}=50 \Omega, \mathrm{C}_{\mathrm{in}}<2 \mathrm{pF}$.
figure 1
TYPICAL CHARACTERISTICS


FIGURE 2


NOTE 1: This parameter was measured using pulse techniques. $\mathbf{t}_{\mathbf{w}}=300 \mu \mathrm{~s}$, duty cycle $<\mathbf{2 \%}$.

CHIP TYPE MN83
N-CHANNEL ENHANCEMENT-TYPE INSULATED-GATE FIELD-EFFECT TRANSISTORS

## TYPICAL CHARACTERISTICS



[^138]2. Capacitance measurements were made using chips mounted in TO-72 packages.

## CHIP TYPE MN84 <br> N-CHANNEL DEPLETION-TYPE <br> INSULATED-GATE FIELD-EFFECT TRANSISTORS

- MN84 is a $21 \times 21-m i 1$, epitaxial, planar, expanded-contact MOS silicon chip which has integrated back-to-back diodes between the gate and the substrate
- Available in TO-72 packages
- For low-power switching and chopper circuits

electrical and operating characteristics at $25^{\circ} \mathbf{C}$ free-air temperature

| PARAMETER |  | CONDITIONS |  |  | OBSERVED VALUES <br> LOW TYP HIGH |  |  | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| $V_{\text {(BR) }}$ GSSF | Forward Gate-Source Breakdown Voltage | $\mathrm{I}_{\mathrm{G}}=1 \mathrm{~mA},$ <br> See Note 1 | $\mathrm{V}_{\mathrm{DS}}=0 .$ | VUS $=0$, | 7* | 10 |  | V |
| $V_{(B R)}$ GSSR | Reverse Gate-Source Breakdown Voltage | $I_{G}=-1 \mathrm{~mA}$ <br> See Note 1 | $V_{D S}=0$ | V US $=0$, | -7* | -35 |  | V |
| IGSSF | Forward Gate-Terminal Current | $\mathrm{VGS}_{\mathbf{G S}}=7 \mathrm{~V}$, | $\mathrm{V}_{\text {DS }}=0$, | $V_{\text {US }}=0$ |  | <0.1 | 10 | nA |
| IGSSR | Reverse Gate-Terminal Current | $\mathrm{V}_{\text {GS }}=-7 \mathrm{~V}$, | $V_{\text {DS }}=0$, | $V_{\text {US }}=0$ |  | -<0.1 | -10 | nA |
| 'S(off) | Source Cutoff Current | $\mathrm{V}_{S D}=12 \mathrm{~V}$, | $V_{G D}=-6 \mathrm{~V}$, | $V_{U D}=0$ |  | $<0.1$ | 1000 | nA |
|  |  | $V_{S D}=12 \mathrm{~V}$. | $V_{G D}=-6 \mathrm{~V}$, | $V_{U D}=-6 \mathrm{~V}$ |  | $<0.1$ | 1000 |  |
| ID(off) | Drain Cutoff Current | $V_{D S}=12 \mathrm{~V}$, | $\mathrm{V}_{\text {GS }}=-6 \mathrm{~V}$, | $V_{\text {US }}=0$ |  | $<0.1$ | 100 | nA |
|  |  | $V_{D S}=12 \mathrm{~V}$, | $\mathrm{V}_{\text {GS }}=-6 \mathrm{~V}$. | $V_{U S}=-6 \mathrm{~V}$ |  | $<0.1$ | 100 |  |
| TUSS | Substrate Reverse Current | $\mathrm{V}_{\text {US }}=-20 \mathrm{~V}$. | $\mathrm{V}_{\text {DS }}=0$, | $\mathrm{V}_{\text {GS }}=0$ |  | -<0.1 | $-10$ | nA |
| VGS(off) | Gate-Source Cutoff Voltage | $V_{\text {DS }}=12 \mathrm{~V}$. | $I_{D}=10 \mu A$, | VUS $=0$ | -0.1 | -0.75 | -1.5 | V |
| IDSS | Zero-Gate-Voitage <br> Drain Current | $V_{\text {DS }}=12 \mathrm{~V}$, | $\mathbf{V}_{\mathbf{G S}}=0$, | $V_{\text {US }}=0$ | 1 | 5 | 12 | mA |
| ID(on) | On-State Drain Current | $\begin{aligned} & V_{\mathrm{DS}}=3 \mathrm{~V}, \quad \mathrm{~V}_{\mathrm{GS}}=6 \mathrm{~V}, \\ & \text { See Note } 2 \end{aligned} \quad-\quad$ |  | $V_{\text {US }}=-6 \mathrm{~V}$ | 50 | 100 |  | mA |
| rdsion) | Small-Signal Drain-Source On-State Resistance | $\begin{aligned} & V_{G S}=6 V, \quad I_{D}=0, \\ & f=1 \mathrm{kHz} \end{aligned}$ |  | Vus $=0$ |  | 18 | 70 | $\Omega$ |
| $\mathrm{C}_{\text {iss }}$ | Common-Source Short-Circuit Input Capacitance | $\begin{array}{ll} V_{D S}=12 \mathrm{~V}, & V_{G S}=-6 \mathrm{~V} \\ f=1 \mathrm{MHz}, & \text { See Note } 3 \end{array}$ |  | $V_{\text {US }}=0$, |  | 5.6 | 7 | pF |
| $\mathrm{C}_{\text {rss }}$ | Common-Source Short-Circuit Reverse Transfer Capacitance | $V_{D S}=0$, $V_{G S}=-6 V$, <br> $f=1 \mathrm{MHz}$, See Note 3 |  | $V_{\text {US }}=0$, |  | 1.4 | 2 | pF |
| $\mathrm{C}_{\text {ds }}$ | Drain-Source Capacitance | $\begin{aligned} & V_{D S}=12 \mathrm{~V}, \\ & f=1 \mathrm{MHz}, \end{aligned}$ | $V_{G S}=-6 V,$ <br> See Notes 3 and | $V_{\text {US }}=0$, |  | 3.5 | 5 | pF |
| td (on) | Turn-On Delay Time | $\begin{aligned} & V_{D D}=12 \mathrm{~V}, \quad(\mathrm{D}(\text { on }) \approx 55 \mathrm{~mA} \\ & V_{G S(\text { on })} \approx 6 \mathrm{~V}, \mathrm{~V}_{\mathrm{GS}(\text { off })} \approx-2 \end{aligned}$$\text { Figure } 1 \text { Circuit }$ |  | $\begin{aligned} & R_{L}=200 \Omega \\ & V_{U S}=-6 V . \end{aligned}$ | 1.4 |  |  | ns |
| $\mathrm{t}_{\mathrm{r}}$ | Rise Time |  |  |  | 0.7 |  |  |
| $t_{\text {d }}$ (off) | Turn-Off Delay Time |  |  |  | 2.5 |  |  |
| $\mathrm{t}_{\mathrm{f}}$ | Fall Time |  |  |  | 4 |  |  |

*This value does not modify guarenteed limits for specific devices and does not justify operation in axcess of absolute maximum ratings.
NOTES: 1. Both gate breakdown voltages are measured while the device is conducting rated gate current. This ensures that the gate-voltage-limiting network is functioning proparly.
2. This parameter was measured using puise techniques. $t_{w}=300 \mu s$, duty eycle $<\mathbf{2 \%}$.
3. Capacitance measurements were made using chips mounted in TO. 72 packages.
4. $\mathrm{C}_{\mathrm{d}}$ measurement amploys a three-terminal capacitance bridge incorporating a guard circuit. The gate and case are connected to the guard terminal of the bridge.

# CHIP TYPE MN84 <br> N-CHANNEL DEPLETION-TYPE INSULATED-GATE FIELD-EFFECT TRANSISTORS 

PARAMETER MEASUREMENT INFORMATION


TEST CIRCUIT

(See Notes a and b) VOLTAGE WAVEFORMS

NOTES: a. The input waveforms are supplied by a genarator with the following characteristics: $Z_{\text {out }}=50 \Omega ; \mathbf{t}_{\mathrm{w}} \approx 200$ ns, duty cycle $<\mathbf{2 \%}$ b. Waveforms are monitored on an oscilloscope with the following characteristics: $\mathrm{tr}_{\mathrm{r}} \leqslant 1 \mathrm{~ns}, \mathrm{R}_{\text {in }} \geqslant 100 \mathrm{k} \Omega, \mathrm{C}_{\mathrm{in}} \leqslant 7 \mathrm{pF}$.

FIGURE 1-SWITCHING TIMES
TYPICAL CHARACTERISTICS

figure 2
luss vs TA


FIGURE 5


FIGURE 3
$\mathbf{V}_{\text {GS (off) }} \mathbf{v s} \mathrm{T}_{\mathbf{A}}$


FIGURE 6
$\mathbf{I D}_{\mathrm{D}}$ (off) ws $\mathbf{T}_{\mathbf{A}}$


FIGURE 4

IDSs vs TA


FIGURE 7

## CHIP TYPE MN84 <br> N-CHANNEL DEPLETION-TYPE <br> INSULATED-GATE FIELD-EFFECT TRANSISTORS

TYPICAL CHARACTERISTICS

$t_{d}(o n), t_{r}, t_{d}(o f f), t_{f}$ vs $R_{L}$


FIGURE 11

NOTE 2: This parameter was measured using pulse techniques. $\mathrm{t}_{\mathbf{w}}=\mathbf{3 0 0} \mu \mathrm{s}$, duty cycle $\leqslant \mathbf{2 \%}$.

## CHIP TYPE MN85 <br> N-CHANNEL DUAL-GATE DEPLETION-TYPE INSULATED-GATE FIELD-EFFECT TRANSISTORS

- MN85 is a $26 \times 26-m i l$, epitaxial, planar, expanded-contact MOS silicon chip which has integrated back-to-back diodes between the gates and the source and substrate
- Available in TO-72 packages
- For use in VHF amplifier and mixer circuits requiring low noise, low
 feedback capacitance, and very high gain


## electrical characteristics at $25^{\circ} \mathrm{C}$ free-air temperature

| PARAMETER |  | CONDITIONS |  |  | OBSERVED VALUES |  |  | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | LOW | TYP | HIGH |  |
| $V_{\text {(BR) }}$ (DS | Drain-Sourca Breakdown Voltage |  |  |  | $1 D^{\prime}=10 \mu A$, | $\mathrm{V}_{\mathrm{G1S}}=\mathrm{V}_{\mathrm{G2S}}=-4 \mathrm{~V}, \mathrm{t}=5 \mathrm{~s}$ |  | $27^{\circ}$ | 40 |  | V |
| V(BR)DS | Instantaneous Drain-Source Breakdown Voltage | $I_{D}=10 \mu A$, | $\mathrm{V}_{\mathrm{G1S}}=\mathrm{V}_{\mathbf{G 2 S}}=-4 \mathrm{~V}$ |  | 25* | 32 | 40 | $V$ |
| $V_{\text {(BA)G }}$ ISSF | Gate-One-Source Forward Breakdown Voltage | $\mathrm{I}_{\mathrm{G} 1}=10 \mathrm{~mA}$, | $V_{G 2 S}=V_{D S}=0$, | See Note 1 | 6* | 12 | 30 | $V$ |
| V(BR)GISSR | Gate-One-Source Reverse Breakdown Voltage | $\mathrm{I}_{\mathrm{G}} \mathbf{1}=-10 \mathrm{~mA}$, | $V_{G 2 S}=V_{D S}=0$ | See Note 1 | $-6$ | -12 | -30 | V |
| $V_{\text {(BA) }}$ G2SSF | Gate-Two-Source Forward Breakdown Voltage | $\mathrm{I}_{\mathrm{G} 2}=10 \mathrm{~mA}$, | $V_{G 1 S}=V_{D S}=0$. | See Note 1 | $6 *$ | 12 | 30 | V |
| $V_{\text {(BR)G2SSR }}$ | Gate-Two-Source Reverse Breakdown Voltage | $\mathbf{I G 2}^{\prime}=-10 \mathrm{~mA}$, | $V_{G 1 S}=V_{D S}=0$ | See Note 1 | $-6 *$ | -12 | -30 | V |
| ${ }^{\prime} \mathrm{G}$ 1SSF | Gate-One-Terminal Forward Current | $V_{G 1 S}=5 \mathrm{~V}$, | $V_{G 2}=V_{\text {DS }}=0$, |  |  | $<0.01$ | 10 | nA |
| ${ }^{\prime} \mathrm{G}$ 15SR | Gate-One-Terminal Reverse Current | $\mathrm{V}_{\mathbf{G 1 S}}=-5 \mathrm{~V}$, | $V_{G 2}=V_{D S}=0$ |  |  | -<0.01 | -10 | nA |
| IG2SSF | Gate-Two-Terminal Forward Current | $V_{G 2 S}=5 \mathrm{~V}$, | $V_{G 1 S}=V_{D S}=0$ |  |  | $<0.01$ | 10 | nA |
| 'G2SSR | Gate-Two-Terminal Reverse Current | $\mathbf{V}_{\mathbf{G 2 S}}=-5 \mathrm{~V}$, | $V_{G 1 S}=V_{\text {DS }}=0$ |  | - $-<0.01-10$ |  |  | nA |
| 'DS | Zero-Gate-One-Voltage Drain Currant | $V_{D S}=15 \mathrm{~V}$ <br> See Note 2 | $\mathrm{V}_{\mathrm{GtS}}=0$, | $\mathbf{V G 2 S}^{\text {a }} \mathbf{4} \mathrm{V}$, | 6 | 1540 |  | mA |
| VG1S(off) | Gate-One-Source Cutoff Voltage | $V_{D S}=15 \mathrm{~V}$, | $V_{G 2 S}=4 \mathrm{~V}$, | $I^{\prime}=20 \mu \mathrm{~A}$ | -0.5 | -1.3 | -5.5 | V |
| $V_{\text {G2S }}$ (off) | Gate-Two-Source Cutoff Voltage | $V_{D S}=15 \mathrm{~V}$, | $V_{G 1 S}=0$, | $I^{\prime}=20 \mu \mathrm{~A}$ | $-0.2$ | -1.0 | -4 | $V$ |
| Vfs $\mid$ | Small-Signal Common-Source Forward Transfer Admittance | $\begin{aligned} & \mathrm{V}_{\mathrm{DS}}=15 \mathrm{~V}, \\ & \mathrm{f}=1 \mathrm{kHz} . \end{aligned}$ | $V_{G 1 S}=0,$ <br> See Note 3 | $\mathrm{V}_{\mathrm{G2S}}=4 \mathrm{~V}$, | 15 | 27 | 40 | mmho |
| $\mathrm{C}_{\text {is }}$ | Common-Source Short-Circuit Input Capacitance | $\begin{aligned} & V_{D S}=15 \mathrm{~V}, \\ & f=1 \mathrm{MHz}, \end{aligned}$ | $V_{G 2 S}=4 V .$ <br> See Note 4 | ${ }^{1} \mathrm{D}=10 \mathrm{~mA}$, | 6 |  |  | pF |
| Coss | Common-Source Short-Circuit Output Capacitance | $\begin{aligned} & V_{D S}=15 \mathrm{~V}, \\ & f=1 \mathrm{MHz}, \end{aligned}$ | $\begin{aligned} & \mathrm{V}_{\mathrm{G} 2 \mathrm{~S}}=4 \mathrm{~V} \\ & \text { See Note } 4 \end{aligned}$ | $I_{D}=10 \mathrm{~mA}$, | 2.5 |  |  | pF |
| $C_{\text {res }}$ | Common-Source Short-Circuit Reverse Transfer Capacitance | $\begin{aligned} & V_{D S}=15 \mathrm{~V}, \\ & f=1 \mathrm{MHz}, \end{aligned}$ | $V_{G 2 S}=4 V$ <br> See Note 4 | ${ }^{\prime} \mathrm{D}^{\prime}=1 \mathrm{~mA}$, | 0.005 | $<0.03$ | 0.05 | pF |

*Thesa values do not modify guaranteed limits for specific devices and do not justify operation in excess of absolute maximum ratings.
NOTES: 1. To ensure that the protective diodes are functioning properiy, this voltage is measured while the device is conducting rated forward gate current.
2. This parameter was measured using pulse techniques. $t_{w}=300 \mu$ s, duty cycle $\leqslant 2 \%$.
3. To avoid overheating the transistor, this parameter must be maasured with blas conditions applied for less than five seconds.
4. Capacitance measurements were made using chips mounted in TO-72 pack ages.

## CHIP TYPE MN85

N-CHANNEL DUAL-GATE DEPLETION-TYPE INSULATED-GATE FIELD-EFFECT TRANSISTORS

TYPICAL CHARACTERISTICS AT $\mathrm{TA}_{\mathbf{A}} \mathbf{= 2 5 ^ { \circ }} \mathbf{C}$


NOTE 2: This parameter was measured using pulse techniques. $t_{w}=300 \mu s$, duty cycle $\leqslant 2 \%$.



FIGURE 11



FIGURE 13


VG2S-Gate Two-Source Voltage-V
FIGURE 15



FrGURE 14

FIGURE 16


FIGURE 18

- MP91 is a $20 \times 20$-mil, epitaxial, planar, expanded-contact MOS silicon chip
- Available in TO-72 packages
- For use in switching and chopper circuits

electrical and operating characteristics at $25^{\circ} \mathrm{C}$ free-air temperature

| PARAMETER |  | CONDITIONS ${ }^{\dagger}$ |  |  | OBSERVED VALUES |  |  | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | LOW | TYP | HIGH |  |
| $V_{\text {(BR) }}$ DSS | Drain-Source Breakdown Voltage |  |  |  | $\mathrm{I}_{\mathrm{D}}=-10 \mu \mathrm{~A}$, | $V_{G S}=0$ |  | -40 | -60 |  | V |
| IGSSF | Forward Gate-Terminal Current | $\mathrm{V}_{\mathbf{G S}}=-40 \mathrm{~V}$, | $V_{\text {DS }}=0$ |  |  | -<1 | -10 | pA |
| 'GSSR | Reverse Gate-Terminal Current | $\mathrm{V}_{\mathrm{GS}}=40 \mathrm{~V}$, | $V_{D S}=0$ |  |  | <1 | 10 | pA |
| IDSS | Zero-Gate-Voltage Drain Current | $\mathrm{V}_{\mathrm{DS}}=-15 \mathrm{~V}$, | $V_{\text {GS }}=0$ |  |  | -0.1 | -0.5 | nA |
| ISDS | Zero-Gate-Voltage Source Current | $\mathrm{V}_{\text {SD }}=-20 \mathrm{~V}$, | $\mathrm{V}_{\mathrm{GD}}=0$, | $V_{U D}=0$ |  | -0.1 | -0.4 | nA |
| $\mathrm{V}_{\mathrm{GS}}(\mathrm{th})$ | Gate-Source Threshold Voltage | $\mathrm{V}_{\mathrm{DS}}=-15 \mathrm{~V}$, | $\mathrm{I}_{\mathrm{D}}=-10 \mu \mathrm{~A}$ |  | -1.5 | -3.5 | -5 | V |
| ID(on) | On-State Drain Cufrent | $\mathrm{V}_{\text {DS }}=-15 \mathrm{~V}$, | $\mathrm{V}_{\mathrm{GS}}=-10 \mathrm{~V}$, | See Note 1 | -5 | -20 | -30 | mA |
| $r_{\text {ds }}$ (on) | Small-Signal Drain-Source On-State Resistance | $\mathrm{V}_{\text {GS }}=-10 \mathrm{~V}$, | $\mathrm{I}_{\mathrm{D}}=0$, | $\mathrm{f}=1 \mathrm{kHz}$ |  | 275 | 450 | $\Omega$ |
|  |  | $\mathrm{V}_{\mathbf{G S}}=-20 \mathrm{~V}$. | $\mathrm{I}_{\mathrm{D}}=0$, | $\mathrm{f}=1 \mathrm{kHz}$ |  | 150 | 250 |  |
| $\left\|\mathrm{Vfs}_{\mathrm{s}}\right\|$ | Small-Signal Common-Source Fonward Transfer Admittance | $V_{D S}=-15 \mathrm{~V}$, | ${ }^{\prime} \mathrm{D}=-10 \mathrm{~mA}$. | $\mathrm{f}=1 \mathrm{kHz}$ | 1 | 3.2 | 5 | mmho |
| $\mid$ Yos $\mid$ | Small-Signal Common-Source Output Admittance |  |  |  |  | 150 | 300 | $\mu \mathrm{mbo}$ |
| $\mathrm{C}_{\text {iss }}$ | Common-Source Short-Circuit Input Capacitance | $\mathrm{V}_{\mathrm{DS}}=-15 \mathrm{~V},$ <br> See Note 2 | $V_{G S}=0$ | $\mathrm{f}=1 \mathrm{MHz},$ |  | 2.5 | 5 | pF |
| $\mathrm{C}_{\text {rss }}$ | Common-Source Short-Circuit Reverse Transfer Capacitance | $V_{D S}=0,$ <br> See Note 2 | $V_{G S}=0$ | $\mathrm{f}=1 \mathrm{MHz}$, |  | 0.3 | 0.5 | pf |
| $C_{\text {oss }}$ | Common-Source Short-Circuit Output Capacitance | $V_{D S}=-15 \mathrm{~V},$ <br> See Note 2 | $V_{G S}=0$ | $f=1 \mathrm{MHz},$ |  | 1.6 | 2.5 | pF |
| tdon) | Turn-On Delay Time | $\begin{aligned} & V_{D D}=-15 \mathrm{~V}, \\ & V_{G S(0 n)} \approx-10 \mathrm{~V}, \end{aligned}$ <br> Figure 1 Circuit | $\begin{aligned} & \mathrm{ID}(\text { on }) \approx-10 \mathrm{~mA} \\ & V_{G S} \text { (off) }=0, \end{aligned}$ | $\begin{aligned} & R_{\mathrm{L}}=1.4 \mathrm{k} \Omega, \\ & R_{\mathrm{G}}=1.4 \mathrm{k} \Omega, \end{aligned}$ |  | 8 |  | ns |
| $\mathrm{tr}_{r}$ | Rise Time |  |  |  |  | 19 |  |  |
| tol(0ff) | Turn-Off Delay Time |  |  |  |  | 6 |  |  |
| $\mathrm{t}_{\mathrm{f}}$ | Fall Time |  |  |  |  | 28 |  |  |
| ${ }^{4} \mathrm{~d}$ (on) | Turn-On Delay Time | $\begin{aligned} & V_{D D}=-15 \mathrm{~V}, \\ & V_{G S}(\text { on) } \approx-10 \mathrm{~V}, \end{aligned}$ <br> Figure 2 Circuit | $\begin{aligned} & I_{D}(o n) \approx-2 m A, \\ & V_{G S(o f f)}=0, \end{aligned}$ | $\begin{aligned} & R_{\mathrm{L}}=8.2 \mathrm{k} \Omega, \\ & R_{\mathrm{G}}=4.5 \mathrm{k} \Omega, \end{aligned}$ |  | 12 |  | ns |
| $\mathrm{t}_{\mathrm{r}}$ | Rise Time |  |  |  |  | 12 |  |  |
| $\mathrm{t}_{\mathrm{d}}$ (off) | Turn-Off Delay Time |  |  |  |  | 10 |  |  |
| $\mathrm{t}_{\mathrm{f}}$ | Fall Time |  |  |  |  | 35 |  |  |

[^139]
## PARAMETER MEASUREMENT INFORMATION



NOTES: The input waveforms are supplied by a generator with the following characteristics: $Z_{\text {out }}=50 \Omega, t_{w} \approx 100$ ns, duty cycie $<\mathbf{2 \%}$. b. Waveforms are monitored on an oscilloscope with the following characteristics: $\mathrm{t}_{\mathrm{r}} \leqslant 1 \mathrm{~ns}, \mathrm{R}_{\text {in }} \geqslant 100 \mathrm{k} \Omega, \mathrm{C}_{\text {in }} \leqslant \mathbf{2} \mathbf{~ p F}$.

FIGURE 1-SWITCHING TIMES


NOTES: a. The input wavaforms are supplied by a generator with the following characteristics: $Z_{\text {out }}=50 \Omega, t_{w} \approx 100$ ns, duty eycle $\leqslant \mathbf{2 \%}$. b. Waveforms are monitored on an oscilloscope with the following characteristics: $t_{r}<1 \mathrm{~ns}, Z_{\text {in }} * 50 \Omega$.

## FIGURE 2-SWITCHING TIMES

## CHIP TYPE MP91 P-CHANNEL ENHANCEMENT-TYPE INSULATED-GATE FIELD-EFFECT TRANSISTORS

TYPICAL CHARACTERISTICS

figure 3
$C_{\text {iss }}$ vs $V_{G S}$


FIGURE 6
$t_{d}(o n), t_{r}, t_{d}(o f f), t_{f} v_{s} R_{G}$


FIGURE 9
$\mathbf{V G S}_{\mathbf{G}(\mathrm{th})} \mathrm{vs}_{\mathbf{T}}$

figURE 4
$C_{\text {rss ws }}$ Vgs


FIGURE 7
$t_{d}(o n), t_{r}, t_{d}(o f f), t_{f} v s R_{L}$


FIGURE 10
$r_{\text {ds }}(o n){ }^{\text {vs }} \mathrm{T}_{\mathrm{A}}$


FIGURE 5
$\mathrm{C}_{\text {oss }} \mathbf{v s} \mathrm{V}_{\mathrm{GS}}$


FIGURE 8
$t_{d}(o n), t_{r}, t_{d}(o f f), t_{f} w R_{L}$


FIGURE 11

NOTE 2: Capacitance measurements were made using chips mounted in TO-72 packages.

- MP92 is a $25 \times 25-m i l$, epitaxial, planar, expanded-contact MOS silicon chip available with or without gate-protection diodes
- Available in TO-72 packages
- For use in chopper, multiplexer, and commutator circuits

electrical and operating characteristics at $25^{\circ} \mathrm{C}$ free-air temperature

| PARAMETER | CONDITIONS ${ }^{\dagger}$ |  |  | OBSERVED VALUES |  | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  | LOW TYP | HIGH |  |
| $V_{\text {(BR)GSSF }}{ }^{\text {Gate-Source Forward }}$ Breakdown Voltage | $\mathrm{I}_{\mathrm{G}}=\mathbf{- 1 0 0} \mu \mathrm{A}$, | $V_{D S}=0$, | See Note 1 | $-25^{*}-50$ |  | $\checkmark$ |
| IGSSF $=$ Gate Terminal <br>  Forward Current | $\mathrm{V}_{G S}=-25 \mathrm{~V}$, | $V_{D S}=0$ |  | -30 | -100 | pA |
| IGSSF Gate Terminal <br>  Forward Current | $\mathrm{V}_{G S}=-25 \mathrm{~V}$ | $V_{\text {DS }}=0$ |  | -1 | -10 | pA |
| IDSS Zero-Gate-Voltage <br> Drain Current <br>   | $V_{D S}=-15 \mathrm{~V}$, | $V_{G S}=0$ |  | $-<0.1$ | -10 | nA |
| ISDS $\begin{array}{l}\text { Zero-Gate-Voltage } \\ \text { Source Current }\end{array}$ <br> VGSI  | $\mathrm{V}_{\mathrm{SD}}=-15 \mathrm{~V}$, | $\mathrm{V}_{\mathrm{GD}}=0$, | $V_{U D}=0$ | -<0.1 |  | nA |
| VGS(th) Gate-Source Threshold Voltage | $\mathrm{V}_{\mathrm{DS}}=-15 \mathrm{~V}$, | $\mathrm{ID}_{\mathrm{D}}=-10 \mu \mathrm{~A}$ |  | $-1.5-3$ | -5 | $V$ |
| VGS Gate-Source Voltage | $\mathrm{V}_{\text {DS }}=-15 \mathrm{~V}$, | $1 \mathrm{D}^{2}=-8 \mathrm{~mA}$ |  | $-4.5-6$ | -8 | V |
| ID(on) On-State Drain Current | $\mathrm{V}_{\text {DS }}=-15 \mathrm{~V}$. | $\mathrm{V}_{\mathrm{GS}}=-15 \mathrm{~V}$. | See Note 2 | -40 -60 | -120 | mA |
| Small-Signal Drain-Source On-State Resistance | $V_{G S}=-5 \mathrm{~V}$, | $\mathrm{I}_{\mathrm{D}}=0$, | $\mathrm{f}=1 \mathrm{kHz}$ | 250 |  | $\Omega$ |
|  | $\mathrm{V}_{\mathrm{GS}}=-10 \mathrm{~V}$, | $I_{D}=0$, | $\mathrm{f}=1 \mathrm{kHz}$ | 100 |  |  |
| $\left\|\mathrm{Vfs}_{\mathrm{s}}\right\| \quad$Small-Signal Common-Source <br> Forward Transfer Admittance | $V_{D S}=-15 \mathrm{~V}$, | $I_{D}=-8 \mathrm{~mA}$, | $\mathrm{f}=1 \mathrm{kHz}$ | 3.54 .2 | 6.5 | mmho |
| \|Yos|Small-Signal Common-Source <br> Output Admittance | $V_{D S}=-15 \mathrm{~V}$, | $I^{\prime}=-8 \mathrm{~mA}$, | $\mathrm{f}=1 \mathrm{kHz}$ | 80 | 250 | $\mu \mathrm{mho}$ |
| $C_{i s s}$ Common-Source Short-Circuit <br> Input Capacitance | $\mathrm{V}_{\mathrm{DS}}=-15 \mathrm{~V} .$ <br> See Note 3 | $\mathrm{I}_{\mathrm{D}}=-8 \mathrm{~mA}$, | $\mathrm{f}=\mathbf{1} \mathbf{M H z}$ | 8 | 10 | pF |
| Crss Common-Source Short-Circuit <br> Reverse Transfer Capacitance | $V_{D S}=-15 \mathrm{~V} .$ <br> See Note 3 | $i_{D}=-8 \mathrm{~mA}$ | $f=1 M H z$ | 2 | 4 | pF |
| tolon) Turn-On Delay Time | $\begin{aligned} & V_{D D}=-10 \mathrm{~V} \\ & V_{G S(o f f)}=0, \end{aligned}$ | ${ }^{\prime} D($ on $)=-10 m$ <br> See Figure 1 | $V_{G S(o n)}=-$ | 6 |  | ns |
| $\mathrm{tr}_{\mathbf{r}} \quad$ Rise Time |  |  |  | 5 |  |  |
| $t_{\text {dloff }}$ Turn-Off Delay Time |  |  |  | 8 |  |  |
| $\mathrm{tf}_{\text {f }}$ Fall Time |  |  |  | 16 |  |  |

[^140]
# CHIP TYPE MP92 P-CHANNEL ENHANCEMENT-TYPE INSULATED-GATE FIELD-EFFECT TRANSISTORS 

## PARAMETER MEASUREMENT INFORMATION



TEST CIRCUIT


NOTES. A. The input waveforms are supplied by a generator with the following characteristics: $Z_{\text {out }}=50 \Omega, t_{w}=200 \mathrm{~ns}$, duty cycle $<2 \%$.
b. Waveforms are monitored on an oscilloscope with the following characteristics: $\mathrm{t}_{\mathrm{r}} \leqslant 1 \mathrm{~ns}, \mathrm{R}_{\text {in }} \geqslant 100 \mathrm{k} \Omega, \mathrm{C}_{\text {in }} \leqslant 7 \mathrm{pF}$.

## FIGURE 1-SWITCHING TIMES

TYPICAL CHARACTERISTICS ${ }^{\dagger}$


## CHIP TYPE MP92 <br> P-CHANNEL ENHANCEMENT-TYPE <br> insulated-gate fleld-effect transistors

TYPICAL CHARACTERISTICS ${ }^{\dagger}$



FIGURE 6
$C_{\text {iss }}$ vs $V_{\mathbf{G S}}$


FIGURE 8
rds(on) ve $T_{A}$


FIGURE 10


FIGURE 7
$\mathbf{C r s s}^{\text {vs }} \mathbf{V}_{\mathbf{G S}}$


FIGURE 9


FIGURE 11
${ }^{\dagger}$ All masuremants axcept ISDS were made with the case and substrate connected to the source.
NOTES: 3. Capacitance measuremente ware made using chips mounted in TO-72 packages.
E. To avoid overheating the translstor, these parametere ware messured with blas conditions applied for less than five saconds.

## CHIP TYPE MP93 <br> P-CHANNEL ENHANCEMENT-TYPE INSULATED-GATE FIELD-EFFECT TRANSISTORS

- MP93 is a $17 \times 20$-mil, epitaxial, planar, expanded-contact MOS silicon chip
- Available in TO-72 packages
- For use in series- and shunt-chopper, multiplexer, and commutator circuits

electrical and operating characteristics at $25^{\circ} \mathrm{C}$ free-air temperature

| PARAMETER | CONDITIONS |  |  | OBSERVED VALUES |  |  | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  | LOW | TYP | HIGH |  |
| IGSSF Forward Gate-Terminal Current | $V_{G S}=-30 V_{1}$ | $V_{D S}=0$ |  |  | -<1 | -2.5 | pA |
| IGSSR Reverse Gate-Terminal Current | $\mathrm{V}_{\mathbf{G S}}=30 \mathrm{~V}$, | $V_{D S}=0$ |  |  | <1 | 2.5 | pA |
| IDSS Zero-Gate-Voltage Drain Current | $V_{D S}=-30 \mathrm{~V}$ | $V_{G S}=0$ |  |  | -<1 | -5 | nA |
| ISDS Zero-Gate-Voltage Source Current | $V_{S D}=-30 \mathrm{~V}$, | $V_{G D}=V_{U D}=0$ |  |  | -<1 | -5 | nA |
| VGS(th) Gate-Source Threshold Voltage | $\mathrm{V}_{\text {DS }}=-15 \mathrm{~V}$, | $I^{\prime}=-10 \mu \mathrm{~A}$ |  | -2 | -4.5 | -6 | $\checkmark$ |
| ID(on) On-State Drain Current | $\mathrm{V}_{\text {DS }}=-15 \mathrm{~V}$, | $V_{G S}=-15 \mathrm{~V}$, | See Note 1 | -3 | $-9.6$ | -12 | mA |
| rds(on) Small-Signal Drain-Source <br> On-State Resistance | $V_{\mathbf{G S}}=-15 \mathrm{~V}$, | $I_{D}=0$, | $\mathbf{f = 1} \mathbf{k H z}$ |  | 600 | 1000 | $\Omega$ |
| \|Yfs $\quad$Small-Signal Common-Source <br> Forward Transfer Admittance | $\begin{aligned} & V_{D S}^{=}-15 \mathrm{~V}, \\ & \text { See Note } 2 \end{aligned}$ | $V_{G S}=-15 \mathrm{~V}$. | $f=1 \mathrm{kHz}$, | 400 | 1750 |  | $\mu \mathrm{mho}$ |
| Hos $1 ~$ Small-Signal Common-Source <br> Output Admittance  |  |  |  | 200 |  |  | $\mu \mathrm{mho}$ |
| Ciss Common-Source Short-Circuit <br> Input Capacitance | $V_{D S}=-15 \mathrm{~V},$ <br> See Notes 2 and 3 | $V_{G S}=-15 \mathrm{~V}$ | $\mathrm{f}=1 \mathrm{MHz}$, |  | 2.5 | 4 | pF |
| Crss Common-Source Short-Circuit <br> Reverse Transfer Capacitance | $V_{D S}=0,$ <br> See Note 3 | $\mathrm{V}_{\mathrm{GS}}=0,$ | $\mathrm{f}=1 \mathrm{MHz}$ 。 |  | 0.4 | 0.7 | pF |
| tdion) Turn-On Delay Time | $\begin{aligned} & V_{D D}=-10 \mathrm{~V} \\ & V_{G S}(o n)=-15 \mathrm{~V} \end{aligned}$ | $\begin{aligned} & \operatorname{ID}(o n)=-1 m A \\ & V_{G S(\text { off })}=0, \end{aligned}$ | $R_{L}=9 \mathrm{k} \Omega,$ <br> See Figure 1 |  | 10 | 30 | ns |
| $\mathrm{Ir}_{\mathrm{r}} \quad$ Rise Time |  |  |  |  | 13 | 50 |  |
| td(off) Turn-Off Delay Time |  |  |  |  | 25 | 76 |  |
| $\mathbf{t}_{\mathbf{t}} \quad$ Fall Time |  |  |  |  | 80 | 100 |  |

NOTES: 1. This perameter was measured uting pulee techniques. $t_{w}=\mathbf{3 0 0} \mu s$, duty evcle $\leqslant \mathbf{2 \%}$.
2. To avoid overheating the transigtor, this parameter must be measured with bise condltons appled for less than five saconds.
3. Capacitance measuremente were mede using chips mounted in TO-72 packeges.


NOTES: a. The input weveforms are supplied by a generator with the following charactaristics: $\mathbf{Z}_{\text {out }}=\mathbf{5 0} \Omega ; \mathbf{t w}_{\mathbf{w}}=\mathbf{2 0 0} \mathbf{n s}, \mathrm{duty}$ cycle $<\mathbf{2 \%}$.
b. Waveforms are monitored on an oscilloscope with the following characteristics: $t_{r} \leqslant 1 \mathrm{~ns}, \mathrm{R}_{\mathrm{in}} \geqslant 100 \mathrm{k} \Omega, \mathrm{C}_{\mathrm{in}} \leqslant 7 \mathrm{pF}$.

FIGURE 1-SWITCHING TIMES
TYPICAL CHARACTERISTICS


NOTES: 1. This parameter was measured using pulse techniques. $t_{w}=300 \mu_{s}$, duty cycle $\leqslant 2 \%$.
2. To avoid overhesting the transistor, this parameter must be masaured with blas conditions applied for less than flve seconds.
3. Capacitance measurements were made using chips mounted in TO-72 packages.

## CHIP TYPE MP94 <br> DUAL P-CHANNEL ENHANCEMENT-TYPE INSULATED-GATE FIELD-EFFECT TRANSISTORS

- MP94 is a $26 \times 38$-mil, epitaxial, planar, expanded-contact, MOS silicon chip containing two transistors available with or without gate-protection diodes
- Available in TO-76 packages
- For use in switching and chopper circuits

electrical characteristics at $\mathbf{2 5}{ }^{\circ} \mathrm{C}$ free-air temperature

${ }^{\dagger}$ For all measurements except $C_{d g}$ the drain, source, and gate leads of the transistor not under test and the common substrate are grounded.
For testing ISDS, ground is the drain of the transistor under test, but for all other measurements, it is the source.
-These parameters apply only for chips having protective diodes.
-These parameters apply only for chips not having protective diodes.
gate current.

2. This parameter was measured using puls using chips mounted in TO-76 packages.
3. $\mathbf{C}_{\mathrm{ds}}$ measurement employs a three-terminal capacitance bridge incorporating a guard circuit. The case and all terminals of both trensistors expept the drain and source of the transistor under test are connected to the guard terminal of the bridge.

## CHIP TYPE MP94

DUAL P-CHANNEL ENHANCEMENT-TYPE INSULATED-GATE FIELD-EFFECT TRANSISTORS

## TYPICAL CHARACTERISTICS

IGSSF vs $\mathrm{T}_{\mathrm{A}}$


FIGURE 1
'DSS vs $\mathrm{T}_{\mathrm{A}}$


FIGURE 4
$r_{\text {dsion }}$ vs $\mathbf{T}_{\mathbf{A}}$

figure 7
igssf vs TA


Figure 2
$I_{\text {SDS }}$ vs $\mathbf{T}_{\mathbf{A}}$

figure 5
$C_{\text {iss }}$ vs $V_{G S}$

figure 8

IGSSR vs TA


FIGURE 3
$\mathbf{V}_{\mathbf{G S}(t h)}$ vs $\mathrm{T}_{\mathbf{A}}$


FIGURE 6
$C_{\text {rss }}$ vs VGS

figure 9

[^141]5. To avoid overheating the transistor, these parameters were measured with bias conditions applied for less than five seconds.

## CHIP TYPE N11 N-P-N SILICON TRANSISTORS

- N11 is a $16 \times 16$-mil, melt-grown (non-epitaxial), planar, direct-contact chip
- Available in TO-18, TO-71, and a short-can version of TO-78 packages
- For use in low-level, low-noise, high-gain amplifier circuits

electrical and operating characteristics at $25^{\circ} \mathrm{C}$ free-air temperature


Refer to notes on the following page.

## CHIP TYPE N11

N-P-N SILICON TRANSISTORS


Notes values do not modify guaranteed limits for specific devices and do not justify operation in excess of absolute maximum ratings.
NOTES: 1. These parameters were measured using pulse techniques. $t_{w}=300 \mu \%$, duty cycle $\leqslant 2 \%$.
3. $\mathrm{C}_{\mathrm{cb}}$ and $\mathrm{C}_{\text {eb }}$ measurements ware made using chips mounted in TO-18 packages.
or collector, respectively) is connected to the gual capacitance bridge incorporating a guard circuit. The third electrode (emitter terminal floating.
4. Average Noise 6 dB/octave.

# CHIP TYPE N11 N-P-N SILICON TRANSISTORS 

TYPICAL CHARACTERISTICS


NOTES: 2. Cepacitance measuremente wore made using chips mounted in TO-18 packeges.
 3. $\mathrm{C}_{\mathrm{cb}}$ and $\mathrm{C}_{\mathrm{eb}}$ messurements employ terminal floting
Avarage Nolse Figure was mestured in an amplifier with response down 3 dB at 10 Hz and 10 kHz and a high-freguency roll-off of $6 \mathrm{~dB} /$ octove.
mOST OFFICE EOX 5012 - DALLAS, TEXAB 75222

## CHIP TYPE N12

N-P-N SILICON TRANSISTORS

- N12 is a $21 \times 21$-mil, epitaxial, planar, direct-contact, double-emitter chip
- Available in TO-72 packages
- For use in low-level, high-speed chopper circuits requiring the very low offset voltage of double-emitter transistors

electrical characteristics at $25^{\circ} \mathrm{C}$ free-air temperature

| PARAMETER |  | CONDITIONS |  |  | OBSERVED VALUES |  |  | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | Collector-Base |  |  |  | LOW | TYP | HIGH |  |
| $V_{(B R) C B O}$ | Breakdown Voltage | ${ }^{1} \mathrm{C}=100 \mu \mathrm{~A}$, | $I_{E 1}=I_{E 2}$ |  | $40^{*}$ | 100 |  | V |
| V(bR)EBO | Emitter-Base <br> Breakdown Voltage | ${ }^{\prime} E=10 \mu \mathrm{~A}$, | $I C=0$, | See Note 1 | 18* | 24 |  | V |
| V(BR)E1E2 | Emitter-Emitter <br> Braakdown Voltage | $\mathrm{E}_{1}= \pm 1 \mu \mathrm{~A}$, | $V_{C B}=0$, | See Note 2 | $\pm 12^{*}$ | $\pm 24$ |  | $V$ |
| ICBO | Collector Cutoff Current | $V_{C B}=30 \mathrm{~V}$ | $\mathrm{IE1}=\mathrm{IE}^{2}$ |  |  |  |  |  |
| TEBO | Emitter Cutoff Current | $V_{E B}=5 \mathrm{~V}$, | $I_{C}=0$, | See Note 1 |  | $<0.01$ $<0.01$ | 10 | nA |
| NE1E2(ofs)! | Emitter-Emitter Offset Voltaga | $\mathrm{VE1E2}^{=} \pm 15 \mathrm{~V}$, | $V_{C B}=0$, | See Note 2 |  | $\pm<0.01$ | $\pm 10$ | nA |
|  | Offset Voltage Change | $I_{B}=1 \mathrm{~mA}$, | $\mathrm{IE}_{\mathrm{E} 1}=\mathrm{IE}_{2}$ |  |  | 7 | 25 | $\mu \mathrm{V}$ |
| $\mid \Delta V_{E 1 E 2}$ (ofs) $\\|\left._{\Delta I}\right\|_{B}$ | with Base Current ${ }^{\text {t }}$ | $\mathrm{I}_{\mathrm{B}(1)}=1.5 \mathrm{~mA}$, | $I_{B(2)}=$ | $I_{E 1}=I_{E 2}=0$ |  | 5 | 75 | $\mu \mathrm{V}$ |
| $\mid \triangle V_{E 1 E 2}$ (ofs) $\\|_{\Delta T_{A}}$ <br> $V_{B C}$ | Offset Voltage Change with Temperaturet | $\mathrm{I}_{\mathrm{B}}=1 \mathrm{~mA}$, | $I_{E 1}=I_{E 2}$ | $\begin{aligned} & T_{A(1)}=100^{\circ} \mathrm{C}, \\ & T_{A(2)}=-25^{\circ} \mathrm{C} \end{aligned}$ |  | 20 | 175 | $\mu \mathrm{V}$ |
| BC | Base-Collector Voltage | $\mathrm{I}_{\mathrm{B}}=1 \mathrm{~mA}$ | $\mathrm{IE1}=1 \mathrm{IE}$ |  |  | 0.7 |  | V |
| re1e2(on) | On-State Resistance | $\begin{aligned} & I_{B}=1 \mathrm{~mA}, \\ & f=1 \mathrm{kHz} \end{aligned}$ | $I_{E 1}=I_{E 2}$ | $\mathrm{I}_{\mathrm{e}}=100 \mu \mathrm{~A}$, |  | 20 | 60 | $\Omega$ |
| $\mathrm{f}_{\mathbf{T}}$ | Transition Frequency | $V_{C E}=5 V$ <br> See Note 1 | $I_{C}=1 \mathrm{~mA}$ | $f=20 \mathrm{MHz}_{\mathrm{L}}$ | 30 | 60 |  | MHz |
| Cobo | Common-Base Open-Circuit <br> Output Capacitance | $V_{C B}=5 V,$ <br> See Note 3 | $I_{E 1}=I_{E 2}$ | $f=1 \mathrm{MHz}$ |  | 4 | 10 | pF |
| $\mathrm{C}_{\text {ibo }}$ | Cormmon-Base Open-Circuit Input Capacitance | $v_{E B}=5 \mathrm{~V} .$ <br> See Notes 1 and 3 | $I_{C}=0$ | $\mathrm{f}=1 \mathrm{MHz},$ |  | 3 | 6 | pF |

[^142]
## CHIP TYPE N12 N-P-N SILICON TRANSISTORS

## TYPICAL CHARACTERISTICS



NOTES: 1. Thene values apply separstely for each emitter with the other emiterer open-alreulted,
2. Thene parameters ware maasured with the eoliocter ihort-olroulted to the base but open-alroulted with renpect to the amliters. The values apply for both polarities of emiteer-to-emitter voltage.
3. Capacitance measurements ware made uning chlps mounted in TO.72 packages.
${ }^{\dagger}$ The pelarity of the offert voltege at $T_{A}=28^{\circ} \mathrm{C}$ and $\mathrm{I}_{\mathrm{B}}=1 \mathrm{~mA}$ was apbltrarliy asiumed to be poaltive.

## CHIP TYPE N13 <br> N-P-N SILICON TRANSISTORS

- N13 is a $26 \times 26-m i l$, epitaxial, planar, direct-contact chip
- Available in TO-18, TO-39, plastic dual-in-line quad, and Silect ${ }^{\dagger}$ packages
- For use as a high-speed, high-current, memory-core driver or in other medium-current (to 1.5 A ) switching circuits

electrical and operating characteristics at $25^{\circ} \mathrm{C}$ free-air temperature


[^143]
# CHIP TYPE N13 <br> N-P-N SILICON TRANSISTORS 



NOTES: a. The input waveforms are supplied by a generator with the following characteristics: $Z_{\text {out }}=\mathbf{5 0} \Omega, \mathrm{t}_{\mathbf{w}} \leqslant \mathbf{2 0 0} \mathbf{n s}$, duty $\mathbf{c y c l e} \leqslant \mathbf{2 \%}$.
b. Waveforms are monitored on an oscilloscope with the following characteristics: $t_{r} \leqslant 1 \mathrm{~ns}, \mathrm{R}_{\mathrm{in}} \geqslant 100 \mathrm{k} \Omega, \mathrm{C}_{\mathrm{in}} \leqslant 7 \mathrm{pF}$.

Figure 1-SWITCHING times
TYPICAL CHARACTERISTICS


FIGURE 2
hfe vs IC


Figure 5
$V_{B E}$ vs $I_{C}$


FIGURE 6


FIGURE 7

NOTE 1: These parameters were measured using pulse techniques. $t_{w}=300 \mu$ s, duty cycle $\leqslant \mathbf{2} \%$.

## CHIP TYPE N13

N-P-N SILICON TRANSISTORS

## TYPICAL CHARACTERISTICS



FIGURE $B$
$\mathbf{C}_{\text {obo }}$ vs $\mathrm{V}_{\mathrm{CB}}$


Figure 9
$c_{\text {ibo vs }} V_{E B}$


FIGURE 10
$t_{d}, t_{r}, t_{s}, t_{f}$ vs IC


FIGURE 11
$t_{d}, t_{r}, t_{s}, t_{f}$ vs $T_{A}$


FIGURE 12

NOTE 2: Capacitance measurements were made using chips mounted in TO-39 packages.

## CHIP TYPE N13 N-P-N SILICON TRANSISTORS

## TYPICAL CHARACTERISTICS



FIGURE 13

Contoura of Constant $t_{5}$


FIGURE 15

Contours of Constant $\mathbf{t}_{\mathbf{r}}$


FIGURE 14

## Contours of Constant $\mathbf{t}_{f}$



## CHIP TYPE N14

## N-P-N SILICON TRANSISTORS

- N14 is a $20 \times 20$-mil, epitaxial, planar, direct-contact chip


## - Available in Silect ${ }^{\dagger}$ Packages

- For use in general purpose, saturated switching, and amplifier circuits

electrical and operating characteristics at $25^{\circ} \mathrm{C}$ free-air temperature

| PARAMETER |  | CONDITIONS |  |  | OBSERVED VALUES |  |  | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | LOW | TYP | HIGH |  |
| $\mathrm{V}_{\text {(BR) }{ }^{\text {c }} \text { ( }}$ | Collector-Base Breakdown Voltage |  |  |  | $\mathrm{I}_{\mathrm{C}}=10 \mu \mathrm{~A}$, | $I_{E}=0$ |  | $50^{*}$ | 100 |  | V |
| $V_{(B R) C E O}$ | Collector-Emitter Breakdown Voltage | $\mathrm{I}^{\prime} \mathrm{C}=1 \mathrm{~mA}$, | ${ }^{\prime} \mathrm{B}=0$, | See Note 1 | $30^{*}$ | 50 |  | V |
| $V_{\text {(BR)EBO }}$ | Emitter-Base Breakdown Voltage | $\mathrm{I}_{\mathrm{E}}=10 \mu \mathrm{~A}$, | $\mathrm{I}_{\mathrm{C}}=0$ |  | $5^{*}$ | 7 |  | V |
| ${ }^{\text {I CBO }}$ | Collector Cutoff Current | $\mathrm{V}_{\mathrm{CB}}=30 \mathrm{~V}$, | $\mathrm{I}_{\mathrm{E}}=0$ |  |  | 4 | 50 | nA |
|  |  | $V_{C E}=1 \mathrm{~V}$, | $\mathrm{I}^{\prime} \mathrm{C}=100 \mu \mathrm{~A}$ |  | 20 | 60 |  |  |
|  |  | $\mathrm{V}_{\text {CE }}=1 \mathrm{~V}$, | ${ }^{1} \mathrm{C}=1 \mathrm{~mA}$ |  | 35 | 110 |  |  |
| hFE | Transfer Ratio | $V_{C E}=1 \mathrm{~V}$. | $l^{\prime} \mathrm{C}=10 \mathrm{~mA}$ |  | 50 | 150 | 300 |  |
|  |  | $V_{C E}=1 \mathrm{~V}$, | $\mathrm{I}_{\mathrm{C}} \mathrm{C}=50 \mathrm{~mA}$ | See Note 1 | 30 | 110 |  |  |
|  |  | $\mathrm{V}_{\text {CE }}=1 \mathrm{~V}$, | $\mathrm{I}^{\prime} \mathrm{C}=100 \mathrm{~mA}$ |  | 15 | 60 |  |  |
|  |  | $\mathrm{I}_{\mathrm{B}}=1 \mathrm{~mA}$, | $\mathrm{I}^{\mathrm{C}} \mathrm{C}=10 \mathrm{~mA}$ | See Note 1 | 0.6 | 0.75 | 0.9 | $V$ |
|  |  | $\mathrm{I}_{\mathrm{B}}=5 \mathrm{~mA}$, | ${ }^{\prime} \mathrm{C}=50 \mathrm{~mA}$ | See Note 1 |  | 0.85 | 0.95 |  |
|  | Collector-Emitter | $\mathrm{I}_{\mathrm{B}}=1 \mathrm{~mA}$, | ${ }^{1} \mathrm{C}=10 \mathrm{~mA}$ |  |  | 0.10 | 0.25 | $\checkmark$ |
|  | Saturation Voltage | $\mathrm{I}_{\mathrm{B}}=5 \mathrm{~mA}$, | ${ }^{1} \mathrm{C}=50 \mathrm{~mA}$ |  |  | 0.15 | 0.4 |  |
| $h_{\text {ie }}$ | Small-Signal Common-Emitter Input Impedance |  |  |  | 1 | 3.7 | 10 | $\mathrm{k} \Omega$ |
| $h_{\text {fe }}$ | Small-Signal Common-Emitter Forward Current Transfer Ratio | $V_{C E}=10 \mathrm{~V}$ | $I_{C}=1 \mathrm{~mA}$ | $=1 \mathrm{kHz}$ | 50 | 140 | 400 |  |
| $h_{\text {re }}$ | Small-Signal Common-Emitter Reverse Voltage Transfer Ratio | $V C E=10 \mathrm{~V}$, | $\mathrm{C}^{\prime}=1 \mathrm{~mA}$, | $=1 \mathrm{kHz}$ | $\begin{aligned} & 0.1 \times \\ & 10^{-4} \end{aligned}$ | $\begin{aligned} & 0.7 \times \\ & 10^{-4} \end{aligned}$ | $\begin{array}{r} 8 \times \\ 10^{-4} \\ \hline \end{array}$ |  |
| $\mathrm{h}_{\text {Oe }}$ | Small-Signal Common-Emitter Output Admittance |  |  |  | 1 | 8 | 40 | $\mu \mathrm{mho}$ |
| ${ }_{\mathbf{T}}$ | Transition Frequency | $\mathrm{V}_{\text {CE }}=20 \mathrm{~V}$. | ${ }^{1} \mathrm{C}=10 \mathrm{~mA}$, | $f=100 \mathrm{MHz}$ | 250 | 800 |  | MHz |
| $\mathrm{C}_{\text {obo }}$ | $\begin{aligned} & \text { Common-Base Open-Circuit } \\ & \text { Output Capacitance } \end{aligned}$ | $\begin{aligned} & \mathrm{V}_{\mathrm{CB}}=5 \mathrm{~V} \\ & \text { See Note } 2 \end{aligned}$ | ${ }^{\prime} E=0,$ | $\mathrm{f}=1 \mathrm{MHz}$, |  | 1.6 | 4 | pF |
| Cibo | Common-Base Open-Circuit Input Capacitance | $V_{E B}=0.5 \mathrm{~V},$ <br> See Note 2 | $\mathrm{I}_{\mathrm{C}}=0$ | $f=1 \mathrm{MHz},$ |  | 6.5 | 8 | pF |
| $\overline{\mathbf{F}}$ | Average Noise Figure | $\begin{aligned} & \hline V_{C E}=5 \mathrm{~V} \\ & \text { Noise Bandwidth } \end{aligned}$ | $\begin{aligned} & { }^{\prime} \mathrm{C}=100 \mu \mathrm{~A}, \\ & 15.7 \mathrm{kHz}, \end{aligned}$ | $\mathbf{R}_{\mathbf{G}}=1 \mathrm{k} \Omega,$ <br> See Note 3 |  |  | 6 | dB |
| $\mathrm{t}_{\mathrm{d}}$ | Delay Time | $\mathrm{V}_{\mathrm{cc}}=3 \mathrm{~V}$, | $\mathrm{I}^{\mathrm{C}}$ ® 10 mA , | 2N3903 |  | 14 |  |  |
| $t_{r}$ | Rise Time | $\mathrm{I}_{\mathrm{B}(1)} \approx 1 \mathrm{~mA}$, | $V_{B E \text { (off) }} \approx-0.5 \mathrm{~V}$ | Data |  | 8 |  | ns |
| $\mathrm{t}_{\text {s }}$ | Storage Time | $V_{C C}=3 \mathrm{~V}$, | ${ }^{\prime} \mathrm{C} \approx 10 \mathrm{~mA}$, | Sheet |  | 22 |  | , |
| ${ }_{\text {t }}$ | Fall Time | $\mathrm{I}_{\mathrm{B}(1)} \approx 1 \mathrm{~mA}$, | $\mathrm{l}_{B(2)} \approx-1 \mathrm{~mA}$ | Circuit |  | 10 |  |  |
| $t_{\text {d }}$ | Delay Time |  |  |  |  | 40 |  |  |
| $\mathrm{t}_{\mathrm{r}}$ | Rise Time | $V_{C C}=30 \mathrm{~V}$. | ${ }^{\prime} \mathrm{C} \approx 10 \mathrm{~mA}$, | $\mathrm{I}_{\mathrm{B}(1)} \approx 1 \mathrm{~mA}$, |  | 8 |  | ns |
| ${ }_{\text {t }}$ | Storage Time | $\mathrm{I}_{\mathrm{B}}(2) \approx-1 \mathrm{~mA}$, | $\mathrm{V}_{\mathrm{BE} \text { (off) }} \approx-4.1 \mathrm{~V}$ | , See Figure 1 |  | 22 |  |  |
| $\mathrm{t}_{\mathrm{f}}$ | Fall Time |  |  |  |  | 10 |  |  |

${ }^{\dagger}$ Trademark of Texas Instruments
-These values do not modify guaranteed limits for specific devices and do not justify operation in excess of absolute maximum ratings.
NOTES: 1. These parameters were measured using pulse techniques. $t_{w}=300 \mu \mathrm{~s}$, duty cycle $\leqslant 2 \%$.
2. Capacitance measurements were made using chips mounted in Silect packages.
3. Averege Noise Figure is measured in an amplifier with response down 3 dB at 10 Hz and 10 kHz and a high-frequency roll-off of $6 \mathrm{~dB} /$ octave.

## CHIP TYPE N14 N-P-N SILICON TRANSISTORS

PARAMETER MEASUREMENT INFORMATION


TEST CIRCUIT

(See Notes a and b) VOLTAGE WAVEFORMS
NOTES: a. The Input waveforms are supplied by a generetor with the following characteristics: $Z_{\text {out }}=50 \Omega$; for measuring $t_{d}$ and $t_{r}$, $t_{w} \approx 200 \mathrm{~ns}$, duty cycte $\leqslant 2 \%$; for measuring $t_{s}$ and $i_{f}, t_{w} \approx 10 \mu s$, duty cycle $\leqslant \mathbf{2 \%}$.
b. Waveforms are monitored on an oscilloscope with the following characteristics: $t_{r}<1 \mathrm{~ns}, R_{i n}>100 \mathrm{k} \Omega, \mathrm{C}_{\mathrm{in}}<7 \mathrm{pF}$.

FIGURE 1-SWITCHING TIMES TYPICAL CHARACTERISTICS


NOTE 1: These parameters were measured using pulse techniques. $t_{w}=300 \mu \mathrm{~s}$, duty cycle $<\mathbf{2 \%}$.

## N-P-N SILICON TRANSISTORS

TYPICAL CHARACTERISTICS



FIGURE 10

Fiquate 13


FIGURE 11


PIOURE 14


FIGURE 12


PIGURE 18

2. Capacitance moasuremante were made using ehips mounted in Sllecr packages.
4. Cob meacurement employe throe-terminal espacitanee bridge Incerperating a gurd oireuit. The emitter is eonneeted te the guard terminal of the bridge. Cobe meewrement is mede with tha third terminal fleating,

## CHIP TYPE N15 <br> N-P-N SILICON TRANSISTORS

- N15 is a $35 \times 35-\mathrm{mil}$, epitaxial, planar, direct-contact chip
- Available in TO-39 and Silect ${ }^{\dagger}$ packages
- For use in high-voltage amplifier circuits, especially in certain critical TV applications

electrical characteristics at $\mathbf{2 5}{ }^{\circ} \mathrm{C}$ free-air temperature

| PARAMETER |  | CONDITIONS |  |  | OBSERVED VALUES |  |  | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | LOW | TYP | HIGH |  |
| $V_{\text {(BR) }}$ CBO | Collector-Base Breakdown Voltage |  |  |  | $I_{C}=100 \mu A$, | $I_{E}=0$ |  | $250{ }^{*}$ | 350 |  | V |
| $V_{\text {(BR)CEO }}$ | Collector-Emitter Breakdown Voltage | ${ }^{\prime} \mathrm{C}=30 \mathrm{~mA}$, | $\mathrm{I}_{\mathrm{B}}=0$, | See Note 1 | 250* | 350 |  | V |
| $V_{\text {(BR)EBO }}$ | Emitter-Base Breakdown Voltage | $I_{E}=100 \mu \mathrm{~A}$, | $I_{C}=0$ |  | $7^{*}$ | 10 |  | V |
| ICBO | Collector Cutoff Current | $V_{C B}=100 \mathrm{~V}$, | $I_{E}=0$ |  |  | $<1$ | 60 | nA |
| IEBO | Emitter Cutoff Current | $\mathrm{VEB}=5 \mathrm{~V}$, | $I^{\prime} \mathrm{C}=0$ |  |  | $<0.1$ | 10 | nA |
| hFE | Static Forward Current Transfer Ratio | $V_{C E}=25 \mathrm{~V}$, | $1 \mathrm{C}=5 \mathrm{~mA}$ | See Note 1 | 10 | 70 |  |  |
|  |  | $V_{C E}=25 \mathrm{~V}$, | $\mathrm{I}_{\mathrm{C}}=30 \mathrm{~mA}$ |  | 35 | 75 | 200 |  |
|  |  | $\mathrm{V}_{\text {CE }}=25 \mathrm{~V}$, | $\mathrm{I}^{\prime} \mathrm{C}=100 \mathrm{~mA}$ |  | 20 | 75 |  |  |
| VBE | Base-Emitter Voltage | $V_{C E}=25 \mathrm{~V}$, | $I_{C}=30 \mathrm{~mA}$, | See Note 1 |  | 0.7 | 0.85 | V |
| VCE(sat) | Collector-Emitter Saturation Voltage | $\mathrm{I}_{\mathrm{B}}=3 \mathrm{~mA}$, | $1 \mathrm{C}=30 \mathrm{~mA}$, | See Note 1 |  | 0.12 | 1 | V |
| $\mathrm{hie}_{\text {ie }}$ | Small-Signal Common-Emitter Input Impedance | $V_{C E}=25 \mathrm{~V}$, | $I_{C}=30 \mathrm{~mA}$, | $f=1 \mathrm{kHz}$ |  | 150 |  | $\Omega$ |
| $\mathrm{hfe}_{\text {fe }}$ | Small-Signal Common-Emitter Forward Current Transfer Ratio |  |  |  |  | 75 |  |  |
| $h_{\text {re }}$ | Small-Signal Common-Emitter Reverse Voltage Transfer Ratio |  |  |  |  | $\begin{array}{r} 2 x \\ 10^{-4} \\ \hline \end{array}$ |  |  |
| $\mathrm{h}_{\text {Oe }}$ | Small-Signal Common-Emitter Output Admittance |  |  |  |  | 30 |  | $\mu \mathrm{mho}$ |
| ${ }^{\text {f }}$ | Transition Frequency | $V_{C E}=25 \mathrm{~V}$, | $I_{C}=10 \mathrm{~mA}$, | $f=20 \mathrm{MHz}$ | 30 | 80 |  | MHz |
| $\mathrm{C}_{\text {obo }}$ | Common-Base Open-Circuit Output Capacitance | $V_{C B}=10 \mathrm{~V}$, | ${ }^{\prime} \mathrm{E}=0$ | $f=1 \mathrm{MHz}$ <br> See Notes 2 and 3 |  | 6 |  | pF |
| Cibo | Common-Base Open-Circuit Input Capacitance | $\mathrm{V}_{\mathrm{EB}}=0.5 \mathrm{~V}$, | $I^{\prime} \mathrm{C}=0$ |  |  | 60 |  | pF |
| $\mathrm{C}_{\mathrm{cb}}$ | Collector-Base Capacitance | $\mathrm{V}_{C B}=10 \mathrm{~V}$. | $\mathrm{IE}_{\mathrm{E}}=0$ |  |  | 5 | 10 | pF |
| $\mathrm{C}_{\text {eb }}$ | Emitter-Base Capacitance | $\mathrm{V}_{\mathrm{EB}}=0.5 \mathrm{~V}$, | $I_{C}=0$ |  |  | 60 | 75 | PF |

[^144]CHIP TYPE N15<br>\section*{N-P-N SILICON TRANSISTORS}

TYPICAL CHARACTERISTICS

figure 1


NOTE 1: This parameter was measured using pulse techniquas. $t_{w}=\mathbf{3 0 0} \mu$ s, duty cycle $\leqslant \mathbf{2 \%}$.

# CHIP TYPE N15 <br> N-P-N SILICON TRANSISTORS 

## TYPICAL CHARACTERISTICS



NOTE 4: To avoid overheating the transistor, this parameter was measured with bias conditions applied for less than five seconds.

TYPICAL CHARACTERISTICS


FIGURE 10


NOTES: 2. Capacitance measurements were made using chips mounted in TO-39 packages.
3. $\mathrm{C}_{\mathrm{cb}}$ and $\mathrm{C}_{e b}$ measurements employ a three-terminal capacitance bridge incorporating agard circuit. The third electrode (emitter or collector, respectively) is connected to the guard terminal of the bridge. Cobo and $C_{i b o}$ measurements are made with the third terminal floating.

## CHIP TYPE N16 N-P-N SILICON TRANSISTORS

- N16 is an $11 \times 15$-mil, epitaxial, planar, expanded-contact chip
- Available in TO-72 and Silect ${ }^{\dagger}$ packages
- For use in high-frequency (nearly to $1 \mathbf{G H z}$ ), low-noise amplifier circuits such as TV mixers and IF-amplifier stages

electrical and operating characteristics at $\mathbf{2 5} \mathbf{}{ }^{\circ} \mathbf{C}$ free-air temperature

| PARAMETER |  | CONDITIONS |  |  | OBSERVED VALUES |  |  | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | LOW | TYP | HIGH |  |
| $\mathrm{V}_{\text {(BR) }} \mathbf{C B O}$ | Collector-Base Breakdown Voltage |  |  |  | ${ }^{1} C=10 \mu A$, | $\mathrm{IE}_{\mathrm{E}}=0$ |  | $30^{*}$ | 60 |  | V |
| $V_{\text {(BR) }}$ CEO | Collector-Emitter Breakdown Voltage | $\mathrm{I}^{\prime} \mathrm{C}=2 \mathrm{~mA}$, | $\mathrm{I}_{\mathrm{B}}=0$, | See Note 1 | 18* | 50 |  | V |
| $V$ (BR)EBO | Emitter-Base Breakdown Voltage | $I_{E}=10 \mu A$, | $\mathrm{IC}^{\prime}=0$ |  | $4 *$ | 5 |  | $V$ |
| ICBO | Collector Cutoff Current | $V_{C B}=15 \mathrm{~V}$, | $\mathrm{IE}_{\mathrm{E}}=0$ |  |  | <0.1 | 100 | nA |
| hfe | Static Forward Current Transfer Ratio | $V_{C E}=10 \mathrm{~V}$, | $I_{C}=2 \mathrm{~mA}$ |  | 30 | 70 | 150 |  |
| VBE | Base-Emitter Voltage | $\mathrm{V}_{\text {CE }}=10 \mathrm{~V}$, | ${ }^{1} \mathrm{C}=2 \mathrm{~mA}$ |  |  | 0.75 |  | V |
| /fel | Small-Signal Common-Emitter Forward Current Transfer Ratio | $V_{C E}=10 \mathrm{~V}$, | $I_{C}=2 \mathrm{~mA}$, | $f=100 \mathrm{MHz}$ | 5 | 9 |  |  |
| \|Viel | Smail-Signal Common-Emitter Input Admittence | $V_{C E}=12 \mathrm{~V}$, | $I^{\prime} \mathrm{C}=2 \mathrm{~mA}$, | $f=45 \mathrm{MHz}$ | 3 |  |  | mmho |
| \|rfel | Small-Signal Common-Emitter Forward Current Transfer Ratio |  |  |  | 70 |  |  | mmho |
| Voel | Small-Signal Common-Emitter Output Admittance |  |  |  | 0.3 |  |  | mmho |
| $\mathrm{C}_{\mathrm{cb}}$ | Collector-Base Capacitance | $\begin{aligned} & V_{C B}=10 \mathrm{~V} \\ & \text { See Notes } 2 \text { and } 3 \end{aligned}$ | $t_{E}=0,$ | $\mathrm{f}=\mathbf{1} \mathbf{M H z}$, |  | 0.45 | 0.65 | pF |
| $r_{\text {iep }}$ | Parallel-Equivalent <br> Common-Emitter <br> Short-Circuit Input Resistance | $V_{C E}=10 \mathrm{~V}$. | $I^{\prime}=2 \mathrm{~mA}$, | $f=10 \mathrm{MHz}$ | 0.9 |  |  | k $\Omega$ |
| roep | Parallel-Equivalent <br> Common-Emitter <br> Short-Circuit Output Resistance |  |  |  | 60 |  |  | $\mathbf{k} \boldsymbol{\Omega}$ |
| $\mathrm{rb}^{\prime} \mathrm{C}_{\mathrm{c}}$ | Collector-Base Time Constant | $V_{C B}=10 \mathrm{~V}$ <br> See Note 2 | $I_{E}=-2 m A \text {, }$ | $f=79.8 \mathrm{MHz}$, |  | 14 | 20 | ps |
| F | Spot Noise Figure | $\begin{aligned} & V_{C E}=10 \mathrm{~V} \\ & f=200 \mathrm{MHz} \end{aligned}$ | $I_{C}=2 m A,$ | $\mathrm{R}_{\mathrm{G}}=50 \Omega$, |  | 3 | 5 | dB |

[^145]
## CHIP TYPE N16 <br> N-P-N SILICON TRANSISTORS

TYPICAL CHARACTERISTICS

hfe vs IC


FIGURE 3


NOTES: 1. This parameter was measured using pulse techniques. $\mathbf{t}_{w}=300 \mu \mathrm{~s}$, duty cycle $\leqslant 2 \%$.
2. Capacitance and $r_{b}{ }^{\prime} \mathrm{C}_{\mathrm{c}}$ measurements were made using chips mounted in Silect packages.
3. $\mathbf{C}_{\mathbf{c b}}$ measurement employs a three-terminal capacitance bridge incorporating a guard circuit. The emitter is connected to the guard terminal of the bridge.

# CHIP TYPE N16 <br> N-P-N SILICON TRANSISTORS 

TYPICAL CHARACTERISTICS AT $455 \mathrm{kHz}, \mathrm{TA}=\mathbf{2 5}^{\circ} \mathrm{C}$


figure 9


Figure 8
roep vs ic

figure 10

## CHIP TYPE N16

## N-P-N SILICON TRANSISTORS

## TYPICAL CHARACTERISTICS AT $10 \mathrm{MHz}, \mathrm{TA}_{\mathrm{A}} \mathbf{= 2 5 ^ { \circ } \mathrm { C }}$



Figure 11


FIGURE 12

Vfalvs IC

figure 13


FIOURE 14


FIGURE 15

# CHIP TYPE N16 N-P-N SILICON TRANSISTORS 

TYPICAL CHARACTERISTICS AT $\mathbf{4 5} \mathbf{~ M H z}, \mathrm{TA}^{\mathbf{~}} \mathbf{2 5} \mathbf{5}^{\circ} \mathrm{C}$


Components of $\mathbf{Y f e} \mathbf{V E} \mathbf{I C}$

figure 18

Componente of Yio ve lc


Components of Yoe vs IC


FIGURE 19

## CHIP TYPE N16

## N-P-N SILICON TRANSISTORS

TYPICAL CHARACTERISTICS AT $100 \mathrm{MHz}, \mathrm{TA}=\mathbf{2 5}{ }^{\circ} \mathrm{C}$


TYPICAL CHARACTERISTICS AT $200 \mathrm{MHz}, \mathrm{T}_{\mathrm{A}}=\mathbf{2 5}{ }^{\circ} \mathrm{C}$


FIGURE 24

- $\mathbf{N} 17$ is a $16 \times 16-m i l$, epitaxial, planar, expanded-contact chip
- Available in Silect ${ }^{\dagger}$ packages with base-emitter-collector lead configuration
- For VHF/UHF RF/IF amplifiers requiring low feedback capacitance and forward-AGC characteristics

electrical and operating characteristics at $\mathbf{2 5}{ }^{\circ} \mathrm{C}$ free-air temperature


[^146]
## CHIP TYPE N17

## N-P-N SILICON TRANSISTORS

TYPICAL CHARACTERISTICS

hfe vs lc


FIGURE 2
$V_{C E(s a t)} \mathbf{v s} \mathbf{I C}_{\mathbf{C}}$


FIGURE 4
$\mathrm{C}_{\text {res vs ic }}$


FIGURE 7


FIGURE 5


FIGURE 6

NOTES: 1. These parameters were measured using pulse techniques. $t_{w}=300 \mu \mathrm{~s}$, duty cycle $\leqslant 2 \%$.
. Capacitance measurements were made using chips mounted in silect packages. a guard circuit. The emittar is connected to the
3. C cb measurement employs
guard terminal of the bridge.

# CHIP TYPE NT N-P-N SILICON TRANSISTORS 

TYPICAL CHARACTERISTICS

$Y_{i e}$ ws IC


FIGURE 8
$y_{f e}$ vs IC


FIGURE 10

Yfe vs IC


FIGURE 11


FIGURE 12


FIGURE 13

## CHIP TYPE Ni8 <br> N-P-N SILICON TRANSISTORS

- N18 is a $19 \times 19$-mil, epitaxial, planar, direct-contact chip
- Available in TO-18 and TO-46 packages
- For use in low-level chopper circuits in inverted connection (collector and emitter terminals reversed). May also be used as a low-level amplifier

electrical characteristics at $25^{\circ} \mathrm{C}$ free-air temperature

| PARAMETER |  | CONDITIONS |  |  | OBSERVED VALUES |  |  | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | LOW | TYP | HIGH |  |
| $V$ (BR)CBO | Collector-Base Breakdown Voltage |  |  |  | ${ }^{\prime} \mathrm{C}=100 \mu \mathrm{~A}$, | $I_{E}=0$ |  | $120{ }^{*}$ | 180 |  | $V$ |
| $V_{\text {(BR) CEO }}$ | Collector-Emitter Breakdown Voltage | ${ }^{\prime} \mathrm{C}=10 \mathrm{~mA}$, | $\mathrm{I}_{\mathrm{B}}=0$, | See Note 1 | 60* | 75 |  | V |
| $V_{\text {(BR)EBO }}$ | Emitter-Base Breakdown Voltage | ${ }^{1} E=100 \mu \mathrm{~A}$, | $\mathrm{I}_{\mathrm{C}}=0$ |  | 18 ${ }^{\text {¢ }}$ | 22 |  | V |
| ${ }^{\text {l CeS }}$ | Collector Cutoff Current | $V_{C E}=25 \mathrm{~V}$, | $\mathrm{V}_{\text {BE }}=0$ |  |  | <0.1 | 10 | nA |
| lebo | Emitter Cutoff Current | $\mathrm{V}_{E B}=15 \mathrm{~V}$, | $\mathrm{I}^{\prime} \mathrm{C}=0$ |  |  | <0.1 | 2 | nA |
| IECS | Emitter Cutoff Current | $\mathrm{V}_{\mathrm{EC}}=15 \mathrm{~V}$, | $\mathrm{V}_{\mathrm{BC}}=0$ |  |  | <0.1 | 2 | nA |
| hFE | Static Forward Current Transfer Ratio | $\mathrm{V}_{\text {CE }}=5 \mathrm{~V}$, | ${ }^{1} \mathrm{C}=10 \mu \mathrm{~A}$ |  | 30 | 140 |  |  |
|  |  | $\mathrm{V}_{\text {CE }}=5 \mathrm{~V}$. | $1 \mathrm{C}=1 \mathrm{~mA}$ |  | 50 | 210 | 500 |  |
| hFE(inv) | Static Forward Current Transfer Ratio (Invertad Connection) | $V_{E C}=5 \mathrm{~V}$, | $\mathrm{I}_{\mathrm{E}}=0.2 \mathrm{~mA}$ |  | 2 | 4 |  |  |
| $V_{B E}$ | Base-Emitter Voltage | $V_{C E}=5 \mathrm{~V}$, | ${ }^{\prime} \mathrm{C}=1 \mathrm{~mA}$ |  |  | 0.6 | 0.8 | V |
| $V_{C E}$ (sat) | Collector-Emitter Saturation Voltage | $\mathrm{I}_{\mathrm{B}}=0.5 \mathrm{~mA}$, | ${ }^{1} \mathrm{C}=10 \mathrm{~mA}$ |  |  | 0.08 | 0.15 | V |
| $V_{\text {EC }}$ (ofs) | Emitter-Collector Offset Voltage (Inverted Connection) | $\mathrm{I}_{B}=200 \mu \mathrm{~A}$, | $\mathrm{I}_{\mathrm{E}}=0$ |  |  | 0.2 | 0.6 | mV |
|  |  | $\mathrm{I}_{B}=1 \mathrm{~mA}$, | $I_{E}=0$ |  |  | 0.5 | 1.2 |  |
| rec(on) | Small-Signal Emitter-Collector On-State Resistance | $\begin{aligned} & \mathrm{I}_{\mathrm{B}}=1 \mathrm{~mA}, \\ & \mathrm{t}_{\mathrm{e}}=100 \mu \mathrm{~A} \end{aligned}$ | $I_{E}=0,$ | $\mathrm{f}=1 \mathrm{kHz}$, |  | 8 | 20 | $\Omega$ |
| ${ }^{+}{ }_{\text {T }}$ | Transition Frequency | $V_{C E}=5 \mathrm{~V}$, | $\mathrm{I}^{\prime} \mathrm{C}=1 \mathrm{~mA}$, | $f=20 \mathrm{MHz}$ | 20 | 60 |  | MHz |
| $\mathrm{C}_{\mathbf{c b}}$ | Collector-Base Capacitance | $V_{C B}=0,$ <br> See Notes 2 and 3 | $I_{E}=0$ | $f=1 \mathrm{MHz},$ |  | 6 | 12 | pF |
| $\mathrm{C}_{\text {eb }}$ | Emitter-Base Capacitance | $V_{E B}=0$ <br> See Notes 2 and 3 | $I_{C}=0,$ | $f=1 M H z,$ |  | 7 | 12 | pF |

- These values do not modify guaranteed limits for specific devices and do not justify operation in excess of absolute maximum ratings.

NOTES: 1. These parameters were measured using pulse techniques. $t_{w}=300 \mu \mathrm{~s}$, duty cycle $\leqslant 2 \%$.
2. Capacitance measurements were made using chips mounted in TO-18 packages.
3. $C_{c b}$ and $C_{e b}$ measurements employ a three-terminal capacitance bridge incorporating a guard circuit. The third electrode (emitter or collector, respectively) is connected to the guard terminal of the bridge.

## CHIP TYPE N18 N-P-N SILICON TRANSISTORS

TYPICAL CHARACTERISTICS


NOTE 1: These parameters were measured using pulse techniques. $\mathrm{t}_{\mathrm{w}}=\mathbf{3 0 0} \boldsymbol{\mu s}$, dutv cycle $<\mathbf{2 \%}$.

N-P-N SILICON TRANSISTORS

## TYPICAL CHARACTERISTICS



NOTE 1 These parameters were measured using pulse techniques. $t_{w}=300 \mu \mathrm{~s}$, duty cycle $<\mathbf{2 \%}$.

## CHIP TYPE N18 N-P-N SILICON TRANSISTORS

TYPICAL CHARACTERISTICS

$V_{\text {ec }} \mathrm{vs} \mathrm{I}_{\mathrm{B}}$
 FIGURE 11

NOTE 1: These parameters were measured using pulse techniques. $\mathbf{t}_{\mathbf{w}}=\mathbf{3 0 0} \boldsymbol{\mu}$, dutv cycle $\boldsymbol{<} \mathbf{2 \%}$.

## CHIP TYPE N18

## N-P-N SILICON TRANSISTORS

TYPICAL CHARACTERISTICS



NOTES: 2. Capacitance measurements were made using chips mounted In TO. 18 packages.
3. $\mathrm{C}_{\mathrm{cb}}$ and $\mathrm{C}_{\mathrm{eb}}$ measurements employ a three-terminal capacitance bridge incorporating a guard circuit. The third electrode (emitter or collector, respectively) is connected to the guard terminal of the bridge.

## CHIP TYPE N19 <br> N-P-N SILICON TRANSISTORS

- N19 is a $19 \times 19$-mil, epitaxial, planar, direct-contact chip
- Available in TO-5 and TO-18 packages
- For use in medium-power switching and general purpose amplifier circuits

electrical and operating characteristics at $25^{\circ} \mathrm{C}$ free-air temperature


[^147]
## CHIP TYPE N19

N-P-N SILICON TRANSISTORS


NOTES: a. The input waveforms are supplied by a generator with the following characteristics: $Z_{o u t}=50 \Omega, t_{w} \approx 200 \mathrm{~ns}, \mathrm{duty} \mathrm{cycle} \leqslant \mathbf{2} \%$, b. Wavaforms are manitored on an oscilloscope with the following characteristics: $\mathrm{tr}_{\mathrm{r}} \leqslant 1 \mathrm{~ns}, \mathrm{R}_{\mathrm{in}} \geqslant 100 \mathrm{k} \Omega, \mathrm{C}_{\text {in }} \leqslant 7 \mathrm{pF}$.


NOTE 1: These parameters were measured using pulse techniques. $\mathbf{t}_{\mathbf{w}}=\mathbf{3 0 0} \mu_{\mathbf{s}}$, duty cycle $\leqslant 2 \%$.

## CHIP TYPE N19 N-P-N SILICON TRANSISTORS

## TYPICAL CHARACTERISTICS



NOTE 2: Capacitance measurements were made using chips mounted in TO-5 packages.

## CHIP TYPE N20

N-P-N SILICON TRANSISTORS

- N20 is a $16 \times 16$-mil, epitaxial, planar, expanded-contact chip
- Available in Silect ${ }^{\dagger}$ packages
- For use in TV mixer and Non-AGC IF circuits

electrical characteristics at $\mathbf{2 5}{ }^{\circ} \mathrm{C}$ free-air temperature


[^148]
## CHIP TYPE N20 N-P-N SILICON TRANSISTORS

TYPICAL CHARACTERISTICS



NOTE 1: This paramater was measured using puise techniques. $\mathrm{t}_{\mathrm{w}}=\mathbf{3 0 0} \mu \mathrm{s}$, duty cycle $<\mathbf{2 \%}$.


NOTES: 2. Capacitance messurements were made using chips mounted in Silect packages.
3. $C_{c b}$ measurement employs a three-tarminal capacitance bridge Incorporating a guard circuit. The emitter is connected to the guard terminal of the bridge.

## CHIP TYPE N21 <br> N-P-N SILICON TRANSISTORS

- N21 is an $18 \times 18$-mil, eptiaxial, planar, direct-contact chip
- Available in Silect ${ }^{\dagger}$ packages
- For low-noise, medium-current (to 100 mA ) amplifier circuits

electrical and operating characteristics at $25^{\circ} \mathrm{C}$ free-air temperature

| PARAMETER |  | CONDITIONS |  | OBSERVED VALUES |  |  | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | $\frac{\text { LOW }}{80^{\circ}}$ | TYP | HIGH |  |
| $V_{\text {(BR) }}$ CBO | Collector-Base Breakdown Voltage |  | $I_{C}=10 \mu A, \quad I E=0$ |  | 100 |  | V |
| $V_{\text {(BR)CEO }}$ | Collector-Emitter Breakdown Voltage | $I_{C}=10 \mathrm{~mA}, \quad I_{B}=0$, | See Note 1 | $40^{+}$ | 60 |  | V |
| $V_{\text {(BR)EBO }}$ | Emitter-Base Breakdown Voltage | $\mathrm{I}_{\mathrm{E}}=10 \mu \mathrm{~A}, \quad \mathrm{IC}=0$ |  | $6{ }^{4}$ | 6.5 |  | $\checkmark$ |
| ${ }^{\text {I CBO }}$ | Collector Cutoff Current | $V_{C B}=30 \mathrm{~V}, \quad I_{E}=0$ |  |  | <0.1 | 100 | nA |
| IEBO | Emitter Cutoff Current | $\mathrm{VEB}=5 \mathrm{~V}, \quad \mathrm{IC}=0$ |  |  | <0.1 | 100 | nA |
|  |  | $V_{C E}=5 \mathrm{~V}, \quad \mathrm{i} C=10 \mu \mathrm{~A}$ |  | 20 | 240 |  |  |
|  | Static Forward Current | $V_{C E}=5 \mathrm{~V}, \quad I_{C}=100 \mu \mathrm{~A}$ |  | 40 | 340 |  |  |
| hFE | Transfer Ratio | $\mathrm{V}_{\text {CE }}=5 \mathrm{~V}, \quad \mathrm{l} C=1 \mathrm{~mA}$ |  | 50 | 475 | 1000 |  |
|  |  | $\mathrm{V}_{C E}=5 \mathrm{~V}, \quad \mathrm{I}_{\mathrm{C}}=10 \mathrm{~mA}$, | See Note 1 | 60 | 600 |  |  |
|  |  | $\mathrm{V}_{\text {CE }}=5 \mathrm{~V}, \quad 1 \mathrm{C}=100 \mathrm{~mA}$, | See Note 1 | 40 |  |  |  |
|  |  | $\mathrm{V}_{\text {CE }}=5 \mathrm{~V}, \quad \mathrm{I}^{\text {C }} \mathrm{C}=100 \mu \mathrm{~A}$ |  |  | 0.55 | 0.65 |  |
| VBE | Base-Emitter Voltage | $V_{C E}=5 \mathrm{~V}, \quad \mathrm{I}^{\prime}=1 \mathrm{~mA}$ |  |  | 0.6 | 0.7 | V |
|  |  | $\mathrm{V}_{\text {CE }}=5 \mathrm{~V}$, IC $=10 \mathrm{~mA}$, | See Note 1 |  | 0.7 | 0.8 |  |
| VCE(sat) | Collector-Emitter Saturation Voltage | $\mathrm{I}_{\mathrm{B}}=1 \mathrm{~mA}, \quad \mathrm{I}^{\prime}=10 \mathrm{~mA}$ |  |  | 0.06 |  | V |
| $\mathrm{h}_{\text {ie }}$ | Small-Signal Common-Emitter Input Impedance |  |  |  | 115 |  | k $\Omega$ |
| $h_{\text {fi }}$ | Small-Signal Common-Emitter Forward Current Transfer Ratio |  | $f=1 \mathrm{kHz}$ |  | 440 |  |  |
| $h_{\text {re }}$ | Small-Signal Common-Emitter Reverse Voltage Transfer Ratio |  | $\mathrm{f}=1 \mathrm{kHz}$ |  | $\begin{array}{r} 30 \times \\ 10^{-4} \\ \hline \end{array}$ |  |  |
| $\mathrm{h}_{\mathbf{o f}}$ | Small-Signal Common-Emitter Output Admittance |  |  |  | 11 |  | $\mu \mathrm{mho}$ |
| fT | Transition Frequency | $V_{C E}=5 \mathrm{~V}, \quad \mathrm{I}_{\mathrm{C}}=10 \mathrm{~mA}$, | $f=100 \mathrm{MHz}$ | 200 | 330 |  | MHz |
| $C_{c b}$ | Collector-Base Capacitance | $\begin{array}{ll} V_{C B}=5 \mathrm{~V}, & \mathrm{I}_{\mathrm{E}}=0, \\ \text { See Notes } 2 \text { and } 3 & \\ \hline \end{array}$ | $\mathrm{f}=1 \mathrm{MHz},$ |  | 3.5 | 4.5 | pF |
| $\mathrm{C}_{\text {eb }}$ | Emitter-Base Capacitance | $V_{E B}=0.5 V, \quad I C=0,$ <br> See Notes 2 and 3 | $\mathrm{f}=\mathbf{4} \mathbf{M H z}$, |  | 8 | 16 | pF |
| F | Spot Noise Figure | $\begin{aligned} & V_{C E}=5 \mathrm{~V}, \\ & f=1 \mathrm{kHz} \end{aligned}$ | $\mathrm{R}_{\mathrm{G}}=10 \mathrm{k} \Omega$, |  | 0.5 | 2 | dB |
| $\bar{F}$ | Average Noise Figure | $\begin{aligned} & \hline V_{C E}=5 \mathrm{~V}, \quad \quad I_{C}=100 \mu \mathrm{~A}, \\ & \text { Noise Bandwidth }=15.7 \mathrm{kHz}, \\ & \hline \end{aligned}$ | $\mathrm{R}_{\mathrm{G}}=10 \mathrm{k} \Omega,$ <br> See Note 4 |  | 0.5 | 3 | dB |

[^149]
## CHIP TYPE N21 <br> N-P-N SILICON TRANSISTORS

## TYPICAL CHARACTERISTICS



VCE(sat) vs lc


NOTE 1: These parameters were measured using pulse techniques. $\mathbf{t}_{\mathbf{w}}=\mathbf{3 0 0} \mu \mathrm{s}$, duty cycle $\leqslant \mathbf{2 \%}$.

# CHIP TYPE N21 N-P-N SILICON TRANSISTORS 

TYPICAL CHARACTERISTICS


NOTES: 2. Capacitence measurements were mede using chips mounted in Silect ${ }^{\dagger}$ packages.
3. $C_{c b}$ and $C_{e b}$ measurements emplov a three-terminal capacitance bridge incorporating a guard circuit. The third alectrode (emitter or collector, respectively) it connected to the guard terminal of the bridge.
5. To obtain reproducible results, these parameters were measured with bias conditions applied for less than five seconds.

TYPICAL CHARACTERISTICS


FIGURE 16

F vs $f$


FIGURE 18

Contours of Constant Fvs IC


FIGURE 17


Figure 19

NOTES: 1. These parameters were measured using pulse techniques. $t_{w}=300 \mu s$, duty cycle $\leqslant 2 \%$,
4. Average Noise Figure was measured in an amplifier with response down 3 dB at 10 Hz and 10 kHz and a high-frequency roll-off of 6 dB/octave.

## CHIP TYPE N22 <br> N-P-N SILICON TRANSISTORS

- $\quad$ 22 is a $10 \times 15-m i l$, epitaxial, planar, expanded-contact chip ${ }^{*}$
- Available in TO-72, a short-can version of TO-78, and Silect ${ }^{\dagger}$ packages
- For use in high-frequency (to $\mathbf{1} \mathbf{G H z}$ ) amplifier and oscillator circuits

electrical and operating characteristics at $25^{\circ} \mathrm{C}$ free-air temperature


[^150]


FIGURE 1
$\mathbf{V}_{\text {BE vs }} \mathbf{I}_{\mathbf{C}}$


FIGURE 3
hfe vs IC


FIGURE 2
$V_{C E}($ sat $)$ vs $\mathbf{I C}^{\prime}$


FIGURE 4

NOTE 1: These parameters were measured using pulse techniques. $t_{w}=300 \mu \mathrm{~s}$, duty cycle $\leqslant \mathbf{2 \%}$.

## CHIP TYPE N22 N-P-N SILICON TRANSISTORS

COMMON-EMITTER EQUIVALENT CIRCUIT USING SHORT-CIRCUIT " $y$ " PARAMETERS


$$
\begin{aligned}
& I_{b}=\left|y_{i e}\right| V_{b e}+\left|y_{r e}\right| V_{c e} \\
& I_{s}=\left|y_{f e}\right| V_{b e}+\left|y_{o e}\right| V_{c e} \\
& \left.\left|y_{i e}\right|=\left.\frac{I_{b}}{V_{b e}}\right|_{V_{c e}}=0=\frac{1}{r_{\text {iep }}}+j \omega C_{\text {iep }} \quad\left|y_{\mathrm{ce}}\right|=\frac{l_{c}}{V_{b e}} \right\rvert\, V_{c e}=0 \\
& \left.\left|y_{\mathrm{re}}\right|=\frac{I_{b}}{V_{c e}} \right\rvert\, V_{b e}=0 \\
& \left|y_{o e}\right|=\left.\frac{I_{c}}{V_{c t}}\right|_{V_{b e}}=0=\frac{1}{r_{\text {oep }}}+j \omega C_{\text {oep }}
\end{aligned}
$$

TYPICAL CHARACTERISTICS AT TA $=25^{\circ} \mathrm{C}$


FIGURE 5


Figure 8


FIGURE 6


FIGURE 9


FIGURE 7

figure 11


FIGURE 13


FIGURE 15
$C_{c b}$ vs $V_{C B}$


Figure 12


FIGURE 14


FIGURE 16

# CHIP TYPE N22 N-P-N SILICON TRANSISTORS 

## TYPICAL CHARACTERISTICS <br> COMMON-EMITTER INPUT REFLECTION COEFFICIENT, sie

NORMALIZED INPUT IMPEDANCE
$V_{C E}=10 \mathrm{~V}, \mathrm{z}_{\mathrm{G}}=\mathrm{Z}_{\mathrm{L}}=50 \Omega+\rho, \mathrm{T}_{\mathrm{A}}=25^{\circ} \mathrm{C}$


| Frequency | $1 \mathrm{C}=0.4 \mathrm{~mA}$ |  | $I_{C}=1 \mathrm{~mA}$ |  | $I_{C}=4 \mathrm{~mA}$ |  | ${ }^{1} \mathrm{C}=10 \mathrm{~mA}$ |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | \| ${ }_{\text {io }}$ \| | $\phi_{\text {gie }}$ | Fiel | $\phi_{\text {sie }}$ | Pial | $\phi_{\text {sia }}$ | Piol | $\phi_{\text {gie }}$ |
| 100 MHz | 0.94 | $-21^{\circ}$ | 0.80 | $-26{ }^{\circ}$ | 0.58 | $-40^{\circ}$ | 0.43 | $-57^{\text {b }}$ |
| 200 MHz | 0.87 | $-27^{\circ}$ | 0.72 | $-33^{\circ}$ | 0.50 | $-51^{\circ}$ | 0.35 | $-79^{\circ}$ |
| 300 MHz | 0.76 | $-36^{\circ}$ | 0.63 | $-43^{\circ}$ | 0.43 | $-63^{\circ}$ | 0.30 | -104 ${ }^{\circ}$ |
| 400 MHz | 0.69 | $-44^{\circ}$ | 0.57 | $-52^{\circ}$ | 0.36 | $-84^{\circ}$ | 0.28 | $-123^{\circ}$ |
| 500 MHz | 0.63 | $-51^{\circ}$ | 0.51 | $-62^{\circ}$ | 0.32 | $-100^{\circ}$ | 0.27 | $-145^{\circ}$ |
| 600 MHz | 0.59 | $-59^{\circ}$ | 0.47 | $-72^{\circ}$ | 0.29 | $-117^{\circ}$ | 0.28 | $-162^{\circ}$ |
| 700 MHz | 0.53 | $-68^{\circ}$ | 0.43 | $-83^{\circ}$ | 0.28 | $-134^{\circ}$ | 0.30 | $-177^{\circ}$ |

[^151]FIGURE 17

## CHIP TYPE N22

N-P-N SILICON TRANSISTORS


| Frequency | $\mathrm{IC}_{\mathrm{C}}=0.4 \mathrm{~mA}$ |  | $l_{C}=1 \mathrm{~mA}$ |  | ${ }^{\prime} \mathrm{C}=4 \mathrm{~mA}$ |  | $I_{C}=10 \mathrm{~mA}$ |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | P00\| | $\Phi_{\text {soe }}$ | $\mathbf{k}_{\text {oe }} 1$ | $\phi_{\text {soe }}$ | $\left.\right\|_{\text {00e }} \mid$ | $\phi_{509}$ | Foel | $\phi_{900}$ |
| 200 MHz | 0.99 | $-4^{\circ}$ | 0.97 | $-4^{\circ}$ | 0.89 | $-3^{\circ}$ | 0.87 | $-2^{\circ}$ |
| 300 MHz | 0.98 | $-8^{\text {b }}$ | 0.95 | $-7^{\circ}$ | 0.88 | $-6^{\circ}$ | 0.86 | $-5^{\circ}$ |
| 400 MHz | 0.95 | $-11^{\circ}$ | 0.93 | $-10^{\circ}$ | 0.87 | -9 ${ }^{\circ}$ | 0.85 | -8 ${ }^{\circ}$ |
| 500 MHz | 0.94 | $-14^{\circ}$ | 0.91 | $-13^{\circ}$ | 0.86 | $-12^{\circ}$ | 0.84 | $-11^{\circ}$ |
| 600 MHz | 0.93 | $-17^{\circ}$ | 0.90 | $-16^{\circ}$ | 0.85 | $-15^{\circ}$ | 0.84 | $-14^{\circ}$ |
| 700 MHz | 0.92 | $-21^{\circ}$ | 0.88 | $-20^{\circ}$ | 0.85 | $-20^{\circ}$ | 0.83 | $-19^{\circ}$ |

These measurements were made using chips mounted in Silect packages.

FIGURE 18

- N23 is a $26 \times 26-m i l$, epitaxial, planar, direct-contact chip
- Available in TO-18, TO-39, a short-can version of TO-78, and Silect ${ }^{\dagger}$ packages
- For use in general purpose amplifier and switching circuits

electrical and operating characteristics at $\mathbf{2 5}{ }^{\circ} \mathrm{C}$ free-air temperature


[^152]CHIP TYPE N23
N-P-N SILICON TRANSISTORS


FIGURE 1-SWITCHING TIMES
TYPICAL CHARACTERISTICS


NOTE 1: These parameters were measured using pulse techniques. $t_{w}=\mathbf{3 0 0} \mu_{\mathrm{s}}$, duty cycle $\leqslant \mathbf{2 \%}$.

## CHIP TYPE N23 <br> N-P-N SILICON TRANSISTORS

## TYPICAL CHARACTERISTICS




FIGURE 10


FIGURE 11


FIGURE 14


FIGURE 15

NOTE 2: Capacitance measurements were made using chips mounted in TO-39 packages.

- N24 is a $19 \times 19$-mil, epitaxial, planar, direct-contact chip
- Available in TO-5, TO-18, TO-39, a short-can version of TO-78, plastic dual-in-line quad, and Silect ${ }^{\dagger}$ packages
- For use in general purpose amplifier and medium-current switching circuits

electrical and operating characteristics at $25^{\circ} \mathrm{C}$ free-air temperature

${ }^{\dagger}$ Trademark of Texas instruments
These values do not modify guaranteed limits for specific devices and do not justify operation in excess of absolute maximum ratings.
. These parameters were measured using pulse techniques. $t_{w}=300 \mu$ s, duty cycle $\leqslant 2 \%$.

3. $\mathrm{C}_{\mathrm{cb}}$ measurement employs were made using chips mounted in TO-5 packages.
guard terminal of the bridge. Chree-terminal capacitance bridge incorporating a guard circuit. The emitter is connected to the
TEST CIRCUIT

(See Notes a and b) VOLTAGE WAVEFORMS

NOTES: a. The input waveforms are supplied by genarator with the following characteristics: $Z_{o u t}=50 \Omega$; for masuring $t_{d}$ and $t_{r}$.


FIGURE 1-SWITCHING TIMES

## TYPICAL CHARACTERISTICS



NOTE 1: These parameters were measured using pulse techniques. $t_{w}=300 \mu$, duty cycle $\leqslant 2 \%$.



FIGURE 11


Figure 13


FIGURE 12


FIGURE 14

NOTES: 2. Capacitance measurements were made using chips mounted in TO-5 peckages,
3. $C_{C b}$ measurament employs a threetermi
 terminal of the bridge. Cobo and Cibo measurements ere made with the third terminal floating.
4. To avoid overheating the transistor, thls parameter was measured with blas conditlons applied for less than 5 seconds.

## CHIP TYPE N26 <br> N-P-N SILICON TRANSISTORS

- N26 is a $10 \times 12$-mil, epitaxial, planar, expanded-contact chip
- Available in Silect ${ }^{\dagger}$ packages
- For use in high-frequency (to $\mathbf{5 0 0} \mathbf{~ M H z}$ ), low-noise, common-base amplifier circuits requiring forward AGC characteristics

electrical and operating characteristics at $25^{\circ} \mathrm{C}$ free-air temperature

| PARAMETER |  | CONDITIONS |  |  | OBSERVED VALUES |  |  | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | LOW | TYP | HIGH |  |
| $V_{\text {(BR) }}$ CBO | Collector-Base Breakdown Voltage |  |  |  | $I_{C}=10 \mu \mathrm{~A}$, | $1 E=0$ |  | $40^{*}$ | 55 |  | V |
| $V_{(B R) C E O}$ | Collector-Emitter Breakdown Voltage | $I_{C}=10 \mathrm{~mA}$, | $1_{B}=0$, | See Note 1 | $30^{*}$ | 50 |  | V |
| $V_{\text {(BR) }}$ EBO | Emitter-Base Breakdown Voltage | $I_{E}=10 \mu A$, | $\mathrm{I}^{\prime}=0$ |  | 4* | 5.5 |  | V |
| ICBO | Collector Cutoff Current | $\mathrm{V}_{C B}=10 \mathrm{~V}$, | $\mathrm{IE}_{\mathrm{E}}=0$ |  |  | <1 | 50 | nA |
|  | Static Forward Current | $\mathrm{V}_{C E}=10 \mathrm{~V}$, | ${ }^{1} C=4 \mathrm{~mA}$ |  | 30 | 100 |  |  |
| hFE | Transfer Ratio | $V_{C E}=10 \mathrm{~V}$, | $I^{\prime} C=10 \mathrm{~mA}$, | See Note 1 |  | 80 |  |  |
|  |  | $V_{C E}=10 \mathrm{~V}$, | $\mathrm{IC}_{\mathrm{C}}=4 \mathrm{~mA}$ |  |  | 0.75 | 0.8 | $V$ |
| VBE | Base-Emitter Voltage | $\mathrm{V}_{\text {CE }}=10 \mathrm{~V}$. | $I_{C}=10 \mathrm{~mA}$, | See Note 1 |  | 0.8 |  |  |
|  | Collector-Emitter | ${ }^{1}{ }^{1}=0.4 \mathrm{~mA}$, | $\mathrm{I}^{\prime} \mathrm{C}=4 \mathrm{~mA}$ |  |  | 0.65 |  | V |
| VCE(sat) | Saturation Voltage | $\mathrm{I}_{B}=1 \mathrm{~mA}$, | ${ }^{1} \mathrm{C}=10 \mathrm{~mA}$, | See Note 1 |  | 2.5 |  |  |
|  |  | $V_{C E}=10 \mathrm{~V}$, | $I_{C}=4 \mathrm{~mA}$, | $f=100 \mathrm{MHz}$ | 450 | 550 |  | MHz |
| ${ }^{\text {f }}$ | Transition Frequency | $V_{C E}=10 \mathrm{~V}$, | ${ }_{1} \mathrm{C}=10 \mathrm{~mA}$, | $f=100 \mathrm{MHz}$ |  | 70 |  |  |
| $c_{c b}$ | Collector-Base Capacitance | $V_{C B}=10 \mathrm{~V}$ <br> See Notes 2 | $I_{E}=0$ | $\mathrm{f}=1 \mathrm{MHz}$, |  | 0.9 |  | pF |
| $\mathrm{C}_{\text {ce }}$ | Collector-Emitter Capacitance | $\begin{aligned} & V_{C E}=10 \mathrm{~V} \\ & \text { See Notes } 2 \text { an } \end{aligned}$ | $I_{B}=0$ | $\mathrm{f}=1 \mathrm{MHz}$, |  | 0.2 | 0.3 | pF |
|  |  | $V_{C B}=10 \mathrm{~V}$. | $\mathrm{IE}=-4 \mathrm{~mA}$, | $f=200 \mathrm{MHz}$ |  | 4 |  | dB |
| $\mid \mathrm{ffb}^{2}$ | Forward Transmission Coefficient $\ddagger$ | $Z_{G}=Z_{L}=50$ <br> See Note 2 |  | $f=400 \mathrm{MHz}$ |  | 3 |  |  |
| F | Spot Noise Figure | $\begin{aligned} & V_{C E}=10 \mathrm{~V}, \\ & f=200 \mathrm{MHz} \end{aligned}$ | $I_{C}=3 \mathrm{~mA},$ | $\mathrm{R}_{\mathrm{G}}=50 \Omega$, |  | 3 | 4 | dB |

[^153]

NOTES 1. These parameters were measured using pulse techniques. $t_{w}=300 \mu s$, duty cycle $<2 \%$.
2. Capacitance and s-parameter measurements were made using chips mounted in TiS 125 packeges.
3. $\mathrm{C}_{\mathrm{cb}}$ and $\mathrm{C}_{\mathrm{ce}}$ measurements employ a three-terminal capacitance bridge incorporating a guard circuit. The third electrode (emitter or base, respectively) is connected to the guard terminal of the bridge.

# CHIP TYPE N26 <br> N-P-N SILICON TRANSISTORS 



These measurements wers made using chips mounted in TIS125 packages.

FIGURE 9

## TYPICAL CHARACTERISTICS

## COMMON-BASE OUTPUT REFLECTION COEFFICIENT, sob

and
NORMALIZED OUTPUT IMPEDANCE
$V_{C B}=10 \mathrm{~V}, Z_{G}=Z_{L}=50 \Omega+j 0, T_{A}=25^{\circ} \mathrm{C}$


| Frequency | $I_{E}=-2 m A$ |  | $I_{E}=-4 \mathrm{~mA}$ |  | $\mathrm{IE}^{=}=-6 \mathrm{~mA}$ |  | $I_{E}=-10 \mathrm{~mA}$ |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | Fobl | $\phi_{\text {sob }}$ | *sobl | $\phi_{\text {sob }}$ | \|Sobl | $\phi_{\text {sob }}$ | Fobl | $\phi_{\text {sob }}$ |
| 200 MHz | 0.99 | $-1^{\circ}$ | 0.99 | $-1^{\circ}$ | 0.99 | $-1^{\circ}$ | 0.97 | $\frac{11^{\circ}}{}$ |
| 300 MHz | 0.99 | $-5^{\circ}$ | 0.99 | $-5^{\circ}$ | 0.99 | $-5^{\circ}$ | 0.96 | $-4^{\circ}$ |
| 400 MHz | 0.99 | $-7^{\circ}$ | 0.99 | $-7^{\circ}$ | 0.99 | $-7^{\circ}$ | 0.94 | $-6^{\circ}$ |
| 500 MHz | 0.98 | $-11^{\circ}$ | 0.98 | $-11^{\circ}$ | 0.98 | $-11^{\circ}$ | 0.93 | $-9^{\circ}$ |
| 600 MHz | 0.96 | $-14^{\circ}$ | 0.96 | $-14^{\circ}$ | 0.96 | $-14^{\circ}$ | 0.91 | $-11^{\circ}$ |
| 700 MHz | 0.93 | $-17^{\circ}$ | 0.93 | $-17^{\circ}$ | 0.93 | $-17^{\circ}$ | 0.88 | $-13^{\circ}$ |

These measurements were made using chips mounted in TIS125 packages

# CHIP TYPE N27 <br> N-P-N SILICON TRANSISTORS 

- $\quad$ 27 is an $18 \times 18$-mil, epitaxial, planar, direct-contact chip
- Available in Silect ${ }^{\dagger}$ packages
- For use in high-voltage amplifier circuits

electrical characteristics at $25^{\circ} \mathrm{C}$ free-air temperature



## ${ }^{\dagger}$ Trademark of Texas Instruments

These values do not modify guaranteed limits for specific devices and do not justify operation in excess of absolute maximum ratings.
NOTES: 1. This parameter was measured using puise techniques. $t_{w}=300 \mu \mathrm{~s}$, duty cycle $\leqslant 2 \%$.
2. Capacitance measurements were made using chips mounted in $\mathbf{T O} 92$ packages. or collector, respectively) is connected to the guard terminsl of the bridge.



FIGURE 6

Figure 7


FIGURE 8

NOTES: 1. This parameter was measured using puise techniques. $t_{w}=300 \mu s$, duty cycle $\leqslant 2 \%$.
2. Capacitance measurements were made using chips mounted in TO-92 packages.
3. $C_{c b}$ and $C_{e b}$ measurements employ a three-terminal capacitance bridge incorporating a guard circuit. The third-electrode (emitter or collector, respectively) is connected to the guard terminal fo the bridge.

## CHIP TYPE N28 <br> N-P-N SILICON TRANSISTORS

- N28 is an $11 \times$ 15-mil, epitaxial, planar, expanded-contact chip
- Available in TO-72 and Silect ${ }^{\dagger}$ packages
- For use in UHF amplifier, oscillator, and mixer circuits requiring low noise and high gain

electrical and operating characteristics at $25^{\circ} \mathrm{C}$ free-air temperature

| PARAMETER |  | CONDITIONS |  |  | OBSERVED VALUES |  |  | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  | TYP | HIGH |  |
| $V$ (BR)CBO | Collector-Base Breakdown Voltage |  |  |  | $l^{\prime}=10 \mu A$, | $\mathrm{I}_{\mathrm{E}}=0$ |  | 25* | 35 |  | V |
| $V$ (BR)CEO | Collector-Emitter Breakdown Voltage | ${ }^{\prime} \mathrm{C}=2 \mathrm{~mA}$, | $\mathrm{I}_{\mathrm{B}}=0$, | See Note 1 | 13* | 20 |  | V |
| $V_{\text {(BR)EBO }}$ | Emitter-Base Breakdown Voltage | $\mathrm{IE}^{\prime}=10 \mu \mathrm{~A}$, | $I_{C}=0$ |  | $3{ }^{*}$ | 5.5 |  | $\checkmark$ |
| ICBO | Collector Cutoff Current | $V_{C B}=6 \mathrm{~V}$, | $\mathrm{I}_{\mathrm{E}}=0$ |  | $<0.1$ |  |  | nA |
| hfe | Static Forward Current Transfer Ratio | $V_{C E}=6 \mathrm{~V}$, | $\mathrm{l}_{\mathrm{c}}=1 \mathrm{~mA}$ |  | 85 |  |  |  |
|  |  | $V_{C E}=6 \mathrm{~V}$, | $i_{C}=5 \mathrm{~mA}$ |  | 20 | 95 | 300 |  |
|  |  | $V_{C E}=6 \mathrm{~V}$, | $\mathrm{I}_{\mathrm{C}}=10 \mathrm{~mA}$ | See Note 1 | 95 |  |  |  |
|  |  | $V_{C E}=6 \mathrm{~V}$, | $\mathrm{I}_{\mathrm{C}}=20 \mathrm{~mA}$ |  | 85 |  |  |  |
| $V_{B E}$ | Base-Emitter Voltage | $V_{C E}=6 \mathrm{~V}$, | $\mathrm{I}_{\mathrm{C}}=5 \mathrm{~mA}$ | See Note 1 |  | 0.75 | 0.95 | V |
|  |  | $V_{C E}=6 \mathrm{~V}$, | $\mathrm{I}^{\prime} \mathrm{C}=20 \mathrm{~mA}$ |  | 0.8 |  |  |  |
| VCE(sat) | Collector-Emitter <br> Saturation Voltage | $\mathrm{I}_{\mathrm{B}}=0.5 \mathrm{~mA}$, | $\mathrm{I}_{\mathrm{C}}=5 \mathrm{~mA}$ | See Note 1 | 0.07 |  |  | V |
|  |  | $\mathrm{I}_{B}=2 \mathrm{~mA}$, | ${ }^{1} \mathrm{C}=20 \mathrm{~mA}$ |  | 0.12 |  |  |  |
| ${ }^{+} \mathbf{T}$ | Transition Frequency | $V_{C E}=6 \mathrm{~V}$. | $\mathrm{I}_{\mathrm{C}}=5 \mathrm{~mA}, \quad \mathrm{f}=400 \mathrm{MHz}$ |  | $1.0 \quad 1.7$ |  |  | GHz |
| Ffel2 | Square of Common-Emitter <br> Forward Transmission Coefficient $\ddagger$ | $\begin{aligned} & V_{C E}=6 \mathrm{~V}, \quad I C=10 \mathrm{~mA}, \\ & Z_{G}=Z_{L}=50 \Omega+j 0, \end{aligned}$ <br> See Note 2 |  | $f \pm 400 \mathrm{MHz}$ | 11 |  |  | dB |
|  |  |  |  | $f=1 \mathrm{GHz}$ | 3.5 |  |  |  |
| $C_{c b}$ | Collector-Base Capacitance | $V_{C B}=6 \mathrm{~V}$, | $I_{E}=0$ | $f=1 M H z,$ <br> See Notes 2 and 3 |  | 0.2 | 0.9 | pF |
| $\mathrm{C}_{\text {eb }}$ | Emitter-Base Capacitance | $\mathrm{VEB}=0.5 \mathrm{~V}$, | $I_{C}=0$ |  | 2 |  |  | pF |
| $r_{b}{ }^{\prime} C_{c}$ | Collector-Base Time Constant | $V_{C B}=6 \mathrm{~V},$ <br> See Note 2 | $I^{\prime}=-5 \mathrm{~mA}$, | $f=79.8 \mathrm{MHz}$, | $8 \quad 13$ |  |  | ps |
| F | Spot Noise Figure | $\begin{aligned} & V_{C B}=6 \mathrm{~V} \\ & I_{E}=-2 \mathrm{~mA} \end{aligned}$ | $\mathrm{R}_{\mathrm{G}}=100 \Omega$, | $f=450 \mathrm{MHz}$ |  | 3.5 | 6 | dB |
|  |  |  | $\mathrm{R}_{\mathrm{G}}=50 \Omega$, | $f=1 \mathrm{GHz}$ | 6.5 |  |  |  |

[^154]
## TYPICAL CHARACTERISTICS



figure 3



Figure 4

NOTE 1: This parameter was measured using pulse techniques. $t_{w}=300 \mu$, duty cycle $\leqslant 2 \%$.

## CHIP TYPE N28 <br> N-P-N SILICON TRANSISTORS

## TYPICAL CHARACTERISTICS



NOTES: 2. Capacitance, $r_{b}{ }^{\prime} C_{c}$, and s-parameter masaraments ware made using chips mounted in TO-72 packages.
3. $\mathrm{C}_{\mathrm{cb}}$ and $\mathrm{C}_{\mathrm{eb}}$ measurements employ a three-terminal capacitance bridga incorporating a guard circuit. The third electrode femitter or colfector, respectiveiv) is connected to the guard terminal of the bridge.

## CHIP TYPE N28

N-P-N SILICON TRANSISTORS

## TYPICAL CHARACTERISTICS <br> COMMON-EMITTER INPUT REFLECTION COEFFICIENT, sie

NORMALIZED INPUT IMPEDANCE
$V_{C E}=6 \mathrm{~V}, \mathrm{Z}_{\mathrm{G}}=\mathrm{Z}_{\mathrm{L}}=\mathbf{5 0 \Omega} \mathbf{\Omega}+\mathrm{jo}, \mathrm{T}_{\mathrm{A}}=\mathbf{2 5 ^ { \circ }} \mathbf{C}$


| Frequency | $\mathrm{IC}_{\mathrm{C}}=1 \mathrm{~mA}$ |  | $I_{C}=4 \mathrm{~mA}$ |  | ${ }^{1} \mathrm{C}=7 \mathrm{~mA}$ |  | $\mathrm{Ic}=10 \mathrm{~mA}$ |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | Piel | $\phi_{\text {sie }}$ | \| ${ }_{\text {ie }} \mid$ | $\phi_{\text {sie }}$ | ${ }_{\text {Piol }} 1$ | $\phi_{\text {sia }}$ | Piel | $\phi_{\text {sip }}$ |
| 100 MHz | 0.71 | $-53^{\circ}$ | 0.53 | -46 ${ }^{\circ}$ | 0.46 | $-44^{\circ}$ | 0.39 | $-44^{\circ}$ |
| 300 MHz | 0.55 | $-67^{\circ}$ | 0.33 | $-65^{\circ}$ | 0.27 | -62 ${ }^{\circ}$ | 0.25 | $-62^{\circ}$ |
| 500 MHz | 0.36 | $-90^{\circ}$ | 0.22 | $-81^{\circ}$ | 0.19 | $-79^{\circ}$ | 0.17 | $-80^{\circ}$ |
| 700 MHz | 0.25 | $-114^{\circ}$ | 0.15 | $-102^{\circ}$ | 0.13 | $-102{ }^{\circ}$ | 0.11 | -105 ${ }^{\circ}$ |
| 900 MHz | 0.18 | -145 ${ }^{\circ}$ | 0.10 | $-137^{\circ}$ | 0.09 | $-140^{\circ}$ | 0.08 | $-149^{\circ}$ |
| 1100 MHz | 0.16 | $176^{\circ}$ | 0.10 | $176^{\circ}$ | 0.09 | $166^{\circ}$ | 0.09 | $160^{\circ}$ |
| 1300 MHz | 0.17 | $139^{\circ}$ | 0.13 | $132^{\circ}$ | 0.13 | $130^{\circ}$ | 0.12 | $129^{\circ}$ |
| 1500 MHz | 0.21 | $113^{\circ}$ | 0.17 | $110^{\circ}$ | 0.17 | $107^{\circ}$ | 0.17 | $106^{\circ}$ |
| 1700 MHz | 0.25 | $93^{\circ}$ | 0.21 | $91^{\circ}$ | 0.21 | $90^{\circ}$ | 0.20 | $90^{\circ}$ |
| 1900 MHz | 0.29 | $77^{\circ}$ | 0.25 | $76^{\circ}$ | 0.24 | $76^{\circ}$ | 0.23 | $76^{\circ}$ |

These measurements were made using chips mounted in TO-72 packages.

FIGURE 11

# CHIP TYPE N28 N-P-N SILICON TRANSISTORS 

## TYPICAL CHARACTERISTICS

# COMMON-EMITTER OUTPUT REFLECTION COEFFICIENT, soe <br> and 

NORMALIZED OUTPUT IMPEDANCE
$V_{C E}=6 \mathrm{~V}, \mathrm{Z}_{\mathrm{G}}=\mathrm{Z}_{\mathrm{L}}=50 \Omega+\mathrm{j0}, \mathrm{~T}_{\mathrm{A}}=\mathbf{2 5 ^ { \circ }} \mathbf{C}$


| Frequency | $\mathrm{IC}_{\mathrm{C}}=1 \mathrm{~mA}$ |  | $l_{C}=4 \mathrm{~mA}$ |  | $1 \mathrm{C}=7 \mathrm{~mA}$ |  | IC $=10 \mathrm{~mA}$ |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | Foel | $\phi_{\text {soe }}$ | Soel | $\phi_{\text {soe }}$ | $\beta_{08}$ | $\phi_{\text {soe }}$ | $\mathbf{F}_{\mathbf{0 e f}}$ | $\phi_{\text {soe }}$ |
| 100 MHz | 0.97 | $-5^{\circ}$ | 0.93 | $-6^{\circ}$ | 0.91 | $-6^{\circ}$ | 0.90 | $-6^{\circ}$ |
| 300 MHz | 0.93 | $-13^{\circ}$ | 0.89 | $-13^{\circ}$ | 0.88 | $-13^{\circ}$ | 0.87 | $-13^{\circ}$ |
| 500 MHz | 0.90 | $-20^{\circ}$ | 0.86 | $-19^{\circ}$ | 0.85 | $-19^{\circ}$ | 0.84 | $-19^{\circ}$ |
| 700 MHz | 0.87 | $-27^{\circ}$ | 0.84 | $-26^{\circ}$ | 0.83 | $-26^{\circ}$ | 0.82 | $-26^{\circ}$ |
| 900 MHz | 0.85 | $-35^{\circ}$ | 0.82 | $-33^{\circ}$ | 0.80 | $-33^{\circ}$ | 0.79 | $-33^{\circ}$ |
| 1100 MHz | 0.83 | $-43^{\circ}$ | 0.79 | $-41^{\circ}$ | 0.78 | $-41^{\circ}$ | 0.77 | $-41^{\circ}$ |
| 1300 MHz | 0.80 | $-52^{\circ}$ | 0.77 | $-49^{\circ}$ | 0.75 | $-48^{\circ}$ | 0.74 | $-48^{\circ}$ |
| 1500 MHz | 0.76 | $-60^{\circ}$ | 0.74 | $-57^{\circ}$ | 0.73 | $-56^{\circ}$ | 0.72 | $-56^{\circ}$ |
| 1700 MHz | 0.73 | $-69^{\circ}$ | 0.72 | $-65^{\circ}$ | 0.71 | $-65^{\circ}$ | 0.70 | $-65^{\circ}$ |
| 1900 MHz | 0.71 | $-79^{\circ}$ | 0.71 | $-74^{\circ}$ | 0.70 | $-74^{\circ}$ | 0.69 | $-74^{\circ}$ |

These measurements were made using chips mounted in TO-72 packages.
FIGURE 12

- N29 is a $10 \times 12-m i l$, epitaxial, planar, expanded-contact chip
- Available in Silect ${ }^{\dagger}$ packages
- For VHF mixers and IF amplifiers not requiring AGC characteristics

electrical and operating characteristics at $25^{\circ} \mathrm{C}$ free-air temperature


Trademark of Texas Instruments
-These values do not modify guaranteed limits for specific devices and do not justify operation in excess of absolute maximum ratings.
$\left.\$\right|_{s_{f}} P$ is equal to the insertion power gain of the transistor alone.
NOTES: 1. These parameters were measured using pulse techniques. $t_{w}=\mathbf{3 0 0} \mu \mathrm{s}$, duty cycle $\leqslant 2 \%$.
2. Capacitance, $r_{b} C_{c}$, and $s$-parameter measurements were made using chips mounted in TIS126 packages.
3. $\mathrm{C}_{c t}$ and $\mathrm{C}_{e b}$ measurements employ a three-terminal capacitance bridge incorporating a guard circuit. The third electrode (emitter or collector, respectively) is connected to the guard terminal of the bridge.

# CHIP TYPE N29 <br> N-P-N SILICON TRANSISTORS 

TYPICAL CHARACTERISTICS


NOTES: 1. These parsmaters ware masaured using pulse techniquee. $t_{w}=300 \mu 8$, duty cycle $<\mathbf{2 \%}$.
2. Capacitance, $\mathrm{r}_{\mathrm{b}} \mathrm{C}_{\mathrm{c}}$, and e-paremoter measuremants wore made using chips mounted in TIS128 packages.

## CHIP TYPE N29

## N-P-N SILICON TRANSISTORS

TYPICAL CHARACTERISTICS
COMMON-EMITTER INPUT REFLECTION COEFFICIENT, sie

## and

NORMALIZED INPUT IMPEDANCE
$\mathrm{V}_{\mathrm{CE}}=10 \mathrm{~V}, \mathrm{z}_{\mathrm{G}}=\mathrm{z}_{\mathrm{L}}=50 \mathrm{~s} 2+\mathrm{jo}, \mathrm{T}_{\mathrm{A}}=\mathbf{2 5} 5^{\circ} \mathrm{C}$


| Frequency | $1 \mathrm{C}=4 \mathrm{~mA}$ |  | $\mathrm{IC}_{\mathrm{C}}=8 \mathrm{~mA}$ |  | $\mathrm{I}_{\mathrm{C}}=15 \mathrm{~mA}$ |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | \| ${ }_{\text {ie }} \mid$ | $\phi_{\text {sie }}$ | $\beta_{i j}$ I | $\phi_{\text {sie }}$ | \| ${ }_{\text {ie }} \mid$ | $\phi_{\text {sie }}$ |
| 100 MHz | 0.50 | $-107^{\circ}$ | 0.37 | $-121^{\circ}$ | 0.41 | -131 ${ }^{\circ}$ |
| 200 MHz | 0.45 | $-129^{\circ}$ | 0.41 | $-145^{\circ}$ | 0.44 | $-155^{\circ}$ |
| 300 MHz | 0.45 | $-153^{\circ}$ | 0.46 | $-169^{\circ}$ | 0.50 | $-176^{\circ}$ |
| 400 MHz | 0.46 | $-165^{\circ}$ | 0.49 | $175^{\circ}$ | 0.54 | $171^{\circ}$ |
| 500 MHz | 0.48 | $-178^{\circ}$ | 0.53 | $165^{\circ}$ | 0.58 | $158^{\circ}$ |
| 600 MHz | 0.52 | $162^{\circ}$ | 0.56 | $155^{\circ}$ | 0.61 | $149^{\circ}$ |
| 700 MHz | 0.56 | $150^{\circ}$ | 0.60 | $144^{\circ}$ | 0.64 | $140^{\circ}$ |
| 800 MHz | 0.61 | $139^{\circ}$ | 0.65 | $134^{\circ}$ | 0.68 | $130^{\circ}$ |

These measurements were made using chips mounted in TIS126 packages.

FIGURE 10

# CHIP TYPE N29 N-P-N SILICON TRANSISTORS 

## TYPICAL CHARACTERISTICS

COMMON-EMITTER OUTPUT REFLECTION COEFFICIENT, soe
and
NORMALIZED OUTPUT IMPEDANCE
$V_{C E}=10 \mathrm{~V}, \mathbf{Z}_{\mathbf{G}}=\mathbf{Z}_{\mathrm{L}}=50 \Omega 2+j 0, \mathrm{~T}_{\mathbf{A}}=\mathbf{2 5} \mathbf{C}$


| Frequency | $I_{C}=4 \mathrm{~mA}$ |  | $I C^{\prime}=8 \mathrm{~mA}$ |  | $\mathrm{IC}^{\prime}=15 \mathrm{~mA}$ |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | $\mathbf{k}_{\mathbf{0 e}} 1$ | $\phi_{\text {Soe }}$ | Poel | $\phi_{\text {soe }}$ | Fool | $\phi_{\text {Soe }}$ |
| 100 MHz | 0.96 | $-2^{6}$ | 0.95 | $-2^{\circ}$ | 0.93 | $-2^{\circ}$ |
| 200 MHz | 0.95 | $-6^{\circ}$ | 0.95 | $-6^{\circ}$ | 0.93 | $-5^{\circ}$ |
| 300 MHz | 0.94 | $-9^{\circ}$ | 0.94 | $-9^{\circ}$ | 0.92 | -9 ${ }^{\circ}$ |
| 400 MHz | 0.93 | $-12^{\circ}$ | 0.93 | $-12^{\circ}$ | 0.92 | $-12^{\circ}$ |
| 500 MHz | 0.92 | -17 | 0.92 | $-17{ }^{\circ}$ | 0.92 | $-17^{\circ}$ |
| 600 MHz | 0.91 | $-21^{\circ}$ | 0.91 | $-21^{\circ}$ | 0.91 | $-21^{\circ}$ |
| 700 MHz | 0.90 | $-27^{\circ}$ | 0.90 | $-27^{\circ}$ | 0.90 | $-27^{\circ}$ |
| 800 MHz | 0.88 | $-32^{\circ}$ | 0.88 | $-32^{\circ}$ | 0.88 | $-32^{\circ}$ |

These measurements ware made using chips mounted in TIS126 packages.

## CHIP TYPE N30 <br> N-P-N SILICON TRANSISTORS

- N30 is a $10 \times 12$-mil, epitaxial, planar, expanded-contact chip
- Available in Silect ${ }^{\dagger}$ packages
- For use in VHF/UHF common-base oscillator and amplifier circuits

electrical charactsristics at $25^{\circ} \mathrm{C}$ free-air temperature

| PARAMETER |  | CONDITIONS |  |  | OBSERVED VALUES |  |  | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | LOW | TYP | HIGH |  |
| V(BR)CBO Colfector-Base Breakdown Voltage |  |  |  |  | $I_{C}=100 \mu A$, | ${ }^{\prime}=0$ |  | $40^{\circ}$ | 55 |  | V |
| $\mathrm{V}_{\text {(BR)CEO }} \begin{aligned} & \text { Collector-Emitter } \\ & \text { Breakdown Voltage } \end{aligned}$ |  | $I^{\prime} \mathrm{C}=1 \mathrm{~mA}$, | $\mathrm{I}_{\mathrm{B}}=0$. | See Note 1 | 25* | 40 |  | V |
| $V_{\text {(RR)EBO }}$ | Emitter-Base Breakdown Voltage | $\mathrm{I}_{\mathrm{E}}=10 \mu \mathrm{~A}$, | $\mathrm{I}^{1} \mathrm{C}=0$ |  | 4* | 5.5 |  | V |
| ICBO | Collector Cutoff Current | $\mathrm{V}_{C B}=25 \mathrm{~V}$, | $\mathrm{IE}_{\mathrm{E}}=0$ |  |  | $<0.1$ | 100 | nA |
| hFE | Static Forward Current <br> Transfer Ratio | $V_{C E}=10 \mathrm{~V}$, | $l_{C}=4 \mathrm{~mA}$ | See Note 1 | 60 | 150 |  |  |
|  |  | $V_{C E}=10 \mathrm{~V}$, | $I_{C}=10 \mathrm{~mA}$ |  |  | 155 |  |  |
| $\mathrm{V}_{\text {BE }}$ | Base-Emitter Voltage | $V_{C E}=10 \mathrm{~V}$, | $1 \mathrm{C}=4 \mathrm{~mA}$, | See Note 1 |  | 0.75 | 0.9 | V |
| $V_{\text {CE (sat) }}$ | Collector-Emitter <br> Saturation Voltage | $\mathrm{I}_{\mathrm{B}}=1 \mathrm{~mA}$, | $\mathrm{I}_{\mathrm{C}}=10 \mathrm{~mA}$, | See Note 1 |  | 0.1 | 0.5 | V |
| ${ }^{4}$ | Transition Frequency | $V_{C E}=10 \mathrm{~V}$ | $\mathrm{IC}^{\prime}=4 \mathrm{~mA}$, | $f=100 \mathrm{MHz}$ | 0.8 |  |  | GHz |
|  |  | $V_{C E}=10 \mathrm{~V}$, | $I_{C}=10 \mathrm{~mA}$, | $f=400 \mathrm{MHz}$ | 1.8 |  |  |  |
| $\beta_{f f}{ }^{2}$ | Square of Common-Emitter <br> Forward Transmission Coefficient $\ddagger$ | $V_{C E}=10 \mathrm{~V}$ <br> See Note 2 | $I^{\prime} \mathrm{C}=4 \mathrm{~mA}$, | $f=400 \mathrm{MHz}$, |  | 10 |  | dB |
| $\mathrm{C}_{\mathrm{cb}}$ | Collector-Base Capacitance | $V_{C B}=10 \mathrm{~V}$. | $\mathrm{I}_{\mathrm{E}}=0$ | $\mathrm{f}=1 \mathrm{MHz}$, |  | 0.6 | 0.9 | pF |
| $\mathrm{C}_{\text {ce }}$ | Collector-Emitter Capacitance | $V_{C E}=10 \mathrm{~V}$. | $\mathrm{I}_{\mathrm{B}}=0$ | See Notes 2 and 3 |  | 0.3 | 0.4 | pF |
| $r_{b}{ }^{\prime} C_{c}$ | Collector-Base Time Constant | $V_{C B}=10 \mathrm{~V},$ <br> See Note 2 | $I_{E}=-10 \mathrm{~mA}$, | $\mathrm{f}=79.8 \mathrm{MHz}$, |  | 6 | 9 | ps |

[^155]
## CHIP TYPE N3O N-P-N SILICON TRANSISTORS

TYPICAL CHARACTERISTICS


NOTE 1: This parameter was measured using pulse techniques. $t_{w}=300 \mu s$, duty cycle $\leqslant \mathbf{2 \%}$.

## N-P-N SILICON TRANSISTORS

TYPICAL CHARACTERISTICS


figure 7


Figure 6


NOTES: 2. Capacitance, $r_{b}{ }^{\prime} C_{c}$, and s-parameter measurements were made using chips mounted in Silect packages.
3. $\mathrm{C}_{\mathbf{c b}}$ and $\mathrm{C}_{\text {ce }}$ measurements employ a three-terminal capacitance bridge incorporating a guard circuit. The third electrode (emitter or base, respectively) is connected to the guard terminal of the bridge.

# CHIP TYPE N30 N-P-N SILICON TRANSISTORS 

## TYPICAL CHARACTERISTICS

COMMON-EMITTER INPUT REFLECTION COEFFICIENT, $s_{i e}$
and
NORMALIZED INPUT IMPEDANCE

$$
V_{C E}=10 \mathrm{~V}, Z_{G}=Z_{L}=50 \Omega+j 0, T_{A}=25^{\circ} \mathrm{C}
$$



| Frequency | $\mathrm{t}^{\prime}=1 \mathrm{~mA}$ |  | $I_{C}=4 \mathrm{~mA}$ |  | $\mathrm{IC}^{\prime}=8 \mathrm{~mA}$ |  | $I_{C}=12 \mathrm{~mA}$ |  | $I^{\prime}=20 \mathrm{~mA}$ |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | $\left\|\beta_{i e}\right\|$ | $\phi_{\text {sia }}$ | \| ${ }_{\text {iel }}$ \| | $\phi_{\text {sie }}$ | \| ${ }_{\text {ie }}$ \| | $\phi_{\text {sie }}$ | Fiel | $\phi_{\text {sie }}$ | Piol | $\phi_{\text {sie }}$ |
| 300 MHz | 0.60 | $-46^{\circ}$ | 0.35 | $-55^{\circ}$ | 0.25 | $-64^{\circ}$ | 0.20 | $-73^{\circ}$ | 0.16 | $-139^{\circ}$ |
| 500 MHz | 0.43 | $-60^{\circ}$ | 0.24 | $-66^{\circ}$ | 0.15 | $-82^{\circ}$ | 0.12 | $-107^{\circ}$ | 0.18 | $180^{\circ}$ |
| 700 MHz | 0.33 | $-71^{\circ}$ | 0.15 | $-84^{\circ}$ | 0.09 | -119 ${ }^{\circ}$ | 0.09 | $-166^{\circ}$ | 0.23 | $148^{\circ}$ |
| 900 MHz | 0.23 | $-89^{\circ}$ | 0.08 | $-122^{\circ}$ | 0.08 | $171^{\circ}$ | 0.13 | $145^{\circ}$ | 0.30 | $127^{\circ}$ |
| 1100 MHz | 0.15 | $-118^{\circ}$ | 0.09 | $164{ }^{\circ}$ | 0.15 | $132^{\circ}$ | 0.20 | $122^{\circ}$ | 0.36 | $113^{\circ}$ |
| 1300 MHz | 0.12 | $-168^{\circ}$ | 0.16 | $126^{\circ}$ | 0.23 | $115^{\circ}$ | 0.28 | $107^{\circ}$ | 0.44 | $100^{\circ}$ |
| 1500 MHz | 0.17 | $144^{\circ}$ | 0.24 | $110^{\circ}$ | 0.31 | $103^{\circ}$ | 0.35 | $98^{\circ}$ | 0.49 | $92^{\circ}$ |
| 1700 MHz | 0.25 | $122^{\circ}$ | 0.33 | $100^{\circ}$ | 0.38 | $96^{\circ}$ | 0.43 | $91^{\circ}$ | 0.56 | $85^{\circ}$ |
| 1900 MHz | 0.35 | $109{ }^{\circ}$ | 0.41 | $93{ }^{\circ}$ | 0.46 | $89^{\circ}$ | 0.50 | $85^{\circ}$ | 0.61 | $79^{\circ}$ |

These measurements were made using chips mounted in Silect packages.
FIGURE 9

## CHIP TYPE N30 <br> N-P-N SILICON TRANSISTORS

TYPICAL CHARACTERISTICS
COMMON-EMITTER OUTPUT REFLECTION COEFFICIENT, soe
and
NORMALIRED OUTPUT IMPEDANCE
$V_{C E}=10 \mathrm{~V}, \mathrm{Z}_{\mathrm{G}}=\mathrm{Z}_{\mathrm{L}}=50 \Omega 2+j 0, \mathrm{~T}_{\mathrm{A}}=25^{\circ} \mathrm{C}$


| Frequency | $\mathrm{I}^{\prime} \mathrm{C}=1 \mathrm{~mA}$ |  | $1 \mathrm{C}=4 \mathrm{~mA}$ |  | $1 \mathrm{C}=8 \mathrm{~mA}$ |  | $\mathrm{IC}_{\mathrm{C}}=12 \mathrm{~mA}$ |  | ${ }^{1} \mathrm{C}=20 \mathrm{~mA}$ |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | Fo8 | $\phi_{80}$ | Poul | $\phi_{500}$ | W00 1 | $\phi_{300}$ | Pod | $\phi_{\text {goe }}$ | Fod | $\phi_{\text {cobe }}$ |
| 100 MHz | 0.94 | $-7^{\circ}$ | 0.83 | $-6^{\circ}$ | 0.83 | $-5^{\circ}$ | 0.82 | $-5^{\circ}$ | 0.84 | $-7^{\circ}$ |
| 300 MHz | 0.86 | $-12^{\circ}$ | 0.79 | $-10^{\circ}$ | 0.79 | $-9^{\circ}$ | 0.79 | $-9^{\circ}$ | 0.80 | $-10^{\circ}$ |
| 500 MHz | 0.82 | $-16^{\circ}$ | 0.75 | $-13^{\circ}$ | 0.74 | $-13^{\circ}$ | 0.74 | $-13^{\circ}$ | 0.77 | $-13^{\circ}$ |
| 700 MHz | 0.79 | $-20^{\circ}$ | 0.71 | $-18^{\circ}$ | 0.70 | $-17^{\circ}$ | 0.69 | $-17^{\circ}$ | 0.72 | $-18^{\circ}$ |
| 900 MHz | 0.76 | $-24^{\circ}$ | 0.68 | $-22^{\circ}$ | 0.67 | $-21^{\circ}$ | 0.67 | $-21^{\circ}$ | 0.70 | $-22^{\circ}$ |
| 1100 MHz | 0.73 | -29 ${ }^{\circ}$ | 0.66 | $-26^{\circ}$ | 0.65 | $-25^{\circ}$ | 0.65 | $-25^{\circ}$ | 0.67 | $-27^{\circ}$ |
| 1300 MHz | 0.71 | $-34^{\circ}$ | 0.64 | $-31^{\circ}$ | 0.63 | $-29^{\circ}$ | 0.63 | $-30^{\circ}$ | 0.65 | $-32^{\circ}$ |
| 1500 MHz | 0.70 | $-39^{\circ}$ | 0.62 | $-36^{\circ}$ | 0.61 | $-35^{\circ}$ | 0.61 | $-35^{\circ}$ | 0.63 | $-39^{\circ}$ |
| 1700 MHz | 0.68 | $-45^{\circ}$ | 0.61 | $-42^{\circ}$ | 0.59 | $-41^{\circ}$ | 0.59 | $-41^{\circ}$ | 0.62 | $-47^{\circ}$ |
| 1900 MHz | 0.68 | $-52^{\circ}$ | 0.60 | $-49^{\circ}$ | 0.59 | $-48^{\circ}$ | 0.59 | $-48^{\circ}$ | 0.62 | $-55^{\circ}$ |

These measuramente were made uing chips mounted in Silect packegas.

## CHIP TYPE N31 <br> N-P-N SILICON TRANSISTORS

- N31 is a $\mathbf{2 6} \times \mathbf{2 6 - m i l}$, epitaxial, planar, direct-contact chip
- Available in TO-39 and Silect ${ }^{\dagger}$ packages
- For use in high-voltage amplifier circuits

electrical characteristics at $25^{\circ} \mathrm{C}$ free-air temperature

| PARAMETER | CONDITIONS |  |  | OBSERVED VALUES |  |  | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  | $\frac{\text { LOW }}{250^{*}}$ | TYP | HiGH |  |
| $V_{\text {(BR) }}$ CBO Collector-Base Breakdown Voltage | $I_{C}=100 \mu A$, | $\mathrm{IE}_{\mathrm{E}}=0$ |  |  | 350 |  | V |
| $V_{\text {(BR)CEO }}$Collector-Emitter <br> Breakdown Voltage | $I^{\prime}=10 \mathrm{~mA}$, | $I_{B}=0$, | See Note 1 | 250* | 350 |  | V |
| V(BR)EBO Emitter-Base Breakdown Voltage | $I_{E}=100 \mu A$, | $1 \mathrm{C}=0$ |  | $6{ }^{\circ}$ | 9.5 |  | V |
| ICBO $\quad$ Collector Cutoff Current | $V_{C B}=100 \mathrm{~V}$. | $I_{E}=0$ |  |  | <0.1 | 50 | nA |
| CBO | $V_{C E}=10 \mathrm{~V}$, | $\mathrm{I}_{\mathrm{C}} \mathrm{C}=4 \mathrm{~mA}$ |  | 20 | 165 |  |  |
| hFE Static Forward Current | $V_{C E}=10 \mathrm{~V}$, | $\mathrm{I}^{\prime} \mathrm{C}=20 \mathrm{~mA}$ | See Note 1 | 30 | 185 | 300 |  |
| Fe Transfer Ratio | $V_{C E}=10 \mathrm{~V}$. | $I^{\prime} \mathrm{C}=40 \mathrm{~mA}$ | See Note 1 | 30 | 150 | 200 |  |
| VBE Base-Emitter Voltage | $V_{C E}=10 \mathrm{~V}$, | $1 \mathrm{C}=20 \mathrm{~mA}$, | See Note 1 |  | 0.7 | 1 | V |
| VCE(sat) Collector-Emitter <br> Saturation Voltage | $\mathrm{I}_{\mathrm{B}}=2 \mathrm{~mA}$, | $I^{\prime}=20 \mathrm{~mA}$, | See Note 1 |  | 0.11 | 1 | V |
| TT Transition Frequency | $V_{C E}=20 \mathrm{~V}$, | $1 \mathrm{C}=20 \mathrm{~mA}$, | $f=20 \mathrm{MHz}$ | 70 | 125 |  | MHz |
| $\mathrm{C}_{\mathrm{cb}}$ Collector-Base Capacitance | $V_{C B}=10 \mathrm{~V}$, | $\mathrm{IE}_{\mathrm{E}}=0$ | $f=1 \mathrm{MHz}$, |  | 2.5 | 3.5 | pF |
| $\mathrm{C}_{\text {eb }}$ Emitter-Base Capacitance | $V_{\text {EB }}=0.5 \mathrm{~V}$, | $I_{C}=0$ | See Notes 2 and 3 |  | 25 |  | pF |

[^156]
## CHIP TYPE N31 <br> N-P-N SILICON TRANSISTORS

## TYPICAL CHARACTERISTICS



FIGURE 1
hfe vs Ic

figure 2

Vbevs ic


FIGURE 3


FIGURE 4
$\mathbf{C b b}_{\text {cb }}$ vs $\mathbf{V B}$


FIGURE 6


FIGURE 5


FIGURE 7

NOTES: 1. This parameter was measured using pulse techniques. $t_{w}=300 \mu s$, duty cycle $\leqslant 2 \%$.
2. Cepacitance measurements were made using chips mounted in TO-39 packages.
3. $\mathbf{C}_{\mathbf{c b}}$ and $\mathrm{C}_{e b}$ measurements employ a three-terminal capacitance bridge incorporating a guard circuit. The third electrode (emitter or collector, respectively) is connected to the guard terminal of the bridge.

## CHIP TYPE P11 <br> P-N-P SILICON TRANSISTORS

- P11 is a $13 \times 21-$ mil, epitaxial, planar, expanded-contact chip
- Available in TO-18 packages
- For use in high-speed, medium-current switching circuits

electrical and operating characteristics at $25^{\circ} \mathrm{C}$ free-air temperature


[^157]PARAMETER MEASUREMENT INFORMATION


TEST CIRCUIT

(See Notes a and b) VOLTAGE WAVEFORNS

NOTES: a. The input waveforms are supplied by a generator with the following characteristics: $\mathbf{Z}_{\text {out }}=\mathbf{5 0} \Omega, \mathrm{t}_{\mathbf{w}} \approx \mathbf{2 0 0} \mathrm{ns}, \mathrm{duty} \mathbf{c y c l e} \leqslant \mathbf{2 \%}$.
b. Waveforms are monitored on an oscilloscope with the following characteristics: $\mathrm{t}_{\mathrm{r}} \approx 1 \mathrm{~ns}, \mathrm{R}_{\text {in }} \geqslant 100 \mathrm{k} \Omega, \mathrm{C}_{\text {in }} \leqslant 7 \mathrm{pF}$.

FIGURE 1-SWITCHING TIMES

## TYPICAL CHARACTERISTICS



FIGURE 2


FIGURE 5


FIGURE 3


FIGURE 6


FIGURE 4


FIGURE 7

NOTE 1: These parameters were measured using pulse techniques. $t_{w}=\mathbf{3 0 0} \mu_{s}$, duty cycle $<\mathbf{2 \%}$.

## CHIP TYPE P11 P-N-P SILICON TRANSISTORS

## TYPICAL CHARACTERISTICS



FIGURE 8


FIGURE 11


FIGURE 14


FIGURE 10


FIGURE 13


FIGURE 16

NOTES: 2. Capacitance measurements were made using chipt mounted In TO-18 packages.
3. $C_{c b}$ measurement employs a three-terminal capacitance bridge incorporating a guard circuit. The emitter is connected to the guard terminal of the bridge. Cobo measurement is made with the third terminal floating.

## P-N-P SILICON TRANSISTORS

- P12 is a $26 \times 26$-mil, epitaxial, planar, direct-contact chip
- Available in TO-39 or plastic dual-in-line quad packages
- For use as a high-speed, high-current memory-core driver or other medium-current (to 1.5 A ) switching circuits

electrical and operating characteristics at $\mathbf{2 5}{ }^{\circ} \mathrm{C}$ free-air temperature

| PARAMETER |  | CONDITIONS |  |  | OBSERVED VALUES |  | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | LOW | TYP HIGH |  |
| $V_{\text {(BR) }}$ CBO | Collector-Base Breakdown Voltage |  |  |  | $I^{\prime}=-10 \mu A$, | $\mathrm{I}_{\mathrm{E}}=0$ |  | $-40^{*}$ | -70 | V |
| $V_{\text {(BR) }}$ CEO | Collector-Emitter Breakdown Voltage | $I_{C}=-10 \mathrm{~mA}$, | $\mathrm{I}_{8}=0$, | See Note 1 | -40* | -50 | V |
| $V_{\text {(BR)EBO }}$ | Emitter-Base Breakdown Voltage | $\mathrm{I}_{\mathrm{E}}=-10 \mu \mathrm{~A}$, | $\mathrm{I}^{\prime} \mathrm{C}=0$ |  | -5* | 8 | $V$ |
| ICBO | Collector Cutoff Current | $V_{C B}=-20 \mathrm{~V}$, | $\mathrm{I}_{E}=0$ |  |  | $\begin{array}{\|cc\|}-10 & -100\end{array}$ | nA |
| IEBO | Emitter Cutaff Current | $V_{E B}=-4 V_{1}$ | $I_{C}=0$ |  |  | -<10 -50 | nA |
| hFE | Static Forward Current Transfer Ratio | $\mathrm{V}_{C E}=-1 \mathrm{~V}_{\text {, }}$ | $1 C^{=}-150 \mathrm{~mA}$ | See Note 1 | 25 | 70 |  |
|  |  | $V_{C E}=-1 \mathrm{~V}$, | $I_{C}=-500 \mathrm{~mA}$ |  |  | $40 \quad 150$ |  |
|  |  | $\mathrm{V}_{\text {CE }}=-5 \mathrm{~V}$, | $1_{C}=-750 \mathrm{~mA}$ |  | 20 | 50 |  |
|  |  | $V_{C E}=-5 \mathrm{~V}$, | $1 \mathrm{C}=-1 \mathrm{~A}$ |  | 15 | 40 |  |
| $V_{B E}$ | Base-Emitter Voltage | $\mathrm{I}_{\mathrm{B}}=-15 \mathrm{~mA}$, | $I_{C}=-150 \mathrm{~mA}$ | See Note 1 |  | -0.80 -1.1 | V |
|  |  | $\mathrm{I}_{\mathrm{B}}=-50 \mathrm{~mA}$, | $I_{C}=-500 \mathrm{~mA}$ |  |  | -0.88-1.5 |  |
|  |  | $\mathrm{I}_{\mathrm{B}}=-100 \mathrm{~mA}$, | $\mathrm{I}_{\mathrm{C}}=-1 \mathrm{~A}$ |  |  | -1.15 -2.0 |  |
| $V_{C E}($ sat) | Collector-Emitter <br> Saturation Voltage | $\mathrm{I}_{\mathrm{B}}=-15 \mathrm{~mA}$, | ${ }^{1} \mathrm{C}=-150 \mathrm{~mA}$ | See Note 1 |  | -0.18-0.35 | $v$ |
|  |  | $\mathrm{I}_{8}=-50 \mathrm{~mA}$, | $\mathrm{I}^{\prime}=-500 \mathrm{~mA}$ |  |  | -0.35 -0.6 |  |
|  |  | $\mathrm{I}_{\mathrm{B}}=-100 \mathrm{~mA}$, | $1 \mathrm{C}=-1 \mathrm{~A}$ |  |  | -0.65 -1.2 |  |
| ${ }^{\dagger} \mathbf{T}$ | Transition Frequency | $\mathrm{V}_{C E}=-10 \mathrm{~V}$, | $1 \mathrm{C}=-50 \mathrm{~mA}$, | $\mathrm{f}=100 \mathrm{MHz}$ | 150 | 350 | MHz |
| $\mathrm{C}_{\text {obo }}$ | Common-Base Open-Circuit Output Capacitance | $\mathrm{V}_{\mathrm{CB}}=-10 \mathrm{~V}$, | $I_{E}=0$ | $f=1 M H z,$ <br> See Notes 2 and 3 |  | $12 \quad 25$ | pF |
| $\mathrm{C}_{\text {ibo }}$ | Common-Base Open-Circuit Input Capacitance | $V_{E B}=-0.5 \mathrm{~V}$, | $1 \mathrm{C}=0$ |  |  | $55 \quad 100$ | pF |
| $\mathrm{C}_{\mathrm{cb}}$ | Collector-Base Capacitance | $\mathrm{V}_{\text {CB }}=-10 \mathrm{~V}$, | $\mathrm{IE}_{\mathrm{E}}=0$ |  |  | 11 | pF |
| $\mathrm{C}_{\mathrm{eb}}$ | Emitter-Base Capacitance | $V_{E B}=-0.5 \mathrm{~V}$, | $\mathrm{I}_{\mathrm{C}}=0$ |  |  | 50 | pF |
| $t_{d}$ | Delay Time | $V_{C C}=-30 \mathrm{~V}$, $I_{C} \approx-500 \mathrm{~mA}$, <br> $\mathrm{I}_{\mathrm{B}(1)} \approx-50 \mathrm{~mA}$, $\mathrm{V}_{\mathrm{BE}(\mathrm{off})} \approx 2 \mathrm{~V}$ |  | 2N3244 <br> Data <br> Sheet <br> Circuit |  | 5 | ns |
| $\mathrm{t}_{\mathrm{r}}$ | Rise Time |  |  |  | 13 |  |
| $\mathrm{t}_{\text {s }}$ | Storage Time | $\begin{aligned} & \mathrm{V}_{\mathrm{CC}}=-30 \mathrm{~V}, \\ & \mathrm{t}_{\mathrm{B}(1)} \approx-50 \mathrm{~mA} . \end{aligned}$ | $\begin{aligned} & I_{C} \approx-500 \mathrm{~mA}, \\ & I_{B}(2) \approx 50 \mathrm{~mA} \end{aligned}$ |  |  | 40 |  |
| $\mathrm{t}_{\mathrm{f}}$ | Fall Time |  |  |  |  | 13 |  |
| $\mathrm{t}_{\mathrm{d}}$ | Delay Time | $\begin{aligned} & V_{C C}=-30 \mathrm{~V} \\ & '_{B(2)} \approx 50 \mathrm{~mA} \end{aligned}$ | $\begin{aligned} & \mathrm{I}_{\mathrm{C}} \approx-500 \mathrm{~mA} \\ & \mathrm{~V}_{\mathrm{BE}}(\mathrm{off}) \approx 4.1 \mathrm{~V} \end{aligned}$ |  | $\mathrm{I}_{\mathrm{B}}(1) \approx-50 \mathrm{~mA},$ <br> See Figure 1 |  | 7 | ns |
| $\mathrm{t}_{\mathrm{r}}$ | Rise Time |  |  |  |  | 13 |  |  |
| $\mathrm{t}_{\text {s }}$ | Storage Time |  |  |  |  | 40 |  |  |
| $\mathrm{t}_{\mathrm{f}}$ | Fall Time |  |  |  |  | 13 |  |  |

- These values do not modify guaranteed limits for specific devices and do not justify operation in excess af absolute maximum ratings.

NOTES: 1. These parameters were measured using pulse techniques. $\mathbf{t}_{\mathbf{w}}=\mathbf{3 0 0} \mu \mathrm{s}$, duty cycle $\leq \mathbf{2 \%}$.
2. Capacitance measurements were made using chips mounted in TO-39 packages.
3. $\mathrm{C}_{\mathrm{cb}}$ and $\mathrm{C}_{e \mathrm{~b}}$ measurements employ a three-terminal capacitance bridge incorporating a guard circuit. The third electrode (emitter or collector, respectively) is connected to the guard terminal of the bridge. $\mathrm{C}_{\mathrm{ob}}$ o and $\mathrm{C}_{\mathrm{ibo}}$ measurements are made with the third terminal floating.

## CHIP TYPE P12 P-N-P SILICON TRANSISTORS

## PARAMETER MEASUREMENT INFORMATION



TEST CIRCUIT

(See Notes a and b) VOLTAGE WAVEFORMS

NOTES: a. The input waveforms are supplied by a generator with the following characteristics: $Z_{\text {out }}=50 \Omega$; measuring $t_{d}$ and $t_{r}$, $t_{w} \approx 200 \mathrm{~ns}$, duty cycle $\leqslant 2 \%$; for measuring $t_{s}$ and $t_{f}, t_{w} \approx 10 \mu$ s, duty cycle $\leqslant 2 \%$.
b. Waveforms are monitored on an oscilloscope with the following characteristics: $\mathrm{t}_{\mathrm{r}} \leqslant 1 \mathrm{~ns}, \mathrm{R}_{\text {in }} \leqslant 100 \mathrm{k} \Omega, \mathrm{C}_{\mathrm{in}} \leqslant 7 \mathrm{pF}$.

FIGURE 1-SWITCHING TIMES

## TYPICAL CHARACTERISTICS


$V_{B E}$ vs $I_{C}$


FIGURE 5

VCE(sat) vs lC


FIGURE 6

NOTE 1: These parameters were measured using pulse techniques. $\mathbf{t}_{\mathbf{w}}=300 \mu \mathrm{~s}$, duty cycle $\leqslant 2 \%$.

TYPICAL CHARACTERISTICS


Figure 7
$t_{d}, t_{r}$ vs $\mathbf{T}_{\mathbf{A}}$

figure 10


FIGURE 13
$C_{\text {oboo }}, C_{c b}$ vs $V_{C B}$


Figure 8



FIGURE 11


FIGURE 14
$c_{\text {ibor }} \mathrm{C}_{\text {eb }}$ vs $\mathrm{V}_{\mathrm{EB}}$


FIGURE 9


FIGURE 12


FIGURE 15

NOTES: 2. Capacitance measuraments were made uting chips mounted in TO-39 packages.
3. $\mathrm{C}_{\mathrm{cb}}$ and $\mathrm{C}_{\text {eb }}$ measuremants emplov a three-terminal capacitance bridge Incorporating a guard circuit. The third electrode (emitter or collector, respectively) is connected to the guard terminal of the bridge. $\mathrm{C}_{\text {obo }}$ abd $\mathrm{C}_{\text {lbo }}$ measuremente are made with the third terminal floating.

## CHIP TYPE P13 <br> P-N-P SILICON TRANSISTORS

- P13 is a $21 \times 21$-mil, epitaxial, planar, direct-contact, double-emitter chip
- Available in TO-72 packages
- For use in low-level, high-speed chopper circuits requiring the very low offset voltage of double-emitter transistors

electrical characteristics at $\mathbf{2 5}{ }^{\circ} \mathrm{C}$ free-air temperature

| PARAMETER |  | CONDITIONS |  | OBSERVED VALUES |  |  | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | LOW | TYP | HIGH |  |
| $V_{\text {(BR) }}$ CBO | Collector-Base Breakdown Voltage |  |  | $I_{C}=-1 \mu A$, | $I_{E 1}=I_{E 2}=0$ | $-70^{*}$ | -90 |  | $V$ |
| $V_{\text {(BR) }}{ }^{\text {(BRCO }}$ | Emitter-Collector Breakdown Voltage | $\mathrm{I}_{E}=-1 \mu A$, | $\mathrm{I}_{\mathrm{B}}=0, \quad$ See Note 1 | $-35^{\circ}$ | -50 |  | V |
| $V_{\text {(BR)E1E2 }}$ | Emitter-Emitter Breakdown Voltage | $\mathrm{I}_{\mathrm{E} 1}= \pm 1 \mu \mathrm{~A}$, | $V_{C B}=0, \quad$ See Note 2 | $\pm 40^{\circ}$ | $\pm 60$ |  | V |
| ${ }^{\text {ICBO }}$ | Collector Cutoff Current | $\mathrm{V}_{C B}=-30 \mathrm{~V}$, | $\mathrm{IE}_{1}=\mathrm{IE2}=0$ |  | -10 | -250 | pA |
| IE1E2(off) | Emitter Cutoff Current | $V_{E 1 E 2}= \pm 25 \mathrm{~V}$, | $V_{C B}=0, \quad$ See Note 2 |  | $\pm 4$ | $\pm 100$ | pA |
| hFE | Static Forward Current Transfer Ratio | $V_{C E}=-6 \mathrm{~V}$. | $\mathrm{l}^{\mathbf{C}} \mathbf{= 1 1 \mathrm { mA }}$, See Note 1 | 50 | 150 |  |  |
| NE1E2(ofs)! | Emitter-Emitter Offset Voltage | $\mathrm{I}_{\mathrm{B}}=-1 \mathrm{~mA}$, | $\mathrm{IE}_{1}=\mathrm{IE}_{2}=0$ |  | 7 | 10 | $\mu \mathrm{V}$ |
| rele2(on) | Small-Signal Emitter-Emitter On-State Resistance | $\begin{aligned} & \mathrm{I}_{\mathrm{B}}=-1 \mathrm{~mA}, \\ & \mathrm{f}=1 \mathrm{kHz} \end{aligned}$ | $I_{E 1}=i_{E 2}=0, I_{e}=100 \mu A$, | 10 | 25 | 50 | $\Omega$ |
| ${ }^{\mathbf{T}} \mathbf{T}$ | Transition Frequency | VCE $=-6 \mathrm{~V}$. <br> See Note 1 | $I_{C}=-1 \mathrm{~mA}, \quad \mathrm{f}=4 \mathrm{MHz},$ | 12 | 24 |  | MHz |
| $\mathrm{C}_{\text {obo }}$ | Common-Base Open-Circuit Output Capacitance | $\begin{aligned} & V_{C B}=-6 V \\ & \text { See Note } 3 \end{aligned}$ | $I_{E 1}=I_{E 2}=0, f=1 \mathrm{MHz}$ |  | 8 | 10 | pF |
| $C_{\text {ibo }}$ | Common-Base Open-Circuit Input Capacitance | $V_{E B}=-6 V .$ <br> See Notes 1 and | $\mathrm{I} C=0, \quad f=1 \mathrm{MHz},$ |  | 2 | 3 | pF |

- Thege valuet do not modify guaranteed limits for specific devices and do not justify operation in excess of absolute maximum ratings.

NOTES: 1. These values apply separ ately for each emitter with the other emitter open-circuited.
2. These parameters were measured with the collector short-circuited to the base but open-circuited with respect to the emitters.

The values apply for both polarities of arnitter-to-emitter voltage.
3. Capacitance measurements were made using chips mounted in TO-72 packages.

## CHIP TYPE P13

P-N-P SILICON TRANSISTORS

TYPICAL CHARACTERISTICS


NOTES: 1. These values apply separately for each emitter with the other emitter open-circuited.
2. These parameters were measured with the collector short-circuited to the base but open-circuited with respect to the emitters. The values apply for both polarities of emitter-to-emitter voltage.
3. Capacitance measurements were made using chips mounted in TO-72 packages.
${ }^{\dagger}$ The polarity of the offset voltage at $\mathrm{T}_{A}=25^{\circ} \mathrm{C}$ and $\mathrm{I}_{B}=-1 \mathrm{~mA}$ is arbitrarily assumed to be positive.

## CHIP TYPE P14 <br> P-N-P SILICON TRANSISTORS

- P14 is a $19 \times 19$ mil, epitaxial, planar, direct-contact chip


## - Available in TO-46 and Silect ${ }^{\dagger}$ Packages

- For use in low-level, high-speed chopper circuits in inverted connection (collector and emitter terminals reversed), and may also be used as a low-level amplifier

electrical characteristics at $\mathbf{2 5}{ }^{\circ} \mathrm{C}$ free-air temperature


[^158]
## CHIP TYPE P14 <br> P-N-P SILICON TRANSISTORS



NOTE 2: These parameters were measured using pulse techniques. $t_{w}=300 \mu \mathrm{~s}$, duty cycle $\leqslant \mathbf{2 \%}$.

# CHIP TYPE P4 P-N-P SILICON TRANSISTORS 

TYPICAL CHARACTERISTICS


NOTE 2: These parameters were measured using pulse techniques, $\mathbf{t}_{w}=\mathbf{3 0 0} \mu \mathrm{s}$, duty evcle $\leqslant 2 \%$.

TYPICAL CHARACTERISTICS
$V_{E C}$ vs $I_{B}$


FIGURE 9
$\mathbf{V B C}_{\mathrm{B}}$ viE


FIGURE 11

VEC(ofs) vs 1 B

$\mathrm{I}_{\mathrm{B}}$ - Bose Current -mA
FIGURE 10
$r_{e c}$ (on) vs $I_{B}$


FIGURE 12

NOTE 2: These parameters were measured using pulse techniques. $f_{w}=300 \mu \mathrm{~s}$, duty cycle $\leqslant 2 \%$.

## TYPICAL CHARACTERISTICS



FIGURE 13


NOTE 1: Capacitance measurements were made using ehips mounted in TO-46 packages.

## CHIP TYPE P15

P-N-P SILICON TRANSISTORS

- P15 is a $19 \times 19$-mil, epitaxial, planar, direct-contact chip
- Available in Silect ${ }^{\boldsymbol{\dagger}}$ packages
- For use in general purpose, saturated switching, and amplifier circuits

electrical and operating characteristics at $\mathbf{2 5}{ }^{\circ} \mathrm{C}$ free-air temperature


[^159]
## CHIP TYPE P15 P-N-P SILICON TRANSISTORS

PARAMETER MEASUREMENT INFORMATION


TEST CIRCUIT

(See Notes a and b) VOLTAGE WAVEFORMS

NOTES: a. The input waveforms are supplied by.a generator with the following characteristics: $\mathbf{Z}_{\text {out }}=50 \Omega$; for $\mathbf{m e a s i n g} \mathbf{t}_{\mathbf{d}}$ and $\mathrm{t}_{\mathrm{r}}$ $t_{w} \approx 200 \mathrm{~ns}$, duty cycle $\leqslant 2 \%$; for measuring $t_{s}$ and $t_{f}, t_{w} \approx 10 \mu \mathrm{~s}$, duty cycle $\leqslant 2 \%$
b. Weveforms are monitored on an oscilloscope with the following characteristics: $t_{r} \approx 1 \mathrm{~ns}, R_{\text {in }} \geqslant 100 \mathrm{k} \Omega, \mathrm{C}_{\mathrm{in}} \leqslant 7 \mathrm{pF}$.

FIGURE 1-SWITCHING TIMES
TYPICAL CHARACTERISTICS


NOTE 1: These parameters were measured using pulse techniques, $\mathrm{t}_{\mathbf{w}}=300 \mu \mathrm{~s}$, duty cycle $\leqslant 2 \%$.

## CHIP TYPE P15 <br> P-N-P SILICON TRANSISTORS

## TYPICAL CHARACTERISTICS



FIGURE 8


FIGURE 9
$\mathrm{f}_{\mathbf{T}} \mathrm{vs} \mathrm{I}_{\mathrm{C}}$


FIGURE 10


FIGURE 11


FIGURE 13


Figure 12


Figure 14

NOTES: 2. Capacitance measurements were made using chips mounted in Silect packages.
3. $\mathrm{C}_{\mathrm{cb}}$ measurement employs a three-terminal capacitance bridge incorporating a guard circuit. The emitter is connected to the guard terminal of the bridge. Cobo and $C_{i b o}$ measurements are made with the third terminal floating.
4. Average Noise Figure is measured in an amplifier with response down 3 dB at 10 Hz and 10 kHz and a high-frequency roll-off of $6 \mathrm{~dB} /$ octave.


## CHIP TYPE PI6 <br> P-N-P SILICON TRANSISTORS

- P16 is a $28 \times 28$-mil, epitaxial, planar, direct-contact chip
- Available in TO-18, TO-39, and Silect ${ }^{\dagger}$ packages
- For use in general purpose amplifier and switching circuits

electrical and operating characteristics at $25^{\circ} \mathrm{C}$ free-air temperature


[^160]
## CHIP TYPE PI6 P-N-P SILICON TRANSISTORS

## PARAMETER MEASUREMENT INFORMATION


 b. Waveforms are monitored on an oscllloscope with the following charscteristics: $t_{r} \leqslant 1 \mathrm{~ns}, \mathrm{R}_{\mathrm{in}}>100 \mathrm{k} \Omega, \mathrm{C}_{\mathrm{in}} \leqslant 7 \mathrm{pF}$.

FIGURE 1-SWITCHING TIMES
TYPICAL CHARACTERISTICS


NOTE 1: These parameters were measured using pulse techniques. $\mathbf{t}_{\mathbf{w}}=\mathbf{3 0 0} \mu_{\mathrm{s}}$, duty cycle $<\mathbf{2 \%}$.

## CHIP TYPE PI6 <br> P-N-P SILICON TRANSISTORS

TYPICAL CHARACTERISTICS


FIGURE 8


FIGURE 10
fT vis

FIGURE 9


FIGURE 11

[^161]

Figure 12


IC-Collector Current-mA


FIGURE 13

figure 15

- P17 is a $\mathbf{2 0} \times \mathbf{2 0}$-mil, epitaxial, planar, direct-contact chip
- Available in TO-5, TO-18, and Silect ${ }^{\dagger}$ packages
- For use in high-voltage amplifier and low-current switching circuits

electrical and operating characteristics at $25^{\circ} \mathrm{C}$ free-air temperature

| PARAMETER |  | CONDITIONS |  |  | OBSERVED VALUES |  |  | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | LOW | TYP | HIGH |  |
| $\mathrm{V}_{\text {(BR) }}$ CBO | Collector-Base Breakdown Voltage |  |  |  | ${ }^{\prime} \mathrm{C}=-10 \mu \mathrm{~A}$, | ${ }_{\text {E }}=0$ |  | -180* | -220 |  | v |
| $\mathrm{V}_{\text {(BR)CEO }}$ | Collector-Emitter Breakdown Voltage | ${ }^{1} \mathrm{C}=-10 \mathrm{~mA}$, | $\mathrm{I}_{\mathrm{B}}=0$, | See Note 1 | -150* | -180 |  | $\checkmark$ |
| $V_{\text {(BR) }}$ EBO | Emitter-Base Breakdown Voltage | $\mathrm{I}_{\mathrm{E}}=-10 \mu \mathrm{~A}$, | $\mathrm{I}^{\prime}=0$ |  | -7* | -8 |  | $\checkmark$ |
| ICBO | Collector Cutoff Current | $V_{C B}=-50 \mathrm{~V}$, | ${ }^{1} \mathrm{E}=0$ |  |  | -<0.1 | -100 | nA |
| IEbo | Emitter Cutoff Current | $V_{E B}=-3 V_{\text {, }}$ | ${ }^{\prime} \mathrm{C}=0$ |  |  | $-<0.1$ | -25 | nA |
| $h_{\text {FE }}$ | Static Forward Current Transfer Ratio | $\mathrm{V}_{\text {CE }}=-10 \mathrm{~V}$, | ${ }^{1} \mathrm{C}=-100 \mu \mathrm{~A}$ |  | 35 | 70 | 280 |  |
|  |  | $V_{C E}=-10 \mathrm{~V}$, | ${ }^{1} \mathrm{C}=-1 \mathrm{~mA}$ | See Note 1 | 40 | 80 | 300 |  |
|  |  | $\mathrm{V}_{C E}=-10 \mathrm{~V}$, | $1 \mathrm{C}=-10 \mathrm{~mA}$ |  | 40 | 90 | 300 |  |
|  |  | $\mathrm{V}_{\mathrm{CE}}=-10 \mathrm{~V}$. | $1 \mathrm{C}=-50 \mathrm{~mA}$ |  | 40 | 70 | 300 |  |
| $\mathrm{V}_{\mathrm{BE}}$ | Base-Emitter Voltage | $\mathrm{I}_{\mathrm{B}}=-1 \mathrm{~mA}$, | $\mathrm{I}_{\mathrm{C}}=\mathbf{- 1 0} \mathrm{mA}$, | See Note 1 | -0.6 | -0.7 | -1.0 | V |
| $V_{\text {CE }}($ sat $)$ | Collector-Emitter Saturation Voltage | $\mathrm{I}_{\mathrm{B}}=-1 \mathrm{~mA}$, | $\mathrm{Ic}=\mathbf{- 1 0} \mathrm{mA}$, | See Note 1 |  | -0.1 | -0.5 | $v$ |
| $\mathrm{hie}_{\text {ie }}$ | Small-Signal Common-Emitter Input Impedance | $\mathrm{V}_{C E}=-10 \mathrm{~V}$, | $I^{\prime}=-10 \mathrm{~mA}$, | $f=1 \mathrm{kHz}$ | 0.1 | 0.34 | 1.2 | $\mathrm{k} \Omega$ |
| $\mathrm{h}_{\mathrm{fe}}$ | Small-Signal Common-Emitter Forward Current Transfer Ratio |  |  |  | 40 | 90 | 300 |  |
| $\mathrm{h}_{\text {re }}$ | Small-Signal Common-Emitter Reverse Voitage Transfer Ratio |  |  |  |  | $\begin{array}{r} 1 \times \\ 10^{-4} \end{array}$ | $\begin{array}{r} 2 \times \\ 10^{-4} \end{array}$ |  |
| $\mathrm{h}_{\text {oe }}$ | Small-Signal Common-Emitter Output Admittance |  |  |  |  | 40 | 300 | umho |
| ${ }_{\text {fT }}$ | Transition Frequency | $\mathrm{V}_{C E}=-10 \mathrm{~V}$, | $\mathrm{I}^{\text {c }}=\mathbf{- 2 0} \mathrm{mA}$, | $\mathrm{f}=100 \mathrm{MHz}$ | 150 | 220 |  | MHz |
| Cobo | Common-Base Open-Circuit Output Capacitance | $V_{C B}=-10 \mathrm{~V},$ <br> See Note 2 | $\mathrm{I}_{\mathrm{E}}=0$, | $f=1 \mathrm{MHz}$, |  | 4 |  | pF |
| Cibo | Common-Base Open-Circuit Input Capacitance | $V_{E B}=-0.5 \mathrm{~V} .$ <br> See Note 2 | IC $=0$, | $\mathrm{f}=1 \mathrm{MHz}$, |  | 22 |  | pF |
| $\mathrm{t}_{\mathrm{d}}$ | Delay Time | $\begin{aligned} & V_{C C}=-30 \mathrm{~V}, \\ & l_{\mathrm{B}(1)} \approx-1 \mathrm{~mA}, \\ & V_{C C}=-30 \mathrm{~V}, \\ & l_{B(1)} \approx-1 \mathrm{~mA}, \end{aligned}$ | $\begin{aligned} & I_{C}=-10 \mathrm{~mA} \\ & \mathrm{~V}_{\mathrm{BE}(\mathrm{off})} \approx 0 \\ & \hline I_{C} \approx-10 \mathrm{~mA} \\ & I_{B(2)} \approx 1 \mathrm{~mA} \\ & \hline \end{aligned}$ | 2N3494 <br> Data <br> Sheet <br> Circuit |  | 35 |  | ns |
| $\mathrm{t}_{\mathrm{r}}$ | Rise Time |  |  |  |  | 85 |  |  |
| $\mathrm{t}_{5}$ | Storage Time |  |  |  |  | 820 |  |  |
| $t_{f}$ | Fall Time |  |  |  |  | 120 |  |  |
| $t_{\text {d }}$ | Delay Time | $\left\{\begin{array}{l} \mathrm{V}_{\mathrm{CC}}=-30 \mathrm{~V}, \\ \mathrm{I}_{\mathrm{B}(2)} \approx 1 \mathrm{~mA}, \end{array}\right.$ | $\begin{aligned} & I_{C} \approx-10 \mathrm{~mA} \\ & \mathrm{~V}_{\mathrm{BE}(\mathrm{off})} \approx 4.1 \end{aligned}$ | $I_{B}(1) \approx-1 \mathrm{~mA} \text {, }$ <br> See Figure 1 |  | 120 |  | ns |
| $\mathrm{t}_{\mathrm{r}}$ | Rise Time |  |  |  |  | 90 |  |  |
| $\mathrm{t}_{\text {s }}$ | Storage Time |  |  |  |  | 820 |  |  |
| ${ }_{4}$ | Fall Time |  |  |  |  | 120 |  |  |

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# CHIP TYPE PT7 <br> P-N-P SILICON TRANSISTORS 

PARAMETER MEASUREMENT INFORMATION


TEST CIRCUIT
NOTES: a. The input waveforms are supplied by a generator with the following characteristics: $Z_{o u t}=50 \Omega$; for measuring $t_{0}$ and $t_{r}$, $t_{w} \approx 100 \mathrm{~ns}$, duty cycle $\leqslant 2 \%$; for measuring $t_{s}$ and $t_{f}, t_{w} \approx 10 \mu_{\mathrm{s}}$, duty cyele $\leqslant 2 \%$.
b. Waveforms are monitored on an oscilloscope with the following characteristics: $t_{r} \leqslant 1 \mathrm{~ns}, \mathrm{R}_{\mathrm{in}} \geqslant 100 \mathrm{k} \Omega, \mathrm{C}_{\mathrm{in}} \leqslant 7 \mathrm{pF}$.

FIGURE 1-SWITCHING TIMES
TYPICAL CHARACTERISTICS


FIGURE 2


FIGURE 4
hFE vs IC


FIGURE 3

VCE(sat) vs ic


FIGURE 5

NOTE 1: These perameters ware measured using puhe techniques. $t_{w}=300 \mu s$, duty cycle $<2 \%$.

## CHIP TYPE P17

P-N-P SILICON TRANSISTORS

TYPICAL CHARACTERISTICS


NOTE 2: Capacitance measurements were made using chips mounted in TO-18 packages.

# CHIP TYPE P18 <br> P-N-P SILICON TRANSISTORS 

- P18 is a $20 \times 20$-mil, epitaxial, planar, direct-contact chip
- Available in TO-18 or Silect ${ }^{\dagger}$ packages
- For use in low-current, low-noise amplifier circuits

electrical and operating characteristics at $25^{\circ} \mathrm{C}$ free-air temperature

| PARAMETER |  | CONDITIONS |  |  | OBSERVED VALUES |  |  | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | LOW | TYP | HIGH |  |
| $V_{\text {(BR) }}$ CBO | Collector-Base Breakdown Voltage |  |  |  | $1 C^{\prime}=-10 \mu A$, | $\mathrm{I}_{\mathrm{E}}=0$ |  | $-50 *-70$ |  |  | V |
| $V$ (bR)CEO | Collactor-Emitter Breakdown Voltage | $1 \mathrm{C}=-10 \mathrm{~mA}$, | $I_{B}=0$, | See Note 1 | -50* | -70 |  | V |
| $V_{\text {(BR)EBO }}$ | Emittar-Base Breakdown Voltage | $E_{E}=-10 \mu \mathrm{~A}$, | $I_{C}=0$ |  | -7* | -8 |  | V |
| l'CBO | Collector Cutoff Current | $\mathrm{V}_{\mathrm{CB}}=-30 \mathrm{~V}$, | $\mathrm{I}_{\mathrm{E}}=0$ |  | -<0.1 -100 |  |  | nA |
| IEBO | Emitter Cutoff Current | $V_{E B}=-4 \mathrm{~V}$, | $\mathrm{I}^{\prime} \mathrm{C}=0$ |  | -<0.1 -100 |  |  | nA |
| hfe | Static Forward Current Transfer Ratio | $V_{C E}=-5 \mathrm{~V}$, | $\mathrm{I}_{\mathrm{C}}=-1 \mu \mathrm{~A}$ |  | $30 \quad 160$ |  |  |  |
|  |  | $V_{C E}=-5 \mathrm{~V}$, | $\mathrm{I}^{\prime} \mathrm{C}=-10 \mu \mathrm{~A}$ |  | 40220 |  |  |  |
|  |  | $V_{C E}=-5 V$, | $I^{\prime} \mathrm{C}=-100 \mu \mathrm{~A}$ |  | 45 | 260 |  |  |
|  |  | $V_{C E}=-5 \mathrm{~V}$, | $1 \mathrm{C}=-1 \mathrm{~mA}$ |  | 50 | 280 | 600 |  |
|  |  | $V_{C E}=-5 \mathrm{~V}$, | $I^{\prime}=-10 \mathrm{~mA}$, | See Note 1 | 50 | 260 |  |  |
| $V_{\text {ge }}$ | Base-Emitter Voltage | $V_{C E}=-5 \mathrm{~V}$, | $1 \mathrm{C}=-1 \mathrm{~mA}$ |  |  | -0.6 | -1.0 | V |
| VCE(sat) | Collector-Emitter Saturation Voltage | ${ }^{\prime} \mathrm{B}=-0.5 \mathrm{~mA}$, | $I^{\prime}=-10 \mathrm{~mA}$, | See Note 1 |  | -0.08 | -0.25 | V |
| $\mathrm{hfo}_{\text {le }}$ | Small-Signal Common-Emitter Input Impedance | $V_{C E}=-5 \mathrm{~V}$, | $I^{\prime}=-1 \mathrm{~mA}$, | $f=1 \mathrm{kHz}$ | 7.5 |  |  | k $\Omega$ |
| $h_{\text {fe }}$ | Small-Signal Common-Emitter Forward Current Transfer Ratio |  |  |  | 280 |  |  |  |
| $n_{\text {re }}$ | Small-Signal Common-Emitter Reverse Voltage Transfer Ratio |  |  |  | $\begin{gathered} 1.6 \times \\ 10^{-4} \end{gathered}$ |  |  |  |
| hoe | Smali-Signal Cormmon-Emitter Output Acrnittance |  |  |  | 15 |  |  | $\mu \mathrm{mho}$ |
| ${ }^{\text {f }}$ | Transition Frequency | $V_{C E}=-5 V_{\text {, }}$ | $l_{C}=-1 \mathrm{~mA}$, | $f=20 \mathrm{MHz}$ | 200 |  |  | MHz |
| Cobo | Common-Base Open-Circuit Output Capacitance | $V_{C B}=-5 V,$ <br> See Note 2 | IE $=0$, | $\mathrm{f}=1 \mathrm{MHz}$, | 36 |  |  | pF |
| $c_{i b 0}$ | Common-Base Open-Circuit Input Capacitance | $V_{E B}=-0.5 V,$ <br> See Note 2 | Ic $=0$, | $f=1 \mathrm{MHz}$, |  | 7 | 15 | pF |
| F | Spot Noise Figure | $\begin{aligned} & V_{C E}=-5 \mathrm{~V}, \\ & f=1 \mathrm{kHz} \end{aligned}$ | $I_{C}=-100 \mu A$, | $R_{G}=10 \mathrm{k} \Omega$, |  | 1 | 3 | dB |

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## P-N-P SILICON TRANSISTORS

TYPICAL CHARACTERISTICS


VEEMIC

figure 3


FIGURE 4
$V_{C E}($ mat $)$ ve $I_{C}$


FIGURE 5

NOTE 1: These parmetere were measured using pulse techniquen. $t_{w}=\mathbf{3 0 0} \mu \mathrm{m}$, duty cycle $\leqslant \mathbf{2 \%}$.

## CHIP TYPE P18 P-N-P SILICON TRANSISTORS

## TYPICAL CHARACTERISTICS



NOTE 2. Capacitance masturements were made using chips mounted In TO-92 packages.

## P-N-P SILICON TRANSISTORS

- P19 is a $20 \times 20-\mathrm{mil}$, epitaxial, planar, direct-contact chip
- Available in TO-18, TO-46, and a short-can version of TO-78 packages
- For use in low-level, low-noise, high-gain amplifier circuits

electrical and operating characteristics at $25^{\circ} \mathrm{C}$ free-air temperature


[^164]
# CHIP TYPE P19 P-N-P SILICON TRANSISTORS 

## TYPICAL CHARACTERISTICS



[^165]

FIGURE 5
$h_{\text {re }}$ vs Ic
 Ic - Collector Current -mA

FIGURE 7


FIGURE 8

# CHIP TYPE P19 P-N-P SILICON TRANSISTORS 

TYPICAL CHARACTERISTICS


NOTES: 2. Capacitence massurements were made using chips mounted in TO-18 packages.
3. $C_{c b}$ and $C_{e b}$ mesurements employ a thresterminal cepacitance bridge incorporating aguard circuit. The third electrode (emitter or collector reepectively) is connected to the guard terminal of the bridge. Cobo and Cibo measurements are made with the third terminal floating.
4. Average Noise Figure is measured in an amplifier with response down 3 dB at 10 Hz and 10 kHz and a high-frequency roll-off of 6 de /octave.

- P20 is a $\mathbf{2 0} \times \mathbf{2 0}$-mil, epitaxial, planar, direct-contact chip
- Available in TO-5, TO-18, TO-39, TO-46, a short-can version of TO-78, plastic dual-in-line quad, and Silect ${ }^{\dagger}$ packages
- For use in general purpose amplifier and medium-current switching circuits

electrical and operating characteristics at $25^{\circ} \mathrm{C}$ free-air temperature

| PARAMETER |  | CONDITIONS |  |  | OBSERVED VALUES |  |  | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | LOW | TYP | HIGH |  |
| $V_{\text {(BR) }}$ CBO | Collector-Base Breakdown Voltage |  |  |  | $I^{\prime}=-10 \mu A, \quad I E=0$ |  |  | $-80^{*}-100$ |  |  | V |
| $V_{\text {(BR) }}$ CEO | Collector-Emitter Breakdown Voltage | $\mathrm{I}_{\mathrm{C}}=-10 \mathrm{~mA}$, | ${ }^{\prime} \mathrm{B}=0$, | See Note 1 | $-65^{*}-80$ |  |  | V |
| $\mathrm{V}_{\text {(BR)EBO }}$ | Emitter-Base Breakdown Voltage | $\mathrm{I}_{\mathrm{E}}=-10 \mu \mathrm{~A}$, | $\mathrm{C}^{\prime}=0$ |  | -6 ${ }^{4}-7.5$ |  |  | V |
| ${ }^{\text {ICBO }}$ | Collector Cutoff Current | $\mathrm{V}_{\mathrm{CB}}=-40 \mathrm{~V}$, | $\mathrm{I}_{\mathrm{E}}=0$ |  | -<0.1-100 |  |  | nA |
| IEBO | Emitter Cutoff Current | $V_{E B}=-4 \mathrm{~V}$, | $\mathrm{i}^{\prime} \mathrm{C}=0$ |  | -<0.1-100 |  |  | nA |
| hFE | Static Forward Current Transfer Ratio | $\mathrm{V}_{\text {CE }}=-10 \mathrm{~V}$, | ${ }^{1} \mathrm{C}=-1 \mathrm{~mA}$ |  | $25 \quad 180$ |  |  |  |
|  |  | $\mathrm{V}_{\text {CE }}=-10 \mathrm{~V}$. | $1 \mathrm{C}=-10 \mathrm{~mA}$ | See Note 1 | $50 \quad 190$ |  |  |  |
|  |  | $\mathrm{V}_{\text {CE }}=-10 \mathrm{~V}$, | $\mathrm{I}^{\prime} \mathrm{C}=-150 \mathrm{~mA}$ |  | 50 | 120 | 500 |  |
|  |  | $\mathrm{V}_{\text {CE }}=-10 \mathrm{~V}$, | ${ }^{1} \mathrm{C}=-500 \mathrm{~mA}$ |  | 20 | 55 |  |  |
| $V_{\text {BE }}$ | Base-Emitter Voltage | $\mathrm{I}_{\mathrm{B}}=-15 \mathrm{~mA}$, | ${ }^{\prime} \mathrm{C}=-150 \mathrm{~mA}$ | See Note 1 | $\begin{array}{ll}-0.9 & -1.0 \\ -1.0\end{array}$ |  |  | V |
|  |  | $\mathrm{I}_{\mathrm{B}}=-50 \mathrm{~mA}$, | ${ }^{\prime} \mathrm{C}=-500 \mathrm{~mA}$ |  |  |  |  |  |
| $\mathrm{V}_{\text {ce(sat }}$ | Collector-Emitter Saturation Voltage | $\mathrm{I}_{\mathrm{B}}=-15 \mathrm{~mA}$, | $\mathrm{I}^{\prime} \mathrm{C}=-150 \mathrm{~mA}$ | See Note 1 |  | $-0.25$ | -0.5 | V |
|  |  | $\mathrm{I}_{\mathrm{B}}=-50 \mathrm{~mA}$, | ${ }^{\prime} \mathrm{C}=-500 \mathrm{~mA}$ |  | $-0.65$ |  |  |  |
| $\mathbf{h i e}_{\text {i }}$ | Small-Signal Common-Emitter Input Impedance | $\mathrm{V}_{C E}=-10 \mathrm{~V}$, | $I_{C}=-10 \mathrm{~mA}$, | $\mathrm{f}=1 \mathrm{kHz}$ | 150600 |  |  | $\Omega$ |
| $h_{\text {fe }}$ | Small-Signal Common-Emitter Forward Current Transfer Ratio |  |  |  | 50 | 190 | 600 |  |
| $h_{\text {re }}$ | Small-Signal Common-Emitter Reverse Voltage Transfer Ratio |  |  |  | $\begin{array}{rr} 1 \times & 15 \times \\ 10^{-4} & 10^{-4} \\ \hline \end{array}$ |  |  |  |
| $h_{\text {oe }}$ | Small-Signal Common-Emitter Output Admittance |  |  |  | 100800 |  |  | $\mu \mathrm{mho}$ |
| ${ }_{\text {f }}$ | Transition Frequency | $\mathrm{V}_{\text {CE }}=-10 \mathrm{~V}$, | $\mathrm{I}^{\text {c }}=-50 \mathrm{~mA}$, | $\mathrm{f}=100 \mathrm{MHz}$ | 100360 |  |  | MHz |
| $\mathrm{C}_{\text {obo }}$ | Common-Base Open-Circuit Output Capacitance | $V_{C B}=-10 \mathrm{~V}$ <br> See Note 2 | $\mathrm{l} E=0$, | $\mathrm{f}=1 \mathrm{MHz}$, | $5 \quad 12$ |  |  | pF |
| Cibo | Common-Base Open-Circuit Input Capacitance | $V_{E B}=-0.5 \mathrm{~V}$ <br> See Note 2 | $\mathrm{I}^{\prime}=0$, | $\mathrm{f}=1 \mathrm{MHz}$, | $16 \quad 30$ |  |  | pF |
| $\mathrm{t}_{\mathrm{d}}$ | Delay Time | $\begin{aligned} & V_{C C}=-30 \mathrm{~V}, \\ & I_{\mathrm{B}(1)} \approx-15 \mathrm{~mA} . \end{aligned}$ | $\begin{aligned} & l_{C} \approx-150 \mathrm{~mA}, \\ & V_{B E} \text { (off) } \approx 0 \end{aligned}$ | 2N2904 <br> Data <br> Sheet <br> Circuit | 4 |  |  | ns |
| $t_{r}$ | Rise Time |  |  |  |  | 13 |  |  |
| $\mathrm{t}_{\mathbf{S}}$ | Storage Time | $\begin{aligned} & \mathrm{V}_{\mathrm{CC}}=-30 \mathrm{~V}, \\ & \mathrm{I}_{\mathrm{B}(1)} \approx-15 \mathrm{~mA}, \end{aligned}$ | $\begin{aligned} & I_{C} \approx-150 \mathrm{~mA}, \\ & \mathrm{~B}(2) \approx 15 \mathrm{~mA} \end{aligned}$ |  | 60 |  |  |  |
| $\mathrm{t}_{\mathrm{f}}$ | Fall Time |  |  |  |  | 20 |  |  |
| ${ }_{\text {t }}$ | Delay Time | $\begin{aligned} & \mathrm{v}_{\mathrm{CC}}=-30 \mathrm{~V} \\ & \mathrm{I}_{\mathrm{B}(2)} \approx 15 \mathrm{~mA}, \end{aligned}$ | $\begin{aligned} & t_{C} \approx-150 \mathrm{~mA}, \\ & V_{B E(o f f} \approx 4.1 \mathrm{~V}, \end{aligned}$ | $\mathrm{I}_{\mathrm{B}(1)} \approx-15 \mathrm{~mA} \text {, }$ <br> See Figure 1 |  | 6 |  | ns |
| $t_{r}$ | Rise Time |  |  |  |  | 13 |  |  |
| $\mathrm{t}_{\text {S }}$ | Storage Time |  |  |  |  | 60 |  |  |
| $t_{\text {f }}$ | Fall Time |  |  |  | 20 |  |  |  |

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## CHIP TYPE P20 P-N-P SILICON TRANSISTORS

## PARAMETER MEASUREMENT INFORMATION



(See Notes a and b)
VOLTAGE WAVEFORMS

NOTES: a. The input wavaforms are supplied by aenerator with the following characteristics: $Z_{\text {out }}=50 \Omega, t_{w} \approx 200 \mathrm{~ns}$, duty cycle $\leqslant 2 \%$.
b. Waveforms are monitored on an oscilloscope with the following characteristics: $\mathrm{t}_{\mathrm{r}} \leqslant 1 \mathrm{~ns}, \mathrm{R}_{\text {in }} \geqslant 100 \mathrm{k} \Omega, \mathrm{C}_{\text {in }} \leqslant 7 \mathrm{pF}$.

FIGURE 1-SWITCHING TIMES
TYPICAL CHARACTERISTICS


NOTE 1: These parameters were measured using pulse techniques. $\mathrm{i}_{\mathbf{w}}=\mathbf{3 0 0} \mu_{\mathrm{s}}$, dutv cycle $<\mathbf{2 \%}$.

## CHIP TYPE P2O <br> P-N-P SILICON TRANSISTORS

TYPICAL CHARACTERISTICS


NOTES: 1. These parameters were measured using pulse techniques. $t_{w}=300 \mu s, d u t y ~ c y c l e<2 \%$.
2. Capacitance measurements were made using chlps mounted in TO-5 packages.

## CHIP TYPE P2O P-N-P SILICON TRANSISTORS

## TYPICAL CHARACTERISTICS



FIGURE 12



FIGURE 13


## CHIP TYPE P22 <br> P-N-P SILICON TRANSISTORS

- P22 is a $20 \times 20$-mil, epitaxial, planar, direct-contact chip
- Available in Silect ${ }^{\dagger}$ packages
- For use in high-voltage amplifier circuits

electrical and operating characteristics at $25^{\circ} \mathrm{C}$ free-air temperature

| PARAMETER |  | CONDITIONS |  |  | OBSERVED VALUES |  | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | LOW TYP HIGH |  |
| $V_{\text {(BR) }}$ CBO | Collector-Base Breakdown Voltage |  |  |  | $I^{\prime} C=-100 \mu A$, | $E=0$ |  | $-150^{*}-175$ |  | V |
| $V_{\text {(BR)CEO }}$ | Collector-Emitter Breakdown Voltage | ${ }^{1} \mathrm{C}=-10 \mathrm{~mA}$, | $\mathrm{I}_{\mathrm{B}}=0$, | See Note 1 | $-140{ }^{*}-165$ |  | V |
| $\mathrm{V}_{\text {(BR)EBO }}$ | Emitter-Base Breakdown Voltage | $I_{E}=-10 \mu A$, | ${ }^{\prime} \mathrm{C}=0$ |  | $-5.5 *$-7 |  | V |
| ${ }^{\text {I CBO }}$ | Collector Cutoff Current | $\mathrm{V}_{\text {CB }}{ }^{\text {m }}-100 \mathrm{~V}$, | $l_{E}=0$ |  | -<0.1 -50 |  | nA |
| IEBO | Emitter Cutoff Current | $V_{E B}{ }^{*}-3 \mathrm{~V}$, | $1 \mathrm{C}=0$ |  | -<0.1 -50 |  | nA |
| hFE | Static Forward Voltage Transfer Ratio | $V_{C E}=-5 \mathrm{~V}$, | $\mathrm{C}^{*}-1 \mathrm{~mA}$ |  | $30 \quad 140$ |  |  |
|  |  | $\mathrm{V}_{\text {CE }}=-5 \mathrm{~V}$, | ${ }^{1} \mathrm{C}=-10 \mathrm{~mA}$ | See Note 1 | $40 \quad 160$ | 240 |  |
|  |  | $V_{C E}=-5 \mathrm{~V}$, | $1 \mathrm{C}=-50 \mathrm{~mA}$ |  | $40 \quad 150$ |  |  |
| $V_{\text {be }}$ | Baso-Emitter Voltage | $V_{C E}=-5 V$, | $I^{\prime} C^{=}=-10 m A$ | See Note 1 | -0.65 | -1.0 | V |
|  |  | $\mathrm{I}_{\mathrm{B}}=-1 \mathrm{~mA}$, | $1 C^{=}=-10 \mathrm{~mA}$ |  | -0.7 | $-1.0$ |  |
|  |  | $\mathrm{I}_{\mathrm{B}}=-5 \mathrm{~mA}$, | $1 \mathrm{C}=-50 \mathrm{~mA}$ |  | -0.8 | -1.0 |  |
| $V_{\text {CE }}$ (sat) | Collector-Emitter Saturation Voltage | $\mathrm{I}_{\mathrm{B}}=-1 \mathrm{~mA}$, | $1 C^{=}=10 \mathrm{~mA}$ | See Note 1 | -0.06 | -0.2 | V |
|  |  | $\mathrm{I}_{\mathrm{B}}=-5 \mathrm{~mA}$, | $\mathrm{l}^{\prime}=-50 \mathrm{~mA}$ |  | -0.1 | -0.5 |  |
| $h_{\text {ie }}$ | Small-Signal Common-Emitter Input Impedance | $V_{C E}=-10 \mathrm{~V}, \quad I^{\prime}=-1 \mathrm{~mA}$, |  | $f=1 \mathrm{kHz}$ | 4.6 |  | k $\Omega$ |
| $\mathrm{h}_{\mathrm{fe}}$ | Small-Signal Common-Emitter Forward Current Transfer Ratio |  |  | $\begin{array}{lll}30 & 170 & 200\end{array}$ |  |  |
| $\mathrm{hr}_{\text {re }}$ | Small-Signal Common-Emitter Reverse Voltage Transfer Ratio |  |  | $\begin{gathered} 2.7 \times \\ 10^{-4} \\ \hline \end{gathered}$ |  |  |
| $\mathrm{h}_{\mathbf{0 e}}$ | Small-Signal Common-Emitter Output Admittance |  |  | 13.4 | $\mu \mathrm{mho}$ |  |
| ${ }_{\text {f }}$ T | Transition Frequency | $V_{C E}=-10 \mathrm{~V}$, | $I^{\prime} C=-10 \mathrm{~mA}$, |  | $f=20 \mathrm{MHz}$ | 100190 |  | MHz |
| Cobo | Common-Base Open-Circuit Output Capacitance | $\begin{aligned} & V_{\mathrm{CB}}=-10 \mathrm{~V} \\ & \text { See Note } 2 \end{aligned}$ | $I_{E}=0,$ |  | $f=1 \mathrm{MHz}$ | 46 |  | pF |
| $C_{i b o}$ | Common-Base Open-Circuit Input Capacitance | $\begin{aligned} & V_{E B}=-1 V \\ & \text { See Note } 2 \end{aligned}$ | $I_{C}=0$ |  | $f=1 \mathrm{MHz}$, | 45 | 60 | pF |
| F | Spot Noise Figure | $\begin{aligned} & V_{C E}=-5 \mathrm{~V}, \\ & f=1 \mathrm{kHz} \end{aligned}$ | $I_{C}=-1 m A$ | $\mathrm{R}_{\mathrm{G}}=10 \mathrm{k} \Omega$, | 3 |  | dB |
| $\bar{F}$ | Average Noise Figure | $\begin{aligned} & \hline V_{C E}=-5 \mathrm{~V} \\ & \text { Noise Bandwidth } \end{aligned}$ | $\begin{aligned} & I^{\prime}=-250 \mu \mathrm{~A}, \\ & 15.7 \mathrm{kHz}, \end{aligned}$ | $R_{G}=1 \mathrm{k} \Omega,$ <br> See Note 3 | 2 | 8 | dB |

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## CHIP TYPE P22 P-N-P SILICON TRANSISTORS

## TYPICAL CHARACTERISTICS



FIGURE 1

VBe vs ic


IC-Collector Current-mA
figure 3


FIGURE 5


FIGURE 2

figure 4

NOTE 1: These parameters were measured using pulse techniques. $t_{w}=300 \mu s$, duty cycle $\leqslant 2 \%$

## CHIP TYPE P22

## P-N-P SILICON TRANSISTORS

TYPICAL CHARACTERISTICS


FIGURE 7


NOTES: 2. Capacitance measurements were made i'sing chips mounted in TO-92 packages.
3. Average Noise Figure was measured in an amplifier with response down 3 dB at 10 Hz and 10 kHz and a high-frequency roll-off of $6 \mathrm{~dB} / \mathrm{octave}$.

- P23 is a $20 \times \mathbf{2 0 - m i l}$, epitaxial, planar, expanded-contact chip
- Available in TO-18 packages
- For use in low-power, general purpose saturated switching and amplifier circuits

electrical and operating characteristics at $25^{\circ} \mathrm{C}$ free-air temperature


These values do not modify guaranteed limits for specific devices and do not justify operation in excess of absolute maximum ratings.
NOTES: 1. These parameters were measured using pulse techniques. $t_{w}=300 \mu$, duty cycle $\leqslant 2 \%$.

1. Cheseacitance measurements were made using chips mounted in TO-18 packages.

## PARAMETER MEASUREMENT INFORMATION



TEST CIRCUIT

(See Notes a and b)
VOLTAGE WAVEFORMS

NOTES: $a$. The input waveforms are supplied by a generator with the following characteristics: $Z_{o u t}=50 \Omega_{\text {; }}$ for measuring $t_{d}$ and $t_{r}$, $t_{w} \approx 200 \mathrm{~ns}$, duty cycle $\leqslant 2 \%$; for measuring $\mathrm{t}_{\mathrm{s}}$ and $\mathrm{t}_{\mathrm{f}}, \mathrm{t}_{\mathrm{w}} \approx 10 \mu \mathrm{~s}$, duty cycle $\leqslant 2 \%$.
b. Waveforms are monitored on an oscilloscope with the following characteristics: $\mathrm{t}_{\mathrm{r}} \leqslant 1 \mathrm{~ns}, \mathrm{R}_{\text {in }} \geqslant 100 \mathrm{k} \Omega, \mathrm{C}_{\mathrm{in}} \leqslant 7 \mathrm{pF}$.

## FIGURE 1-SWITCHING TIMES

TYPICAL CHARACTERISTICS


FIGURE 2


FIGURE 5

FIGURE 3


FIGURE 6
hfe vs lc


FIGURE 4


FIGURE 7

NOTE 1: These parameters were measured using pulse rechniques. $t_{w}=300 \mu_{s}$, duty cycle $\leqslant \mathbf{2 \%}$.

## CHIP TYPE P23 <br> P-N-P SILICON TRANSISTORS

## TYPICAL CHARACTERISTICS



NOTE 2: Capacitance measurements were made using chips mounted in TO-18 packages.

## CHIP TYPE P23

P-N-P SILICON TRANSISTORS
TYPICAL CHARACTERISTICS


FIGURE 13


FIGURE 15



## CHIP TYPE P24 <br> P-N-P SILICON TRANSISTORS

- P24 is a $\mathbf{2 0} \times \mathbf{2 0}$-mil, epitaxial, planar, direct-contact chip
- Available in Silect ${ }^{\dagger}$ packages
- For use in AM/FM/TV RF/IF converter and amplifier circuits to 300 MHz

electrical and operating characteristics at $25^{\circ} \mathrm{C}$ free-air temperature


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NOTE 1: These parameters were measured using pulse techniques. $t_{w}=\mathbf{3 0 0} \mu \mathrm{s}$, duty cycle $\leqslant 2 \%$.

# CHIP TYPE P24 <br> P-N-P SILICON TRANSISTORS 

## TYPICAL CHARACTERISTICS



NOTES 2. Capacitance measurements were made using chips mounted in TO-92 packages.
3. $C_{c b}$ and $C_{e b}$ measurements employ a three-terminal capacitance bridge incorporating a guard circuit. The third electrode (emitter or collector, respectively) is connected to the guard terminal of the bridge.

- P25 is a $10 \times 12-$ mil, epitaxial, planar, expanded-contact chip
- Available in Silect ${ }^{\dagger}$ packages
- For use in VHF/UHF common-base amplifier circuits requiring forward-AGC characteristics

electrical and operating characteristics at $25^{\circ} \mathrm{C}$ free-air temperature

| PARAMETER | CONDITIONS |  | OBSERVED VALUES | UNIT |
| :---: | :---: | :---: | :---: | :---: |
|  |  |  | LOW TYP HIGH |  |
| $V_{\text {(BR) }}$ CBO Collector-Base Braakdown Voltage | $\mathrm{I}^{1} \mathrm{C}=-100 \mu \mathrm{~A}, \quad \mathrm{IE}=0$ |  | $-60^{\circ}-110$ | V |
| $V_{\text {(BR)CEO }}$Collector-Emitter <br> Breakdown Voltage | $I_{C}=-1 \mathrm{~mA}, \quad \mathrm{I}_{\mathrm{B}}=0$. | See Note 1 | -45* -100 | V |
| $V_{\text {(BR)EBO }}$ Emitter-Base Breakdown Voltage | $\mathrm{I}_{\mathrm{E}}=-100 \mu \mathrm{~A}, \quad \mathrm{I}^{\prime} \mathrm{C}=0$ |  | $-4 *-6$ | V |
| ICBO Collector Cutoff Current | $V_{C B}=-25 \mathrm{~V}, \quad \mathrm{I}_{E}=0$ |  | -<0.1-100 | nA |
| hFE Static Forward Current <br> Transfer Ratio | $V_{C E}=-10 \mathrm{~V}, \quad \mathrm{I}_{\mathrm{C}}=-2 \mathrm{~mA}$ |  | 3050 |  |
| VGE Base-Emitter Voltage | $\mathrm{V}_{C E}=-10 \mathrm{~V}, \quad \mathrm{I}^{\prime} \mathrm{C}=-2 \mathrm{~mA}$ |  | -0.8 -1.1 | V |
| V  <br> CE(sat) Collector-Emitter <br> Saturation Voltage | $\mathrm{I}_{\mathrm{B}}=-0.25 \mathrm{~mA}, \quad \mathrm{I}_{\mathrm{C}}=-2.5 \mathrm{~mA}$ |  | -0.3 -1.0 | V |
| $\mathrm{f}_{\mathbf{T}} \quad$ Transition Frequency | $V_{C E}=-10 \mathrm{~V}, \quad i C=-2 \mathrm{~mA}$, | $f=100 \mathrm{MHz}$ | 650900 | MHz |
| Bfb\|2 Square of Common-Base Forward <br> Transmission Coefficient $\ddagger$ | $\begin{aligned} & V_{C B}=-10 V, \quad I_{E}=2 m A \\ & Z_{G}=Z_{L}=50 \Omega+j 0, \end{aligned}$ | $f=400 \mathrm{MHz}$ <br> See Note 2 | 3 | dB |
| $\mathrm{C}_{\mathbf{c b}} \quad$ Collector-Base Capacitance | $\mathrm{V}_{C B}=-10 \mathrm{~V}$. $\mathrm{I}^{\prime}=0$ | $\mathrm{f}=1 \mathrm{MHz}$, | 0.5 | pF |
| $\frac{\mathrm{C}_{\text {ce }}}{}$ Collector-Emitter Capacitance | $V_{C E}=-10 \mathrm{~V}, \quad \mathrm{I}_{\mathrm{B}}=0$ | See Notes 2 and 3 | $0.25 \quad 0.30$ | pF |
| F $\quad$ Spot Noise Figure | $\begin{aligned} & V_{C B}=-10 \mathrm{~V}, \quad \mathrm{I}=2 \mathrm{~mA}, \\ & f=850 \mathrm{MHz} \end{aligned}$ | $\mathrm{R}_{\mathrm{G}}=\mathbf{5 0 \Omega}$, | 56.5 | dB |

${ }^{\dagger}$ Trademark of Texas Instruments
-These values do not modify guaranteed limits for specific devices and do not justify operation in excess of absolute maximum ratings.
$\ddagger k_{\mathrm{fb}} \mid \mathbf{k}$ is equal to the insertion power gain of the transistor alone.
NOTES: 1. These parameters were measured using pulse techniques. $\mathbf{t}_{w}=\mathbf{3 0 0} \mu \mathrm{s}$, duty cycle $\leqslant \mathbf{2 \%}$.
2. Capacitance and s-parameter measurements were made using chips mounted in Silect packages.
3. $\mathrm{C}_{\mathrm{cb}}$ and $\mathrm{C}_{\mathrm{ce}}$ measurements employ a three-terminal capacitance bridge incorporating a guard circuit. The third electrode (emitter or base, respectively) is connected to the guard terminal of the bridge.

## CHIP TYPE P25 P-N-P SILICON TRANSISTORS

TYPICAL CHARACTERISTICS


VBE vs IC

figure 3

figure 6
$\mathbf{V}_{\mathbf{C E} \text { (sat) }} \mathbf{v s}^{\mathrm{I}} \mathbf{C}$


FIGURE 4

figure 7
ft ws lc

figure 5


FIGURE 8

NOTES. 1. These parameters were measured using pulse techniques. $t_{w}=300 \mu s$, duty cycle $\leqslant 2 \%$.
2. Capacitance and s-parameter measurements were made using chips mounted in Silect packages.
3. $\mathrm{C}_{\mathrm{cb}}$ and $\mathrm{C}_{\mathrm{ce}}$ measurements employ a three-terminal capacitance bridge incorporating a guard circuit. The third electrode (emitter or base, respectively) is connected to the guard terminal of the bridge.

## CHIP TYPE P25 <br> P-N-P SILICON TRANSISTORS

TYPICAL CHARACTERISTICS
COMMON-BASE INPUT REFLECTION COEFFICIENT, sib

## and

NORMALIZED INPUT IMPEDANCE
$V_{C B}=-10 \mathrm{~V}, Z_{G}=Z_{L}=50 \Omega+j 0, T_{A}=25^{\circ} \mathrm{C}$


| Frequency | $I_{E}=1 \mathrm{~mA}$ |  | $I_{E}=2 \mathrm{~mA}$ |  | $I_{E}=3 \mathrm{~mA}$ |  | $\mathrm{I}_{\mathrm{E}}=5 \mathrm{~mA}$ |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | \|ibl | $\phi_{\text {sib }}$ | $\left\|{ }_{\text {Pib }}\right\|$ | $\phi_{\text {sib }}$ | \|ibl | $\phi_{\text {sib }}$ | \| ${ }_{\text {ib }}$ \| | $\phi_{\text {sib }}$ |
| 100 MHz | 0.33 | $167^{\circ}$ | 0.57 | $167^{\circ}$ | 0.65 | $166^{\circ}$ | 0.70 | $162^{\circ}$ |
| 200 MHz | 0.35 | $157^{\circ}$ | 0.59 | $157^{\circ}$ | 0.67 | $157^{\circ}$ | 0.68 | $150^{\circ}$ |
| 300 MHz | 0.38 | $145^{\circ}$ | 0.62 | $146^{\circ}$ | 0.70 | $145^{\circ}$ | 0.68 | $139^{\circ}$ |
| 400 MHz | 0.41 | $138{ }^{\circ}$ | 0.65 | $137^{\circ}$ | 0.73 | $1.35{ }^{\circ}$ | 0.70 | $129^{\circ}$ |
| 500 MHz | 0.45 | $129^{\circ}$ | 0.69 | $129^{\circ}$ | 0.76 | $125^{\circ}$ | 0.71 | $121^{\circ}$ |
| 600 MHz | 0.49 | $119^{\circ}$ | 0.72 | $118^{\circ}$ | 0.79 | $115^{\circ}$ | 0.73 | $111^{\circ}$ |
| 700 MHz | 0.53 | $111^{\circ}$ | 0.77 | $108^{\circ}$ | 0.84 | $105^{\circ}$ | 0.74 | $102^{\circ}$ |
| 800 MHz | 0.59 | $102{ }^{\circ}$ | 0.81 | $102^{\circ}$ | 0.88 | $99^{\circ}$ | 0.77 | $95^{\circ}$ |

These measurements were made using chips mounted in Silect packages.

## FIGURE 9

# CHIP TYPE P25 P-N-P SILICON TRANSISTORS 

## TYPICAL CHARACTERISTICS

## COMMON-BASE OUTPUT REFLECTION COEFFICIENT, sob

and
NORMALIZED OUTPUT IMPEDANCE
$V_{C B}=-10 \mathrm{~V}, Z_{G}=Z_{L}=50 \Omega+j 0, T_{A}=25^{\circ} \mathrm{C}$


| Frequency | IE $=1 \mathrm{~mA}$ |  | $\mathrm{IE}_{\mathrm{E}}=2 \mathrm{~mA}$ |  | $1 E=3 \mathrm{~mA}$ |  | ${ }^{1} \mathrm{E}=5 \mathrm{~mA}$ |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | Pobl | $\phi_{\text {sol }}$ | \%obl | \$20b | Fobl | $\phi_{\text {sob }}$ | Fobl | $\phi_{\text {sob }}$ |
| 100 MHz | 0.998 | -20 | 0.998 | $-2^{\circ}$ | 0.998 | -2 ${ }^{\circ}$ | 0.998 | $-2^{\circ}$ |
| 200 MHz | 0.998 | $-5^{\circ}$ | 0.998 | $-5^{\circ}$ | 0.998 | $-5^{\circ}$ | 0.998 | -5 |
| 300 MHz | 0.998 | $-8^{\circ}$ | 0.998 | $-8^{\circ}$ | 0.998 | $-8^{\circ}$ | 0.998 | $-8^{\circ}$ |
| 400 MHz | 0.998 | $-11^{\circ}$ | 0.998 | $-11^{\circ}$ | 0.998 | $-11^{\circ}$ | 0.998 | $-11^{\circ}$ |
| 500 MHz | 0.998 | $-14^{\circ}$ | 0.998 | $-14^{\circ}$ | 0.998 | $-14^{\circ}$ | 0.998 | $-14^{\circ}$ |
| 600 MHz | 0.998 | $-16^{\circ}$ | 0.998 | $-16^{\circ}$ | 0.998 | $-16^{\circ}$ | 0.998 | $-16^{\circ}$ |
| 700 MHz | 0.998 | $-19^{\circ}$ | 0.998 | $-19^{\circ}$ | 0.998 | $-19^{\circ}$ | 0.998 | $-19^{\circ}$ |
| 800 MHz | 0.998 | $-22^{\circ}$ | 0.998 | $-22^{\circ}$ | 0.998 | $-22^{\circ}$ | 0.998 | $-22^{\circ}$ |

These measurements ware made using chips mounted in Silect packages.

FIGURE 10

- P27 is a $15 \times$ 15-mil, epitaxial, planar, expanded-contact chip
- Available in TO-72 and Silect ${ }^{\dagger}$ packages
- For high-speed switching or high-frequency (to $2 \mathbf{~ G H z}$ ) amplifier circuits

electrical and operating characteristics at $\mathbf{2 5}{ }^{\circ} \mathrm{C}$ free-air temperature

${ }^{\dagger}$ Trademark of Texas Instruments
-These values do not modify guaranteed limits for specific devices and do not justify operation in excess of absolute maximum ratings. $\dagger_{\mathrm{f}_{\boldsymbol{f}}}{ }^{2}$ is equal to the insertion power gain of the transistor alone.
NOTES: 1. These parameters were measured using pulse techniques. $t_{w}=300 \mu$, duty cycle $\leqslant \mathbf{2 \%}$.

2. Capacitance, $\mathrm{r}_{\mathrm{b}}{ }^{\prime} \mathrm{C}_{\mathrm{c}}$, and s -parameter measurements were made using chips mounted in TO-72 packages.
3. $\mathrm{C}_{\mathrm{cb}}$ and $\mathrm{C}_{\mathrm{eb}}$ measurements employ a three-terminal capacitance bridge incorporating a guard circuit. The third electrode (emirter or collector, respectively) is connected to the guard terminal of the bridge.

CHIP TYPE P27<br>P-N-P SILICON TRANSISTORS

## TYPICAL CHARACTERISTICS


figure 1



FIGURE 6


NOTES: 1. This parameter was measured using pulse techniques. $t_{w}=\mathbf{3 0 0} \mu \mathrm{s}$, duty cycle $<\mathbf{2 \%}$.
2. Capacitance, $r_{b}{ }^{\prime} C_{c}$, and s-parameter measurements ware made using chips mounted in TO-72 packeges.
3. $C_{c b}$ and $C_{e b}$ measurements employ a three-terminal capacitance bridge incorporating a guard circuit. The third electrode femitter or collector, respectively) is connected to the guard terminal of the bridge.

## CHIP TYPE P27 P-N-P SILICON TRANSISTORS



| Frequency | $I_{C}=-2 \mathrm{~mA}$ |  | $I C=-5 m A$ |  | $I_{C}=-10 \mathrm{~mA}$ |  | IC $=-15 \mathrm{~mA}$ |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | \$iel | $\phi_{\text {sie }}$ | Piel. | $\phi_{\text {sie }}$ | Fiel | $\phi_{\text {sie }}$ | Piel | $\phi_{\text {sie }}$ |
| 100 MHz | 0.82 | $-34^{\circ}$ | 0.51 | $-46^{\circ}$ | 0.37 | $-51^{\circ}$ | 0.29 | $-53^{\circ}$ |
| 300 MHz | 0.43 | $-75^{\circ}$ | 0.25 | $-78^{\circ}$ | 0.17 | $-78^{\circ}$ | 0.13 | $-75^{\circ}$ |
| 500 MHz | 0.28 | $-102^{\circ}$ | 0.14 | $-102{ }^{\circ}$ | 0.09 | $-99^{\circ}$ | 0.07 | $-93^{\circ}$ |
| 700 MHz | 0.18 | $-131{ }^{\circ}$ | 0.09 | $-131{ }^{\circ}$ | 0.05 | $-131^{\circ}$ | 0.04 | $-133^{\circ}$ |
| 900 MHz | 0.14 | $-165^{\circ}$ | 0.08 | $-176^{\circ}$ | 0.05 | $170^{\circ}$ | 0.05 | $156^{\circ}$ |
| 1100 MHz | 0.14 | $164^{\circ}$ | 0.09 | $143^{\circ}$ | 0.07 | $130^{\circ}$ | 0.07 | $130^{\circ}$ |
| 1300 MHz | 0.16 | $133^{\circ}$ | 0.12 | $118^{\circ}$ | 0.11 | $112^{\circ}$ | 0.11 | $112^{\circ}$ |
| 1500 MHz | 0.18 | $115^{\circ}$ | 0.15 | $107^{\circ}$ | 0.14 | $103^{\circ}$ | 0.14 | $103^{\circ}$ |
| 1700 MHz | 0.20 | $103^{\circ}$ | 0.17 | $95^{\circ}$ | 0.18 | $93^{\circ}$ | 0.16 | $93^{\circ}$ |
| 1900 MHz | 0.24 | $90^{\circ}$ | 0.20 | $85^{\circ}$ | 0.19 | $84^{\circ}$ | 0.19 | $84^{\circ}$ |

These measurements were made using chips mounted in TO-72 packages.
Figure 11

## CHIP TYPE P27 <br> P-N-P SILICON TRANSISTORS

TYPICAL CHARACTERISTICS
COMMON-EMITTER OUTPUT REFLECTION COEFFICIENT, $s_{\text {oe }}$ and
NORMALIZED OUTPUT IMPEDANCE
$V_{C E}=-6 \mathrm{~V}, \mathrm{Z}_{\mathbf{G}}=\mathrm{Z}_{\mathrm{L}}=50 \Omega+\mathrm{i} 0, \mathrm{~T}_{\mathrm{A}}=25^{\circ} \mathrm{C}$


| Frequency | $C^{=}=-2 \mathrm{~mA}$ |  | $\mathrm{I}^{\prime}=\mathbf{= - 5} \mathrm{mA}$ |  | $I_{C}=-10 \mathrm{~mA}$ |  | $\mathrm{I}_{\mathrm{C}}=-15 \mathrm{~mA}$ |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | $\mathbf{F}_{\mathbf{o b}}$ \| | $\phi_{\text {soe }}$ | Soal | $\phi_{\text {soe }}$. | $\mathbf{3}_{\text {oel }} 1$ | $\phi_{\text {soe }}$ | Foel | $\phi_{\text {SOP }}$ |
| 100 MHz | 0.71 | $-17^{\circ}$ | 0.62 | $-18^{\circ}$ | 0.59 | $-18^{\circ}$ | 0.56 | $-18^{\circ}$ |
| 300 MHz | 0.68 | $-24^{\circ}$ | 0.59 | $-24^{\circ}$ | 0.56 | $-23^{\circ}$ | 0.54 | $-22^{\circ}$ |
| 500 MHz | 0.66 | $-28^{\circ}$ | 0.57 | $-27^{\circ}$ | 0.54 | $-27^{\circ}$ | 0.52 | $-26^{\circ}$ |
| 700 MHz | 0.64 | $-33^{\circ}$ | 0.56 | $-32^{\circ}$ | 0.52 | $-31^{\circ}$ | 0.51 | $-30^{\circ}$ |
| 900 MHz | 0.62 | $-38^{\circ}$ | 0.55 | $-36^{\circ}$ | 0.51 | $-35^{\circ}$ | 0.49 | $-34^{\circ}$ |
| 1100 MHz | 0.60 | $-44^{\circ}$ | 0.54 | $-42^{\circ}$ | 0.50 | $-40^{\circ}$ | 0.48 | $-39^{\circ}$ |
| 1300 MHz | 0.58 | $-50^{\circ}$ | 0.52 | $-47^{\circ}$ | 0.49 | $-45^{\circ}$ | 0.47 | $-45^{\circ}$ |
| 1500 MHz | 0.56 | $-56^{\circ}$ | 0.51 | $-54^{\circ}$ | 0.48 | $-53^{\circ}$ | 0.46 | $-52^{\circ}$ |
| 1700 MHz | 0.55 | $-62^{\circ}$ | 0.50 | $-60^{\circ}$ | 0.48 | $-58^{\circ}$ | 0.46 | $-57^{\circ}$ |
| 1900 MHz | 0.53 | $-72^{\circ}$ | 0.50 | $-67^{\circ}$ | 0.47 | $-65^{\circ}$ | 0.45 | $-64^{\circ}$ |

These measurements were made using chips mounted in TO-72 packages.

- U41 is a $20 \times 20-m i l$, epitaxial, planar, direct-contact, p-n-p-n thyristor chip with an n-gate
- Available in TO-18 and Silect ${ }^{\dagger}$ packages
- For unijunction applications requiring programmable $\eta$, rBB, IV, and IP

electrical and operating characteristics at $25^{\circ} \mathrm{C}$ free-air temperature



## PARAMETER MEASUREMENT INFORMATION



FIGURE 1-PROGRAMMABLE UNIJUNCTION CIRCUIT
FIGURE 2-EQUIVALENT CIRCUIT USED FOR TESTING

[^169]CHIP TYPE U41
PROGRAMMABLE UNIJUNCTION TRANSISTORS


TYPICAL CHARACTERISTICS


## CHIP TYPE U42 P-N PLANAR UNIJUNCTION TRANSISTORS

- U42 is a $15 \times 15-m i l$, P-N, direct-contact chip
- Available in modified TO-18 and Silect ${ }^{\dagger}$ packages
- For use in simple relaxation oscillator circuits as SCR drivers, timers, motor-speed controls, waveform generators, multivibrators, ring counters, electronic organs, and ordnance fuzes

electrical and operating characteristics at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

| PARAMETER |  | CONDITIONS |  | OBSERVED VALUES |  |  | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | LOW | TYP | HIGH |  |
|  |  |  |  | $V_{B 2 B 1}=3 V, \quad I_{E}=0$ |  | 4 | 6 | 12 | k $\Omega$ |
| r8B | Interbase Resistance | $\begin{aligned} & V_{B 2 B 1}=3 \mathrm{~V}, \quad I_{E}=0, \\ & T_{A}=-65^{\circ} \mathrm{C} \text { to } 100^{\circ} \mathrm{C}, \end{aligned}$ | See Note 1 | 0.1 |  | 0.9 | \% $/{ }^{\circ} \mathrm{C}$ |
| $\alpha_{\text {rBB }}$ | Temperature Coafficient |  |  |  |  |  |  |
| $\dagger$ | Intrinsic Standoff Ratio | $\mathrm{V}_{\mathrm{B2B1}}=10 \mathrm{~V}$ |  | 0.50 |  | 0.86 |  |
| $1 \mathrm{B2}$ (mod) | Modulated Interbase Current | $V_{B 2 B 1}=10 \mathrm{~V}, \quad \mathrm{I}_{\mathrm{E}}=50 \mathrm{~mA}$, | See Note 2 | 12 | 28 |  | mA |
| IEB20 | Emitter Reverse Current | $\mathrm{V}_{\mathrm{EB} 2}=-30 \mathrm{~V}, \quad \mathrm{I}_{\mathrm{B} 1}=0$ |  |  | -2.5 | -10 | nA |
| Ip | Peak-Point Emitter Current |  |  |  | 0.4 | 2 | $\mu \mathrm{A}$ |
| VEB1(eat) | Emitter Saturation Voltage | $V_{B 2 B 1}=20 \mathrm{~V}, \quad \mathrm{I}^{2}=50 \mathrm{~mA}$, | See Note 2 |  | 1.8 | 3 | V |
| IV | Valley-Point Emitter Current | $\mathrm{V}_{\mathrm{B2B} 21}=20 \mathrm{~V}$ |  | 1 | 5 | 20 | mA |
| VOB1 | Base-One Peak Pulse Voltage | See Figure 1 |  |  | 7.5 |  | V |

tTrademerk of Texas Instruments
NOTES: 1. Temperature coefficient $\alpha_{r B}$ is determined by the following formula:

$$
\alpha_{\mathrm{rBB}}=\left[\frac{\left(r_{B B} 100^{\circ} \mathrm{C}\right)-\left(r_{B B}-65^{\circ} \mathrm{C}\right)}{\left(r_{B B}\left(25^{\circ} \mathrm{C}\right)\right.}\right] \frac{100 \%}{165^{\circ} \mathrm{C}}
$$

To obtain $\mathrm{r}_{\mathrm{BB}}$ for a given temperature $\mathrm{T}_{\mathrm{A}(2)}$, use the following formula:

$$
r_{\mathrm{BB}(2)}=\left[\mathrm{r}_{\mathrm{BB}} \oplus 25^{\circ} \mathrm{C}\right]\left[1+\left(\alpha_{\mathrm{rBB}} / 100 \%\right)\left(\mathrm{T}_{\mathrm{A}(2)}-25^{\circ} \mathrm{C}\right)\right]
$$

2. These paramaters were measured using pulse techniques. $t_{w}=300 \mu s$, duty cycle $\leqslant \mathbf{2 \%}$.

## CHIP TYPE U42 <br> P-N PLANAR UNIJUNCTION TRANSISTORS

## PARAMETER MEASUREMENT INFORMATION



FIGURE $1-V_{\text {OB1 }}$ TEST CIRCUIT
TYPICAL CHARACTERISTICS


NOTE 2: These parameters were measured using pulse techniques. $\mathrm{t}_{\mathrm{w}}=\mathbf{3 0 0} \mu \mathrm{s}$, duty cycle $\leqslant \mathbf{2 \%}$.

Vebive le

$I_{E}-$ Emither Current - mA
FIGURE 7


FIGURE 9
$V_{E B 1(s a t)}$ vs $T_{A}$


FIGURE 8


NOTE 2: These parameters were massured using pulse techniques. $t_{w}=\mathbf{3 0 0} \mu \mathrm{s}$, duty cycle $\mathbf{< 2 \%}$.

# Transistor Quality and Reliability Information 

## QUALITY AND RELIABILITY INFORMATION QUALITY INSPECTION LEVELS

All transistor types listed in this catalog are subject to electrical and mechanical sampling inspection performed by the Quality and Reliability Group to the following AQLs (Acceptance Quality Levels):

| PARAMETER SUBGROUP | AQL, <br> PARTIAL | AQL, <br> CUMULATIVE |
| :--- | :---: | :---: |
| Static Parameters at $25^{\circ} \mathrm{C}$ | - | 0.65 |
| Static Parameters at other than $25^{\circ} \mathrm{C}$ | 1.5 | 4.0 |
| Dynamic Parameters ( $\leqslant 1 \mathrm{kHz}$ ) | 1.5 | 4.0 |
| Dynamic Parameters $>1 \mathrm{kHz}$ ) | 1.5 | 4.0 |
| Capacitances | 1.5 | 4.0 |
| Operating Characteristics | 1.5 | 4.0 |
| Switching Characteristics | 1.5 | 4.0 |
| All Other Parameters | 1.5 | 4.0 |
| Inoperatives | - | 0.25 |

## RELIABILITY OF SILICON TRANSISTORS

The technology for epitaxial planar silicon transistor chips with aluminum metallization has been established for several years. This technology, for the most part, is well understood. Processes for fabricating epitaxial planar silicon transistors are mature, and failure modes for transistors fabricated in a controlled process are defined. The failure-mode distribution for this process is shown in Figure 1. The primary failure modes are related to wire-bond-to-chip (contact) integrity and certain surface phenomena.

Understanding of the epitaxial planar silicon chip technology, maturity of the process, and knowledge of the failure-mode distribution make possible the definition of the reliability of these transistors. The reliability to be expected for transistors manufactured by the standard process is shown in the plot of average failure rate as a function of junction temperature in Figure 1. Data for Figure 2 are derived from life-tests at maximum-rated conditions-some as long as 35,000 hours ( 4 years, continuous). Specifically, the reliability of transistors from the standard process is defined by the curve labeled "Hermetically Packaged, Commercial".

Improvement in the reliability of these transistors can be achieved only by additional process requirements such as special selection of chips, more stringent pre-encapsulation criteria, or special screens such as active burn-in or high-temperature reverse-bias screening of encapsulated transistors. These measures are effective in removing devices with manufacturing anomalies which might cause failure of the parts during use. Column $B$ of Figure 2 shows the relative improvement in failure rate and occurrence of failures which result from imposing special process requirements and subsequent screens.

The degree of reliability improvement obtained by the imposition of special process requirements and screens depends upon their efficacy. For example, Texas Instruments, experience shows that $100 \%$ pre-encapsulation inspection to the requirements of MIL-STD-750, Method 2072, is effective in removing visual defects which may ultimately be related to device reliability. On the other hand, inspection to more stringent criteria may very well result in the costly rejection of devices for reasons which in all probability are not related to ultimate reliability of failure-rate improvement.

The types and levels of stress used in screening transistors to improve reliability vary by device series. Some devices, for example, general purpose N-P.N transistors, are more effectively screened by active burn-in; others, for example, general purpose P-N-P transistors, by high-temperature reverse bias. In some cases, such as in attaining stabilization for a very low-level hFE, a combination of both stresses is more desirable. If the types and levels of stress are properly specfied for the particular transistor series involved, no more than 168 hours of stress screening should be required. In some cases as little as $\mathbf{4 8}$ to $\mathbf{7 2}$ hours is sufficient. In general, stress screening longer than 168 hours does not significantly improve transistor reliability.

Figure 2 shows a plot of average failure rates as a function of virtual junction temperatures for different chip technologies, package configurations, and stress-screening requirements.

Figure 2 may also be interpreted as a rough thermal-derating guide for design purposes.

## PLASTIC-ENCAPSULATED TRANSISTORS

Plastic-encapsulated transistors are fabricated with the same epitaxial planar silicon chips as used in hermetically packaged transistors. Processes for these plastic-encapsulated transistors are still changing because of improvements in the technology and packaging techniques of plastic compounds.

Packaging defects in conventional metal-case transistors are primarily related to hermeticity, whereas encapsulation with plastics introduces several additional variables including glass-transition temperature (a temperature at which certain plastic compounds suffer irreversible chemical changes), impurity levels, and coefficient of expansion of the plastic.

The failure-rate curve for plastic-encapsulated transistors in Figure 1 will be subject to significant improvements as plastic technology is further developed.

## HERMETICALLY PACKAGED TRANSISTORS

The failure-rate curve in Figure 1 labeled "Hermetically Packaged, Commercial" reflects the expected average reliability of conventional transistors with standard process controls and with no special stress screening to remove potential failures. The curve in Figure 1 labeled "Hermetically Packaged, JAN" reflects an improvement in failure rate reliability through lot screening of devices for manufacturing anomalies and by lot-acceptance testing which includes both environmental and life-test requirements.

The failure-rate curve labeled "Hermetically Packaged, Special Screens" shows still further improvement in reliability as a result of additional process and stress-screening requirements. The absolute location of this curve is determined by the efficiency of special processing and screening, with a maximum improvement in failure rate of approximately one order of magnitude in comparison with transistors which do not receive this special processing. The failure rates shown on this particular curve correspond to the level of processing employed in the fabrication of transistors ranging from JANTX to high-reliability military and space applications.

## SUMMARY

The process capability and reliability of epitaxial planar silicon transistors are well established. Several levels of reliability of these transistors can be attained by specific process and stress-screening requirements. Further improvements in reliability are attainable only by the introduction of different technologies. The reliability of plastic-encapsulated transistors is expected to improve significantly as plastic technology is further developed.

## OUALITY AND RELIABILITY INFORMATION TRANSISTOR RELIABILITY

## AVERAGE FAILURE RATES (AND ESTIMATED FIELD <br> FAILURE RATES) OF SILICON TRANSISTORS

 vs TEMPERATURE

FAILURE-MODE DISTRIBUTION
OF SILICON TRANSISTORS
$\left.\begin{array}{|l|}\hline \text { OTHER } \\ \hline \text { METALLIZATION } \\ \hline \text { ELECTRICALLY } \\ \text { MARGINAL }\end{array}\right]$

FIGURE 2

## QUALITY AND RELIABILITY INFORMATION FACILITIES AND EQUIPMENT

## FACILITIES AND EQUIPMENT

## A. LIFE-TEST AND BURN-IN FACILITIES

1. Texas Instruments incorporated is equipped with extensive facilities to provide life-test and burn-in capabilities for silicon transistors and diodes.
2. Facilities are available for a wide range of tests including:
a. Storage life testing up to $300^{\circ} \mathrm{C}$.
b. Voltage-temperature stress testing at both ambient and elevated temperature conditions.
c. Free-air operating for transistors and diodes.
d. Intermittent operating at various cycle times and power levels.
B. ENVIRONMENTAL FACILITIES
3. Test capabilities of the Environmental Laboratory are shown in two different ways. First, Military Standard Test Capability which lists capability per MIL-STD-202, MIL-STD-750, and MIL-STD-883 for each test category; and second, Overall Test Capability which lists capability limits and, where applicable, combined environment capability for each test category.
4. Laboratory capabilities required for performance of tests per MIL-STD-202, MIL-STD-750, and MIL-STD-883 are listed in Table I. Those tests which are noted as exceptions are beyond the capability of the Environmental Laboratory.
5. Laboratory capability limits, including limits of combined environments, are shown in Table II for each test category.

# QUALITY AND RELIABILTY INFORMATION FACILITIES AND EQUIPNENT 

TABLE I-MILITARY STANDARD TEST CAPABILITY

| TEST CATEGORY | MIL-STD-202 | MIL-STD-750 | MIL-STD-883 |
| :---: | :---: | :---: | :---: |
| Altitude | All Conditions | All Conditions | All Conditions |
| Dew Point |  | All Conditions | All Conditions |
| Flammability | All Conditions |  |  |
| Moisture Resistance | All Conditions | All Conditions | All Conditions |
| Resistance to Solvents (Symbolization) | All Conditions |  |  |
| Salt Atmosphere |  | All Conditions | All Conditions |
| Salt Spray | All Conditions | All Conditions |  |
| Seal, Gross Leak | All Gross Leak Conditions (Method 112A, Conditions A, B, and Procedure IV of Condition C. Method 104A, Conditions A, B \& C) ${ }^{\dagger}$ | All Gross Leak Conditions (Method 1071, Conditions C. D, E \& FI ${ }^{\dagger}$ | All Gross Leak Conditions (Method 1014, Conditions C \& D) ${ }^{\dagger}$ |
| Solderability | All Conditions | All Conditions | All Conditions |
| Soldering Heat |  | All Conditions |  |
| Temperature Cycling | All Conditions <br> EXCEPT: Method 107, Conditions D \& F | All Conditions EXCEPT: Method 1051, Con- ditions D \& E | All Conditions EXCEPT: Method 1010, Con- ditions E \& F |
| Terminal Strength (Lead Integrity) | All Conditions | All Conditions | All Conditions |
| Thermal Shock (Glass Strain) |  | All Conditions | All Conditions |
| Acceleration, Sustained (Centrifuge) | All Conditions | All Conditions | All Conditions <br> EXCEPT: Method 2001, Condition J <br> NOTE: $\mathbb{I}$ Method 2001, Condition $G$ and $H$, may require special fixturing. Limited capability for these condtions is available for special package types. |
| $\ddagger$ Shock (Mechanical) | All Conditions <br> EXCEPT: Method 213, Conditions B, C, G, J, and K | All Conditions | All Conditions <br> NOTE: 【 Method 2002, Condition F and G, may require special fixturing. Capability for these conditions is available for special package types. |
| Vibration, Fatigue |  | All Conditions | All Conditions |
| Vibration, Noise |  | All Conditions | All Conditions |
| $\triangle$ Vibration, Random | All Conditions |  |  |
| AVibration, Variable-Frequency | All Conditions | All Conditions | All Conditions |
| Seal, Fine Leak <br> (Radioactive Tracer Gas) | ONLY Method 112A, Condition C, Procedure III.B | ONLY Method 1071, Condition G | ONLY Method 1014, Condition B |
| -X-Ray, Film | All Conditions | All Conditions | All Conditions |
| -X-Ray, Real Time (TV X-Ray) | All Conditions | All Conditions | All Conditions |

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## QUALITY AND RELIABILTTY INFORMATION

 FACILITIES AND EQUIPMENT| TABLE II-OVERALL TEST CAPABILITY |  |
| :---: | :---: |
| TEST | CAPABILITY |
| Acceleration, Sustained (Centrifuge) | $50-50,000 \mathrm{~g}$ (Standard) |
|  | 50,000-100,000 g (Nonstandard) |
| Altitude (Barometric Pressure, Reduced) | $450,000 \mathrm{ft}$. Simulated Altitude with $-125^{\circ} \mathrm{C}$ to $125^{\circ} \mathrm{C}$ Capability |
| Cryogenic Exposure | $-75^{\circ} \mathrm{C}$ to $-196^{\circ} \mathrm{C}$ |
| Dew Point | $-65^{\circ} \mathrm{C}$ to $150^{\circ} \mathrm{C}$ |
| Flammability | $900^{\circ} \mathrm{C}$ to $1100^{\circ} \mathrm{C}$ |
| Moisture Resistance | $2^{\circ} \mathrm{C}$ to $96^{\circ} \mathrm{C}, 40 \%$ to $100 \% \mathrm{RH}$ |
| Radiographic Inspection (X-Ray) |  |
| Film | Resolution to 0.001 Inch, $150 \mathrm{kV}-5 \mathrm{~mA}$ |
| Real Time | $360^{\circ}$ Rotation-Resolution to 0.001 Inch |
| Salt Atmosphere/Spray | $\mathbf{2 5}{ }^{\circ} \mathrm{C}$ to $71^{\circ} \mathrm{C}$, Up to $\mathbf{2 0 \%}$ Salt Solution by Weight |
| Seal |  |
| Gross Leak | $>5 \times 10^{-6}, 150^{\circ} \mathrm{C}$, Fluorocarbons, Mineral Oils, Ethylene Glycol Hydrostatic Pressure-0-300 psig |
| Radioactive Tracer Gas | $\geq 1 \times 10^{-11}$ |
| Symbolization (Resistance to Solvents) |  |
| Shock (Mechanical) | PULSE SHAPE-APPROXIMATELY |
|  | HALF-SINE |
|  | $1,500-30,000 \mathrm{~g} @ 0.2 \mathrm{~ms} \pm 0.1 \mathrm{~ms}$ |
|  | $1,000-6,000 \mathrm{~g} @ 0.3 \mathrm{~ms} \pm 0.1 \mathrm{~ms}$ |
|  | $500-10,000 \mathrm{~g} @ 0.5 \mathrm{~ms} \pm 0.15 \mathrm{~ms}$ |
|  | $500-4,000 \mathrm{~g} @ 1 \mathrm{~ms} \pm 0.3 \mathrm{~ms}$ |
|  | $500 \& 1,000 \mathrm{~g} @ 1.5 \mathrm{~ms} \pm 0.45 \mathrm{~ms}$ |
|  | $1,800 \mathrm{~g} @ 3 \mathrm{~ms} \pm 0.6 \mathrm{~ms}$ |
|  |  |
|  | $50-200 \mathrm{~g} @ 7 \mathrm{~ms} \pm 1.05 \mathrm{~ms}$ |
|  | $15-150 \mathrm{~g} @ 11 \mathrm{~ms} \pm 1.65 \mathrm{~ms}$ |
|  | PULSE SHAPE-SAWTOOTH |
|  | $100 \mathrm{~g} @ 6 \mathrm{~ms}$ |
| Solderability/Soldering | Up to $280^{\circ} \mathrm{C}$ |
| Temperature Cycling | $-185^{\circ} \mathrm{C}$ to $300^{\circ} \mathrm{C}$ |
| Terminal Strength (Lead Integrity) | Lead Fatigue, Tension, Stud Torque, Terminal Torque |
| Thermal Shock | $-196^{\circ} \mathrm{C}$ to $200^{\circ} \mathrm{C}$ |
| Ultrasonics | $\mathbf{0 - 1 0 0} \mathrm{psi}$ at 25 kHz or 40 kHz |
| Ultraviolet Exposure | To $12.5 \mathrm{~mW} / \mathrm{cm}^{2}$ |
| Vibration, Fatigue | $10-100 \mathrm{~Hz}, 5-70 \mathrm{~g}$ |
| Vibration, Rendom | $\mathbf{2 0 - 2 0 0 ~ H z}$, Power Density $1.3 \mathrm{~g} / \mathrm{g}^{\mathbf{/ H z}}$ |
| Vibration, Variable | $5-2,000 \mathrm{~Hz}$ as Limited by 1 Inch DA and 60 Inches/Second Velocity. $\mathbf{0 - 7 0} \mathrm{g}$ (Standard), 70-100 g (Nonstandard) |

# Diode <br> Product <br> Spectrum 

## DIODE PRODUCTS

TI manufactures one of the broadest lines of discrete axial-lead diodes and multiple-diode arrays available to the electronic industry. These product families are divided into the following categories:

## Discrete Diodes

1. Switching diodes . . . logic, core driver and high-voltage
2. Pico-second diodes . . . fast switching
3. Radiation-tolerant diodes
4. Tuning diodes . . . AFC, UHF, VHF
5. General purpose diodes . . 20 V thru 720 V
6. Rectifiers . . . 50 V thru 1000 V
7. Voltage regulators . . . 3.3 V thru $33 \mathrm{~V}, 400 \mathrm{~mW}$ thru 1 W

## Diode Arrays

1. Dual diodes (TO-18)
2. Diode arrays (plastic dual-in-line, metal and ceramic flat packages)
3. Programmable matrices (ceramic dual-in-line and metal flat packages)

## DISCRETE DIODES

TI manufactures discrete diodes featuring double-plug construction, which results in a proven, highly reliable product. TI has recently completed a program to utilize this package concept on all axial-lead diodes. This double-plug package, proven by years of volume production, ensures the best in mechanical integrity and the lowest possible junction temperature when compared to the thermal characteristics of whisker packages. The individual piece parts used have closely matched coefficients of thermal expansion to ensure superior reliability over extended temperature excursions. This double-plug construction affords integral positive contact by means of a thermal-compression bond. Moisture-free stability is achieved through hermetic sealing. The chips used in these products feature diffused mesa and planar construction utilizing true glass passivation.

## DIODE ARRAYS

In addition to discrete diodes, TI also manufactures a very broad spectrum of diode arrays and diode matrices in integrated-circuit packages. These arrays feature multiple diode junctions fabricated by a planar process and assembled by a hybrid technique. They are ideal for logic and core-driver applications in computer, consumer, and other switching applications. Diode arrays offer many of the same advantages as integrated circuits, such as high density packaging and improved reliability. The high degree of reliability results from fewer connections, more uniform device parameters, smaller size, less weight, fewer glass-to-metal seals, and elimination of pressure contacts and whiskers. Dual-in-line packages facilitate use of wire-wrap techniques in the assembly of electronic equipment. To meet this requirement TI offers a broad selection of planar silicon diode-array products, both in the popular 14-pin dual-in-line packages and in the 10 - or 14 -pin flat pack ages.

## HIGH-REL SPECIAL CAPABILITY

In addition to the above standard product line, TI also has extensive capabilities to manufacture special discrete diodes such as high-reliability diodes. This high-rel capability is based on the philosophy that reliability must be built into a product and not tested into it. Consequently. TI established a high-rel manufacturing facility with a Class- 100 clean-room atmosphere that is virtually particle-free with a manufacturing flow designed to meet or exceed the most stringent specifications. Individual piece parts are cleaned and inspected prior to assembly which results in the ultra-high-rel features of these products.

## DIODE PRODUCT SPECTRUM

In addition to assembly capability, TI has available extensive environmental and electrical-test facilities for performing environmental tests such as temperature cycling, mechanical shock, vibration, centrifuge, radiographic inspection, visual inspection, high-temperature reverse blocking, d-c operation, liquid bath for parameter matching, and other environmental tests.

Upon request, TI will supply customers with quotations for hi-rel diode products.

## DISCRETE DIODE SHIPPING CONTAINERS

Texas Instruments ships axial-lead diode products using several methods including bulk, bag, and reel packaging.

1. Bulk Pack

Bulk pack is TI's standard method of shipment. Diodes are packed in plastic boxes measuring 3 by $21 / 8$ by 1 1/8 inches. (See illustration). The quantity of parts per box varies according to the package outline as shown below:

|  | DO-41 | DO.7 | PPt | DO-35 | DO.34 |
| :---: | :---: | :---: | :---: | :---: | :---: |
| Maximum Quantity | 250 | 250 | 500 | 500 | 500 |

Up to 10 plastic boxes are packed in cardboard containers for ease of handling.

2. Bag Pack

Upon request, diodes can be placed in plastic bags. The average quantity is 5,000 per bag. This method is most commonly used for clipped-lead diodes and offers maximum economy to the customer.

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## DIODE PRODUCT SPECTRUM

## 3. Reel Pack

Texas Instruments will supply, upon request, reel-packed diodes. These reel packages meet industry accepted standards for component spacing when used with automatic insertion equipment.

Reel-packed diodes are shipped on standard 14 -inch reels with the following quantity per reel:

|  | DO-41 | DO-7 | PP $\dagger$ | DO-35 | DO-34 |
| :---: | :---: | :---: | :---: | :---: | :---: |
| Maximum Quantity $\ddagger$ | 5,000 | 5,000 | 8,000 | 10,000 | 10,000 |



| BODY DIA | DIODE <br> SPACING <br> "A" | TAPE <br> SPACING <br> "B" | REEL <br> WIDTH <br> "C" |
| :---: | :---: | :---: | :---: |
| Up to 0.200 | $0.200 \pm 0.015$ | 2 to $2 \frac{3}{32}$ | $3 \pm \frac{1}{32}$ | REEL PACK DIMENSIONS $^{\text {REASIONS ARE IN INCHES }}$

NOTES: 1. Any kink or bend that projects outside of the lead position is less than $3 / 64$ inch radius.
Overall length-of devices is $1 / 8$ to $1 / 4$ inch shorter than the " $C$ " dimension of the real.
All diodes are oriented in one direction. The cathode lead tape is red and the anode lead rape is white.
Lead tape is $\mathbf{1 / 4}$-inch Minnesota Mining and Manufacturing Company $\# 267$ tape or equivalent. Reals are disposeble metal, chipboard, piattic, or equivalent.
A minimum 36 -inch leader tape is provided before the first and after the last diode on the reel.
50 - or 60-lb. kraft paper is wound between layers of diodes. Width of this paper is $\mathbf{1 / 1 6}$ inch to $\mathbf{3 / 4}$ inch less then the "C" dimansion of the real.
8. Rows of dodes are cantered $\pm 3 / 64$ inch between tapes. Individual diodes may deviate $\pm 1 / 32$ inch from the center of the diode row.
9. No steples or other mechanical devices are used for splicing. Up to four layers of tape may be used in one splice area. No tape is offset from another by more than $1 / 32$ inch. Tape splices overlap at least six inches and are as strong as the unspliced tape.
10. A maximum of 10 diodes may be missing from any 10 -foot section. A maximum of three consecutive diodes may be missing provided this gep is followed by six consecutive diodes.
11. Reels and cartons are marked as follows:

Ti Part No.
Purchase Order No.
Quantity
Date Code or Codes
tsee packege drawing on pege 8-14.
FQuantities lese then 100 are shipped in bulk pack.

# Diode <br> Selection Guides 

## DIODE SELECTION GUIDES

These guides are arranged into application families. These families are:
Switching Diodes ..... 8-1
Picosecond Diodes ..... 8-2
Radiation-Tolerant Diodes ..... 8-2
Tuning Diodes ..... 8-3
General Purpose Diodes ..... 8.3
Rectifiers ..... 8-4
Voltage Regulators ..... 8-5
Dual Diodes ..... 8-12
Diode Arrays ..... 8-12
Diode Matrices ..... $8-13$

The tabular entries within these families are not made in the usual manner of increasing type number, which would have little inherent utility, but rather are ranked by the most-significant electrical characteristic of that family. Where there is more than one diode type having the identical primary characteristic, the types within that group are further ranked by a secondary characteristic, and so on.

This form of organization works most efficiently when the user's selection criteria coincides with the organizational layout but should not present undue difficulties if it does not.

# PRODUCT SELECTION GUIDE DIODES AND RECTIFIERS 

## SWITCHING DIODES

| device TYPE | FORWARD CURRENT |  | VBR <br> (V) | MAXIMUM $\mathbf{I}_{\text {R }}$ |  |  |  | $\begin{aligned} & C_{T} \\ & (\mathrm{pF}) \end{aligned}$ | $\begin{aligned} & \mathbf{t}_{\mathbf{r r}} \\ & (\mathrm{ns}) \end{aligned}$ | PACKAGE* |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  | $25^{\circ} \mathrm{C}$ | $150^{\circ} \mathrm{C}$ |  |  |  |  |
|  | $I_{F}(\mathrm{~mA})$ | $V_{F}(\mathrm{~V})$ |  | (V) | $(\mu \mathrm{A})$ | (V) | ( $\mu \mathrm{A}$ ) |  |  |  |
| 1N625 | 4.0 | 1.5 |  | 30 | 20 | 1.0 |  |  |  | 1000 | PP |
| 1 N626 | 4.0 | 1.5 | 50 | 35 | 1.0 |  |  |  | 1000 | PP |
| 1N627 | 4.0 | 1.5 | 100 | 75 | 1.0 |  |  |  | 1000 | PP |
| 1 N628 | 4.0 | 1.5 | 150 | 125 | 1.0 |  |  |  | 1000 | PP |
| 1N629 | 4.0 | 1.5 | 200 | 175 | 1.0 |  |  |  | 1000 | PP |
| 1N251 | 5.0 | 1.0 | 40 | 10 | 0.1 |  |  |  | 150 | PP |
| T171 | 6.0 | 1.0 | 40 | 20 | 1.0 |  |  |  | 10 | PP |
| 1N659 | 6.0 | 1.0 | 60 | 50 | 5.0 |  |  |  | 300 | PP |
| 1N660 | 6.0 | 1.0 | 120 | 100 | 5.0 |  |  |  | 300 | PP |
| 1N661 | 6.0 | 1.0 | 240 | 200 | 5.0 |  |  |  | 300 | PP |
| 1N4727 | 10 | 0.85 | 30 | 20 | 0.1 |  |  | 4.0 |  | D0-35 |
| 1N4305 | 10 | 0.85 | 75 | 50 | 0.1 | 50 | 100 | 2.0 | 4.0 | DO-35 |
| 1N917 | 10 | 1.0 | 40 | 10 | 0.05 |  |  | 2.5 | 6.0 | PP |
| TI72 | 10 | 1.0 | 40 | 20 | 1.0 |  |  |  | 20 | PP |
| 1N4532 | 10 | 1.0 | 75 | 50 | 0.1 | 50 | 100 | 2.0 | 4.0 | DO-34 |
| 1N4454 | 10 | 1.0 | 75 | 50 | 0.1 | 50 | 100 | 2.0 | 4.0 | DO-35 |
| 1N3064 | 10 | 1.0 | 75 | 50 | 0.1 | 50 | 100 | 2.0 | 4.0 | PP |
| 1 N662 | 10 | 1.0 | 100 | 10 | 1.0 |  |  |  | 500 | PP |
| 1N916 | 10 | 1.0 | 100 | 20 | 0.025 | 20 | 50 | 2.0 | 8.0 | PP |
| 1N914 | 10 | 1.0 | 100 | 20 | 0.025 | 20 | 50 | 4.0 | 8.0 | PP |
| 1N4149 | 10 | 1.0 | 100 | 20 | 0.025 | 20 | 50 | 2.0 | 4.0 | DO-35 |
| 1N4531 | 10 | 1.0 | 100 | 20 | 0.025 | 20 | 50 | 4.0 | 8.0 | D0-34 |
| 1 N4148 | 10 | 1.0 | 100 | 20 | 0.025 | 20 | 50 | 4.0 | 4.0 | DO. 35 |
| 1N643 | 10 | 1.0 | 200 | 100 | 1.0 | 30 | 50 |  | 300 | PP |
| 1N4533 | 20 | 0.88 | 40 | 30 | 0.05 | 30 | 50 | 2.0 | 4.0 | D0-34 |
| 1N4152 | 20 | 0.88 | 40 | 30 | 0.05 | 30 | 50 | 2.0 | 4.0 | D0-35 |
| 1N4534 | 20 | 0.88 | 75 | 50 | 0.05 | 50 | 50 | 2.0 | 4.0 | DO-34 |
| 1N4153 | 20 | 0.88 | 75 | 50 | 0.05 | 50 | 50 | 2.0 | 4.0 | DO-35 |
| TI73 | 20 | 1.0 | 40 | 20 | 1.0 |  |  |  | 20 | PP |
| 1N916A | 20 | 1.0 | 100 | 20 | 0.025 | 20 | 50 | 2.0 | 8.0 | PP |
| 1N4446 | 20 | 1.0 | 100 | 20 | 0.025 | 20 | 50 | 2.0 | 4.0 | DO-35 |
| 1N914A | 20 | 1.0 | 100 | 20 | 0.025 | 20 | 50 | 4.0 | 8.0 | PP |
| 1N4447 | 20 | 1.0 | 100 | 20 | 0.025 | 20 | 50 | 4.0 | 4.0 | DO-35 |
| 1N4536 | 30 | 1.0 | 35 | 20 | 0.1 | 20 | 100 | 4.0 | 4.0 | DO-34 |
| 1N4154 | 30 | 1.0 | 35 | 25 | 0.1 | 25 | 100 | 4.0 | 4.0 | DO-35 |
| Ti74 | 30 | 1.0 | 40 | 15 | 1.0 |  |  |  | 30 | PP |
| 1N4449 | 30 | 1.0 | 100 | 20 | 0.025 | 20 | 50 | 2.0 | 4.0 | DO-35 |
| 1N916B | 30 | 1.0 | 100 | 20 | 0.025 | 20 | 50 | 2.0 | 8.0 | PP |
| 1N915 | 50 | 1.0 | 65 | 10 | 0.025 |  |  | 4.0 | 10 | PP |
| 1N4151 | 50 | 1.0 | 75 | 50 | 0.05 | 50 | 50 | 2.0 | 4.0 | DO-35 |
| TID40 | 50 | 1.0 | 250 | 100 | 0.1 | 20 | 50 | 5.0 | 30 | PP |
| TID45 | 50 | 1.0 | 250 | 200 | 2.0 |  |  | 1.5 | 50 | PP |
| T175 | 75 | 1.0 | 40 | 35 | 5.0 |  |  |  | 50 | PP |
| 1N4444 | 100 | 1.0 | 70 | 50 | 0.05 | 50 | 50 | 2.0 | 4.0 | DO-35 |
| TID38 | 100 | 1.0 | 75 | 50 | 0.1 |  |  | 3.0 | 5.0 | DO-35 |
| TID37 | 100 | 1.0 | 75 | 50 | 0.1 | 50 | 100 | 4.0 | 6.0 | DO-35 |

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## SWITCHING DIODES (Continued)

| DEVICE TYPE | FORWARD CURRENT |  | $V_{B R}$ <br> (V) | MAXIMUM $\mathbf{I}_{\mathbf{R}}$ |  |  |  | $\begin{gathered} C_{T} \\ (p F) \end{gathered}$ | $\begin{aligned} & \mathbf{t}_{\mathbf{r r}} \\ & \text { (ns) } \end{aligned}$ | PACKAGE* |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  | $25^{\circ} \mathrm{C}$ | $150^{\circ} \mathrm{C}$ |  |  |  |  |
|  | $I_{F}(\mathrm{~mA})$ | $V_{F}(\mathrm{~V})$ |  | (V) | ( $\mu \mathrm{A}$ ) |  | $(\mu \mathrm{A})$ |  |  |  |
| TID39 | 100 | 1.0 |  | 75 | 50 | 0.1 |  |  | 5.0 | 20 | DO.35 |
| 1N914B | 100 | 1.0 | 100 | 20 | 0.025 | 20 | 50 | 4.0 | 8.0 | PP |
| 1 N4448 | 100 | 1.0 | 100 | 20 | 0.025 | 20 | 50 | 4.0 | 4.0 | DO-35 |
| TID36 | 100 | 1.0 | 100 | 50 | 0.1 | 50 | 100 | 4.0 | 10 | DO-35 |
| 1 N663 | 100 | 1.0 | 100 | 75 | 5.0 |  |  |  | 500 | PP |
| TID42 | 100 | 1.0 | 150 | 100 | 0.1 | 20 | 50 | 5.0 | 30 | PP |
| TID41 | 100 | 1.0 | 200 | 100 | 0.1 | 20 | 50 | 5.0 | 30 | PP |
| 1N4938 | 100 | 1.0 | 250 | 175 | 0.1 | 175 | 100 | 5.0 | 50 | DO-35 |
| 1N3070 | 100 | 1.0 | 250 | 175 | 0.1 | 175 | 100 | 5.0 | 50 | PP |
| TID35 | 150 | 1.0 | 75 | 50 | 0.1 | 50 | 100 | 4.0 | 10 | DO-35 |
| TID34 | 150 | 1.0 | 100 | 50 | 0.1 | 50 | 100 | 4.0 | 10 | DO-35 |
| TID43 | 150 | 1.0 | 150 | 100 | 0.1 | 20 | 50 | 5.0 | 30 | PP |
| 1N4150 | 200 | 1.0 | 50 | 50 | 0.1 | 50 | 100 | 2.5 | 4.0 | D0-35 |
| TID31 | 200 | 1.0 | 75 | 50 | 0.1 | 50 | 100 | 2.5 | 6.0 | DO.35 |
| TID33 | 200 | 1.0 | 75 | 50 | 0.1 | 50 | 100 | 4.0 | 10 | DO-35 |
| TID32 | 200 | 1.0 | 100 | 50 | 0.1 | 50 | 100 | 4.0 | 10 | DO-35 |
| TID44 | 200 | 1.0 | 100 | 100 | 0.1 | 20 | 50 | 5.0 | 30 | PP |
| 1N4606 | 250 | 1.1 | 85 | 50 | 0.1 |  |  | 2.5 | 6.0 | DO-35 |
| 1N4607 | 400 | 1.1 | 85 | 50 | 0.1 |  |  | 4.0 | 10 | DO-35 |
| 1N4608 | 500 | 1.1 | 85 | 50 | 0.1 |  |  | 4.0 | 10 | DO-35 |

PICO-SECOND DIODES

| DEVICE <br> TYPE | FORWARD CURRENT |  | VBR <br> (V) | MAXIMUM IR |  |  |  | $\begin{aligned} & C_{T} \\ & (\mathrm{pF}) \end{aligned}$ | $\begin{aligned} & t_{\text {rr }} \\ & \text { (ps) } \end{aligned}$ | PACKAGE* |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  | $25^{\circ} \mathrm{C}$ | $150^{\circ} \mathrm{C}$ |  |  |  |  |
|  | $I_{F}(\mathrm{~mA})$ | $V_{F}(\mathrm{~V})$ |  | (V) | $(\mu \mathrm{A})$ | (V) | ( $\mu \mathrm{A})$ |  |  |  |
| TID778 | 50 | 1.35 |  | 30 | 20 | 0.1 | 20 | 100 | 1.0 | 750 | D0.35 |
| TID777 | 50 | 1.35 | 20 | 20 | 0.1 | 20 | 100 | 1.3 | 750 | DO-35 |

RADIATION TOLERANT DIODES

| DEVICE TYPE | FORWARD CURRENT |  | $V_{B R}(V)$ |  | MAXIMUM IR |  |  |  | $\begin{aligned} & C_{T} \\ & (p F) \end{aligned}$ | $\begin{aligned} & \mathbf{t}_{\mathbf{r r}} \\ & \text { (ns) } \end{aligned}$ | PACKAGE* |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  | $25^{\circ} \mathrm{C}$ | $125^{\circ} \mathrm{C}$ |  |  |  |  |
|  | $I_{F}(\mathrm{~mA})$ | $V_{F}(V)$ |  |  |  | MAX | (V) | $(\mu \mathrm{A})$ |  |  |  | (V) | ( $\mu \mathrm{A}$ ) |
| T1550 | 100 | 1.0 | 200 | 300 | 175 | 0.1 | 175 | 10 | 20 | 0.7 | PP |
| TI551 | 100 | 1.0 | 290 | 400 | 225 | 0.1 | 225 | 10 | 20 | 0.7 | PP |

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# PRODUCT SELECTION GUIDE DIODES AND RECTIFIERS 

TUNING DIODES

| DEVICE <br> TYPE | PF CAPACITANCE VR |  |  | CAP RATIO |  | FIGURE OF | VBR <br> (V) | FUNCTION | PACKAGE* |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | MIN | MAX | $\mathbf{V}$ | MIN | MAX | MERIT $\mathbf{Q}$ | (V) |  |  |
| TIV306 | 5 | 9 | 4 | 1.5 |  | 200 | 20 | AFC | DO-35 |
| TIV307 | 7 | 11 | 4 | 1.5 |  | 200 | 20 | AFC | DO-35 |
| TIV22 | 9 | 14 | 3 | 4.0 | 5.0 | 150 | 30 | UHF | DO-34 |
| TIV23 | 9 | 14 | 3 | 4.0 | 6.0 | 100 | 30 | UHF | DO-34 |
| TIV21 | 9 | 14 | 3 | 4.5 | 6.0 | 150 | 30 | UHF | DO-34 |
| TIV308 | 9 | 14 | 4 | 1.5 |  | 200 | 20 | AFC | DO-35 |
| TIV24 | 22 | 34 | 3 | 3.5 | 6.0 | 80 | 30 | VHF | DO-34 |
| TIV25 | 23 | 34 | 3 | 4.5 | 6.0 | 80 | 30 | VHF | DO-34 |

GENERAL PURPOSE DIODES

| DEVICE TYPE | FORWARD CURRENT |  | $V_{B R}$ (V) | MAXIMUM $\mathbf{I}_{\mathbf{R}}$ |  |  |  | PACKAGE* |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  | $25^{\circ} \mathrm{C}$ | $150^{\circ} \mathrm{C}$ |  |  |
|  | $I_{F}(\mathrm{~mA})$ | $\mathbf{V F}_{F}(\mathrm{~V})$ |  | (V) | ( $\mu \mathrm{A})$ | (V) | $(\mu \mathrm{A})$ |  |
| 1N463 | 1.0 | 1.0 |  | 200 | 175 | 0.5 | 175 | 30 | D0.7 |
| 1N464 | 3.0 | 1.0 | 150 | 125 | 0.5 | 125 | 30 | DO-7 |
| 1N459 | 3.0 | 1.0 | 200 | 175 | 0.025 | 175 | 5 | DO-7 |
| 1N462 | 5.0 | 1.0 | 70 | 60 | 0.5 | 60 | 30 | DO-7 |
| 1N458 | 7.0 | 1.0 | 150 | 125 | 0.025 | 125 | 5 | DO-7 |
| 1N461 | 15.0 | 1.0 | 30 | 25 | 0.5 | 25 | 30 | DO-7 |
| 1N457 | 20.0 | 1.0 | 70 | 60 | 0.025 | 60 | 5 | D0.7 |
| 1N456 | 40.0 | 1.0 | 30. | 25 | 0.025 | 25 | 5 | DO-7 |
| G129 | 100 | 1.0 | 6 | 2 | 0.1 |  |  | DO-7 |
| G130 | 100 | 1.0 | 6 | 2 | 0.1 |  |  | D0.7 |
| 1N456A | 100 | 1.0 | 30 | 25 | 0.025 | 25 | 5 | D0.7 |
| 1N461A | 100 | 1.0 | 30 | 25. | 0.5 | 25 | 30 | DO-7 |
| 1N482A | 100 | 1.0 | 40 | 30 | 0.025 | 30 | 15 | D0-7 |
| 1N482B | 100 | 1.0 | 40 | 30 | 0.025 | 30 | 5 | DO-7 |
| 1N457A | 100 | 1.0 | 70 | 60 | 0.025 | 60 | 5 | D0-7 |
| 1N462A | 100 | 1.0 | 70 | 60 | 0.5 | 60 | 30 | DO. 7 |
| 1N483A | 100 | 1.0 | 80 | 60 | 0.025 | 60 | 15 | DO-7 |
| 1 N483B | 100 | 1.0 | 80 | 60 | 0.025 | 60 | 5 | DO-7 |
| 1N458A | 100 | 1.0 | 150 | 125 | 0.025 | 125 | 5 | D0.7 |
| 1N464A | 100 | 1.0 | 150 | 125 | 0.5 | 125 | 30 | DO-7 |
| 1N484A | 100 | 1.0 | 150 | 125 | 0.025 | 125 | 15 | DO-7 |
| 1N484B | 100 | 1.0 | 150 | 125 | 0.025 | 125 | 5 | DO-7 |
| 1N459A | 100 | 1.0 | 200 | 175 | 0.025 | 175 | 5 | D0-7 |
| 1N463A | 100 | 1.0 | 200 | 175 | 0.5 | 175 | 30 | D0-7 |
| 1N485A | 100 | 1.0 | 200 | 175 | 0.025 | 175 | 15 | DO-7 |
| 1N485B | 100 | 1.0 | 200 | 175 | 0.025 | 175 | 5 | DO-7 |
| 1 N482 | 100 | 1.1 | 40 | 30 | 0.250 | 30 | 30 | D0.7 |
| 1N483 | 100 | 1.1 | 80 | 70 | 0.250 | 70 | 30 | DO-7 |
| 1N484 | 100 | 1.1 | 150 | 125 | 0.250 | 125 | 30 | D0.7 |
| 1N485 | 100 | 1.1 | 200 | 175 | 0.250 | 175 | 30 | DO-7 |
| T151 | 200 | 1.0 | 20 | 10 | 1.0 |  |  | DO-7 |
| TI52 | 200 | 1.0 | 30 | 20 | 1.0 |  |  | D0-7 |

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## PRODUCT SELECTION GUIDE <br> DIODES AND RECTIFIERS

GENERAL PURPOSE DIODES (Continued)

| DEVICE <br> TYPE | FORWARD CURRENT |  | $V_{B R}$ <br> (V) | MAXIMUM $\mathbf{I}_{\mathbf{R}}$ |  |  |  | PACKAGE* |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | $I_{F}(\mathrm{~mA})$ | $V_{F}(\mathrm{~V})$ |  | $25^{\circ} \mathrm{C}$ |  | $150^{\circ} \mathrm{C}$ |  |  |
|  |  |  |  | (V) | $(\mu \mathrm{A})$ | (V) | ( $\mu \mathrm{A}$ ) |  |
| TI53 | 200 | 1.0 | 40 | 30 | 1.0 |  |  | DO-7 |
| T154 | 200 | 1.0 | 50 | 40 | 1.0 |  |  | D0-7 |
| TI55 | 200 | 1.0 | 80 | 60 | 1.0 |  |  | DO-7 |
| T156 | 400 | 1.0 | 120 | 100 | 1.0 |  |  | D0.7 |
| T157 | 400 | 1.0 | 200 | 150 | 1.0 |  |  | DO-7 |
| T158 | 400 | 1.0 | 270 | 175 | 1.0 |  |  | DO-7 |
| 1N645 | 400 | 1.0 | 275 | 225 | 0.2 |  |  | DO-7 |
| 1N645A | 400 | 1.0 | 275 | 225 | 0.2 |  |  | D0-7 |
| T159 | 400 | 1.0 | 320 | 200 | 1.0 |  |  | D0-7 |
| 1 N646 | 400 | 1.0 | 360 | 300 | 0.2 |  |  | DO-7 |
| T160 | 400 | 1.0 | 400 | 300 | 1.0 |  |  | DO-7 |
| 1 N647 | 400 | 1.0 | 480 | 400 | 0.2 |  |  | DO-7 |
| 1 N648 | 400 | 1.0 | 600 | 500 | 0.2 |  |  | DO-7 |
| 1N649 | 400 | 1.0 | 720 | 600 | 0.2 |  |  | DO-7 |

RECTIFIERS

| Device TYPE | $\begin{aligned} & 10 \\ & \text { (A) } \end{aligned}$ | SURGE <br> (A) | FORWARD CURRENT |  | $V_{B R}$ <br> (V) | MAXIMUM $\mathbf{I}_{\mathbf{R}}$ |  |  |  | PACKAGE* |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  | $I_{F}(\mathrm{~A})$ | $V_{F}(\mathrm{~V})$ |  | $25^{\circ} \mathrm{C}$ |  | $100^{\circ} \mathrm{C}$ |  |  |
|  |  |  |  |  |  | V | $\mu \mathrm{A}$ | V | $\mu \mathrm{A}$ |  |
| 1N645 | 0.400 | 3 | 0.400 | 1.0 | 275 | 225 | 0.2 | 225 | 15 | DO-7 |
| 1N645A | 0.400 | 3 | 0.400 | 1.0 | 275 | 225 | 0.2 | 225 | 15 | DO-7 |
| 1N646 | 0.400 | 3 | 0.400 | 1.0 | 360 | 300 | 0.2 | 300 | 15 | DO-7 |
| 1 N647 | 0.400 | 3 | 0.400 | 1.0 | 480 | 400 | 0.2 | 400 | 20 | DO-7 |
| 1N648 | 0.400 | 3 | 0.400 | 1.0 | 600 | 500 | 0.2 | 500 | 20 | DO-7 |
| 1N649 | 0.400 | 3 | 0.400 | 1.0 | 720 | 600 | 0.2 | 600 | 25 | DO-7 |
| 1N2069A | 0.750 | 6 | 0.500 | 1.0 | 200 | 200 | 5 |  |  | DO-41 |
| 1N2069 | 0.750 | 6 | 0.500 | 1.2 | 200 | 200 | 10 |  |  | DO.41 |
| 1N2070A | 0.750 | 6 | 0.500 | 1.0 | 400 | 400 | 5 |  |  | 00-41 |
| 1N2070 | 0.750 | 6 | 0.500 | 1.2 | 400 | 400 | 10 |  |  | DO-41 |
| 1N2071A | 0.750 | 6 | 0.500 | 1.0 | 600 | 600 | 5 |  |  | D0.41 |
| 1N2071 | 0.750 | 6 | 0.500 | 1.2 | 600 | 600 | 10 |  |  | DO-41 |
| 1N4001 | 1.0 | 30 | 1.0 | 1.1 | 50 | 50 | 10 | 50 | 50 | DO-41 |
| 1N4002 | 1.0 | 30 | 1.0 | 1.1 | 100 | 100 | 10 | 100 | 50 | DO-41 |
| 1N4003 | 1.0 | 30 | 1.0 | 1.1 | 200 | 200 | 10 | 200 | 50 | DO-41 |
| 1N4004 | 1.0 | 30 | 1.0 | 1.1 | 400 | 400 | 10 | 400 | 50 | D0-41 |
| 1N4005 | 1.0 | 30 | 1.0 | 1.1 | 600 | 600 | 10 | 600 | 50 | D0.41 |
| 1N4006 | 1.0 | 30 | 1.0 | 1.1 | 800 | 800 | 10 | 800 | 50 | DO-41 |
| 1 N4007 | 1.0 | 30 | 1.0 | 1.1 | 1000 | 1000 | 10 | 1000 | 50 | DO-41 |
| TID381 | 1.0 | 50 | 1.0 | 1.1 | 50 | 50 | 10 | 50 | 250 | DO-41 |
| TID382 | 1.0 | 50 | 1.0 | 1.1 | 100 | 100 | 10 | 100 | 250 | D0-41 |
| TID383 | 1.0 | 50 | 1.0 | 1.1 | 200 | 200 | 10 | 200 | 250 | DO.41 |
| TID384 | 1.0 | 50 | 1.0 | 1.1 | 400 | 400 | 10 | 400 | 250 | DO-41 |
| TID385 | 1.0 | 50 | 1.0 | 1.1 | 600 | 600 | 10 | 600 | 250 | D0-41 |

[^175]
## PRODUCT SELECTION GUIDE DIODES AND RECTIFIERS

VOLTAGE REGULATORS

| DEVICE TYPE | $\begin{gathered} P_{D} \oplus 25^{\circ} \mathrm{C} \\ (\mathrm{~mW}) \end{gathered}$ | $\mathrm{V}_{\mathbf{z}} \mathrm{I}_{\text {IT }}$ |  | $\begin{gathered} \text { TOL } \\ \hline \end{gathered}$ | $\mathbf{I R}_{\mathbf{R}} \mathrm{V}_{\mathrm{R}}$ |  | $\frac{z_{\mathbf{Z}} @ \mathbf{I}_{\mathbf{Z T}}}{\operatorname{MAX} \Omega}$ | PACKAGE* |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | (V) | (mA) |  | (V) | ( 1 A) |  |  |
| 1N702 | 400 | 2.6 | 5 | 20 | 1 | 75 | 60 | DO-7 |
| 1N702A | 400 | 2.6 | 5 | 5 | 1 | 75 | 60 | D0.7 |
| 1N746 | 400 | 3.3 | 20 | 10 | 1 | 10 | 28 | DO-7 |
| 1N746A | 400 | 3.3 | 20 | 5 | 1 | 10 | 28 | DO-7 |
| 1N3506 | 400 | 3.3 | 20 | 5 | 1 | 4 | 24 | D0.7 |
| 1N703 | 400 | 3.45 | 5 | 20 | 1 | 50 | 55 | DO-7 |
| 1N703A | 400 | 3.45 | 5 | 5 | 1 | 50 | 55 | DO-7 |
| 1N747 | 400 | 3.6 | 20 | 10 | 1 | 10 | 24 | DO-7 |
| 1N747A | 400 | 3.6 | 20 | 5 | 1 | 10 | 24 | D0.7 |
| 1N3507 | 400 | 3.6 | 20 | 5 | 1 | 2 | 22 | DO-7 |
| 1N748 | 400 | 3.9 | 20 | 10 | 1 | 10 | 23 | D0-7 |
| 1N748A | 400 | 3.9 | 20 | 5 | 1 | 10 | 23 | D0.7 |
| 1N3508 | 400 | 3.9 | 20 | 5 | 1 | 0.4 | 20 | D0.7 |
| 1N704 | 400 | 4.1 | 5 | 20 | 1 | 5 | 45 | DO-7 |
| 1N704A | 400 | 4.1 | 5 | 5 | 1 | 5 | 45 | DO-7 |
| 1N749 | 400 | 4.3 | 20 | 10 | 1 | 2 | 22 | DO-7 |
| 1N749A | 400 | 4.3 | 20 | 5 | 1 | 2 | 22 | D0-7 |
| 1N3509 | 400 | 4.3 | 20 | 5 | 1 | 0.1 | 18 | D0.7 |
| 1N750 | 400 | 4.7 | 20 | 10 | 1 | 2 | 19 | DO-7 |
| 1N750A | 400 | 4.7 | 20 | 5 | 1 | 2 | 19 | D0-7 |
| 1N3510 | 400 | 4.7 | 20 | 5 | 2 | 5 | 16 | DO-7 |
| 1N705 | 400 | 4.85 | 5 | 20 | 1.5 | 5 | 35 | D0.7 |
| 1N705A | 400 | 4.85 | 5 | 5 | 1.5 | 5 | 35 | DO-7 |
| 1N761 | 400 | 4.85 | 10 | 10 |  |  | 40 | D0-7 |
| 1N751 | 400 | 5.1 | 20 | 10 | 1 | 1 | 17 | DO-7 |
| 1N751A | 400 | 5.1 | 20 | 5 | 1 | 1 | 17 | DO-7 |
| 1N3511 | 400 | 5.1 | 20 | 5 | 2 | 2 | 14 | DO-7 |
| 1N752 | 400 | 5.6 | 20 | 10 | 1 | 1 | 11 | DO-7 |
| 1N752A | 400 | 5.6 | 20 | 5 | 1 | 1 | 11 | D0.7 |
| 1N3512 | 400 | 5.6 | 20 | 5 | 3 | 5 | 8 | D0.7 |
| 1N708 | 400 | 5.6 | 25 | 10 |  |  | 3.6 | D0-7 |
| 1N708A | 400 | 5.6 | 25 | 5 |  |  | 3.6 | D0-7 |
| 1N706 | 400 | 5.8 | 5 | 20 | 1.5 | 5 | 20 | D0.7 |
| 1N706A | 400 | 5.8 | 5 | 5 | 1.5 | 5 | 20 | DO-7 |
| 1N762 | 400 | 5.8 | 10 | 10 |  |  | 18 | DO-7 |
| 1N753 | 400 | 6.2 | 20 | 10 | 1 | 0.1 | 7 | DO-7 |
| 1N753A | 400 | 6.2 | 20 | 5 | 1 | 0.1 | 7 | DO-7 |
| 1 N3513 | 400 | 6.2 | 20 | 5 | 4 | 5 | 3 | DO-7 |
| 1N709 | 400 | 6.2 | 25 | 10 |  |  | 4.1 | D0-7 |
| 1N709A | 400 | 6.2 | 25 | 5 |  |  | 4.1 | DO-7 |
| 1 N957 | 400 | 6.8 | 18.5 | 20 |  |  | 4.5 | D0-7 |
| 1N957A | 400 | 6.8 | 18.5 | 10 | 5.2 | 150 | 4.5 | DO-7 |
| 1N957B | 400 | 6.8 | 18.5 | 5 | 5.2 | 150 | 4.5 | DO. 7 |
| 1N754 | 400 | 6.8 | 20 | 10 | 1 | 0.1 | 5 | DO-7 |
| 1N754A | 400 | 6.8 | 20 | 5 | 1 | 0.1 | 5 | D0.7 |
| 1N3514 | 400 | 6.8 | 20 | 5 | 5 | 1 | 3 | D0.7 |

VOLTAGE REGULATORS (Continued)

| DEVICE TYPE | $\begin{gathered} \text { PD @ } 25^{\circ} \mathrm{C} \\ (\mathrm{~mW}) \end{gathered}$ | $V_{z}$ @ IzT |  | $\begin{gathered} \text { TOL } \\ \% \end{gathered}$ | $\mathbf{I}_{\mathbf{R}} @ \mathrm{~V}_{\mathbf{R}}$ |  |  | PACKAGE* |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | (V) | (mA) |  | (V) | ( $\mu$ A) |  |  |
| 1N710 | 400 | 6.8 | 25 | 10 |  |  | 4.7 | DO-7 |
| 1N710A | 400 | 6.8 | 25 | 5 |  |  | 4.7 | DO-7 |
| 1N707 | 400 | 7.1 | 5 | 20 | 3.5 | 5 | 10 | DO-7 |
| 1N707A | 400 | 7.1 | 5 | 5 | 3.5 | 5 | 10 | DO-7 |
| 1N763 | 400 | 7.1 | 10 | 10 |  |  | 7 | DO-7 |
| 1 N3515 | 400 | 7.5 | 10 | 5 | 6 | 0.5 | 4 | DO-7 |
| 1N958 | 400 | 7.5 | 16.5 | 20 |  |  | 5.5 | DO-7 |
| 1N958A | 400 | 7.5 | 16.5 | 10 | 5.7 | 75 | 5.5 | DO-7 |
| 1 N958B | 400 | 7.5 | 16.5 | 5 | 5.7 | 75 | 5.5 | DO-7 |
| 1N755 | 400 | 7.5 | 20 | 10 | 1 | 0.1 | 6 | D0-7 |
| 1N755A | 400 | 7.5 | 20 | 5 | 1 | 0.1 | 6 | DO-7 |
| 1N711 | 400 | 7.5 | 25 | 10 |  |  | 5.3 | DO. 7 |
| 1N711A | 400 | 7.5 | 25 | 5 |  |  | 5.3 | D0.7 |
| 1N3516 | 400 | 8.2 | 10 | 5 | 7 | 0.25 | 5 | D0-7 |
| 1N959 | 400 | 8.2 | 15 | 20 |  |  | 6.5 | D0-7 |
| 1N959A | 400 | 8.2 | 15 | 10 | 6.2 | 50 | 6.5 | D0-7 |
| 1N959B | 400 | 8.2 | 15 | 5 | 6.2 | 50 | 6.5 | D0.7 |
| 1N756 | 400 | 8.2 | 20 | 10 | 1 | 0.1 | 8 | DO-7 |
| 1N756A | 400 | 8.2 | 20 | 5 | 1 | 0.1 | 8 | DO-7 |
| 1 N712 | 400 | 8.2 | 25 | 10 |  |  | 6 | DO-7 |
| 1N712A | 400 | 8.2 | 25 | 5 |  |  | 6 | DO-7 |
| 1N764 | 400 | 8.75 | 10 | 10 |  |  | 12 | DO-7 |
| 1N3517 | 400 | 9.1 | 10 | 5 | 7 | 0.025 | 6 | DO-7 |
| 1N713 | 400 | 9.1 | 12 | 10 |  |  | 7 | DO-7 |
| 1N713A | 400 | 9.1 | 12 | 5 |  |  | 7 | DO-7 |
| 1N960 | 400 | 9.1 | 14 | 20 |  |  | 7.5 | DO-7 |
| 1N960A | 400 | 9.1 | 14 | 10 | 6.9 | 25 | 7.5 | DO-7 |
| 1 N960B | 400 | 9.1 | 14 | 5 | 6.9 | 25 | 7.5 | DO-7 |
| 1N757 | 400 | 9.1 | 20 | 10 | 1 | 0.1 | 10 | DO.7 |
| 1N757A | 400 | 9.1 | 20 | 5 | 1 | 0.1 | 10 | D0.7 |
| 1 N3518 | 400 | 10 | 10 | 5 | 8 | 0.010 | 7 | DO-7 |
| 1N714 | 400 | 10 | 12 | 10 |  |  | 8 | DO-7 |
| 1N714A | 400 | 10 | 12 | 5 |  |  | 8 | DO-7 |
| 1N961 | 400 | 10 | 12.5 | 20 |  |  | 8.5 | D0-7 |
| 1N961A | 400 | 10 | 12.5 | 10 | 7.6 | 10 | 8.5 | DO-7 |
| 1N961B | 400 | 10 | 12.5 | 5 | 7.6 | 10 | 8.5 | DO-7 |
| 1N758 | 400 | 10 | 20 | 10 | 1 | 0.1 | 17 | DO-7 |
| 1N758A | 400 | 10 | 20 | 5 | 1 | 0.1 | 17 | D0.7 |
| 1N765 | 400 | 10.5 | 5 | 10 |  |  | 45 | D0.7 |
| 1N3519 | 400 | 11 | 10 | 5 | 9 | 0.010 | 8 | D0.7 |
| 1N962 | 400 | 11 | 11.5 | 20 |  |  | 9.5 | D0-7 |
| 1N962A | 400 | 11 | 11.5 | 10 | 8 | 5 | 9.5 | D0.7 |
| 1 N962B | 400 | 11 | 11.5 | 5 | 8.4 | 5 | 9.5 | D0.7 |
| 1N715 | 400 | 11 | 12 | 10 |  |  | 9 | D0-7 |
| 1N715A | 400 | 11 | 12 | 5 |  |  | 9 | DO-7 |
| 1N3520 | 400 | 12 | 10 | 5 | 10 | 0.010 | 10 | DO-7 |
| 1N963 | 400 | 12 | 10.5 | 20 |  |  | 11.5 | DO-7 |
| 1N963A | 400 | 12 | 10.5 | 10 | 8.6 | 5 | 11.5 | DO-7 |

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## PRODUCT SELECTION GUIDE DIODES AND RECTIFIERS

Voltage regulators (Continued)

| DEVICE TYPE | $\begin{gathered} \hline \mathrm{PD}_{\mathrm{D}} @ 25^{\circ} \mathrm{C} \\ (\mathrm{~mW}) \end{gathered}$ | $\mathrm{V}_{\mathbf{Z}}$ © İİT |  | $\begin{gathered} \text { TOL } \\ \% \\ \hline \end{gathered}$ | $\mathbf{I}_{\mathbf{R}} \oplus \mathrm{V}_{\mathbf{R}}$ |  | $\frac{z_{Z} @ I \mathbf{Z T}}{\operatorname{MAX} \Omega}$ | PACKAGE* |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | (V) | (mA) |  | (V) | ( $\mu$ A) |  |  |
| 1N963B | 400 | 12 | 10.5 | 5 | 9.1 | 5 | 11.5 | DO. 7 |
| 1N716 | 400 | 12 | 12 | 10 |  |  | 10 | D0.7 |
| 1N716A | 400 | 12 | 12 | 5 |  |  | 10 | D0-7 |
| 1N759 | 400 | 12 | 20 | 10 | 1 | 0.1 | 30 | D0.7 |
| 1N759A | 400 | 12 | 20 | 5 | 1 | 0.1 | 30 | DO-7 |
| 1N766 | 400 | 12.75 | 5 | 10 |  |  | 55 | D0.7 |
| 1N3521 | 400 | 13 | 5 | 5 | 11 | 0.010 | 12 | DO-7 |
| 1N964 | 400 | 13 | 9.5 | 20 |  |  | 13 | DO-7 |
| 1N964A | 400 | 13 | 9.5 | 10 | 9.4 | 5 | 13 | D0-7 |
| 1N964B | 400 | 13 | 9.5 | 5 | 9.9 | 5 | 13 | DO-7 |
| 1N717 | 400 | 13 | 12 | 10 |  |  | 11 | DO-7 |
| 1N717A | 400 | 13 | 12 | 5 |  |  | 11 | DO-7 |
| 1N3522 | 400 | 15 | 5 | 5 | 13 | 0.010 | 14 | DO-7 |
| 1N965 | 400 | 15 | 8.5 | 20 |  |  | 16 | DO-7 |
| 1N965A | 400 | 15 | 8.5 | 10 | 10.8 | 5 | 16 | DO-7 |
| 1N965B | 400 | 15 | 8.5 | 5 | 11.4 | 5 | 16 | DO-7 |
| 1N718 | 400 | 15 | 12 | 10 |  |  | 13 | DO-7 |
| 1N718A | 400 | 15 | 12 | 5 |  |  | 13 | DO.7 |
| 1N767 | 400 | 15.75 | 5 | 10 |  |  | 70 | D0-7 |
| 1N3523 | 400 | 16 | 5 | 5 | 14 | 0.010 | 16 | DO-7 |
| 1N966 | 400 | 16 | 7.8 | 20 |  |  | 17 | D0.7 |
| 1N966A | 400 | 16 | 7.8 | 10 | 11.5 | 5 | 17 | D0-7 |
| 1N966B | 400 | 16 | 7.8 | 5 | 12 | 5 | 17 | D0-7 |
| 1N719 | 400 | 16 | 12 | 10 |  |  | 15 | DO-7 |
| 1N719A | 400 | 16 | 12 | 5 |  |  | 15 | DO-7 |
| 1 N3524 | 400 | 18 | 5 | 5 | 16 | 0.010 | 18 | D0. 7 |
| 1N967 | 400 | 18 | 7 | 20 |  |  | 21 | DO-7 |
| 1N967A | 400 | 18 | 7 | 10 | 13 | 5 | 21 | D0. 7 |
| 1N967B | 400 | 18 | 7 | 5 | 14 | 5 | 21 | D0.7 |
| 1N720 | 400 | 18 | 12 | 10 |  |  | 17 | DO-7 |
| 1N720A | 400 | 18 | 12 | 5 |  |  | 17 | DO-7 |
| 1N768 | 400 | 19 | 5 | 10 |  |  | 100 | D0.7 |
| 1N721 | 400 | 20 | 4 | 10 |  |  | 20 | D0-7 |
| 1N721A | 400 | 20 | 4 | 5 |  |  | 20 | DO-7 |
| 1N3525 | 400 | 20 | 5 | 5 | 18 | 0.010 | 20 | DO-7 |
| 1N968 | 400 | 20 | 6.2 | 20 |  |  | 25 | D0.7 |
| 1N968A | 400 | 20 | 6.2 | 10 | 14.4 | 5 | 25 | DO-7 |
| 1N968B | 400 | 20 | 6.2 | 5 | 15 | 5 | 25 | DO-7 |
| 1N722 | 400 | 22 | 4 | 10 |  |  | 24 | D0.7 |
| 1N722A | 400 | 22 | 4 | 5 |  |  | 24 | DO-7 |
| 1N3526 | 400 | 22 | 5 | 5 | 19 | 0.010 | 35 | DO-7 |

## PRODUCT SELECTION GUIDE <br> DIODES AND RECTIFIERS

VOLTAGE REGULATORS (Continued)

| DEVICE TYPE | $\begin{gathered} \mathrm{P}_{\mathrm{D}} @ \mathbf{2 5 ^ { \circ }} \mathrm{C} \\ (\mathrm{~mW}) \end{gathered}$ | $\mathrm{V}_{\mathrm{z}} \mathrm{l}^{\prime} \mathrm{zT}$ |  | $\begin{gathered} \hline \text { TOL } \\ \% \\ \hline \end{gathered}$ | $\mathrm{I}_{\mathrm{R}} @ \mathrm{~V}_{\mathrm{R}}$ |  | $\frac{\mathbf{z}_{\mathbf{Z}} \oplus \mathbf{I}_{\mathbf{Z}}}{\operatorname{MAX} \Omega}$ | PACKAGE* |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | (V) | (mA) |  | (V) | ( $\mu \mathrm{A}$ ) |  |  |
| 1N969 | 400 | 22 | 5.6 | 20 |  |  | 29 | DO-7 |
| 1 N 969 A | 400 | 22 | 5.6 | 10 | 15.8 | 5 | 29 | DO-7 |
| 1N969B | 400 | 22 | 5.6 | 5 | 17 | 5 | 29 | D0-7 |
| 1N769 | 400 | 23.5 | 5 | 10 |  |  | 150 | DO-7 |
| 1 N723 | 400 | 24 | 4 | 10 |  |  | 28 | DO-7 |
| 1N723A | 400 | 24 | 4 | 5 |  |  | 28 | DO-7 |
| 1N3527 | 400 | 24 | 5 | 5 | 20 | 0.010 | 38 | DO-7 |
| 1N970 | 400 | 24 | 5.2 | 20 |  |  | 33 | DO-7 |
| 1N970A | 400 | 24 | 5.2 | 10 | 17.3 | 5 | 33 | DO-7 |
| 1N970B | 400 | 24 | 5.2 | 5 | 18 | 5 | 33 | DO-7 |
| 1N724 | 400 | 27 | 4 | 10 |  |  | 35 | DO-7 |
| 1N724A | 400 | 27 | 4 | 5 |  |  | 35 | DO-7 |
| 1 N3528 | 400 | 27 | 4 | 5 | 22 | 0.010 | 40 | DO-7 |
| 1N971 | 400 | 27 | 4.6 | 20 |  |  | 41 | DO-7 |
| 1N971A | 400 | 27 | 4.6 | 10 | 19.4 | 5 | 41 | D0.7 |
| 1N971B | 400 | 27 | 4.6 | 5 | 21 | 5 | 41 | DO-7 |
| 1N725 | 400 | 30 | 4 | 10 |  |  | 42 | DO-7 |
| 1N725A | 400 | 30 | 4 | 5 |  |  | 42 | D0.7 |
| 1N3529 | 400 | 30 | 4 | 5 | 24 | 0.010 | 48 | DO. 7 |
| 1N972 | 400 | 30 | 4.2 | 20 |  |  | 49 | DO-7 |
| 1N972A | 400 | 30 | 4.2 | 10 | 21.6 | 5 | 49 | DO-7 |
| 1N972B | 400 | 30 | 4.2 | 5 | 23 | 5 | 49 | DO-7 |
| 1N3530 | 400 | 33 | 3 | 5 | 26 | 0.010 | 50 | D0.7 |
| 1N973 | 400 | 33 | 3.8 | 20 |  |  | 58 | DO-7 |
| 1N973A | 400 | 33 | 3.8 | 10 | 23.8 | 5 | 58 | D0-7 |
| 1N973B | 400 | 33 | 3.8 | 5 | 25 | 5 | 58 | DO-7 |
| 1N726 | 400 | 33 | 4 | 10 |  |  | 50 | D0.7 |
| 1N726A | 400 | 33 | 4 | 5 |  |  | 50 | DO-7 |
| 1 N5226 | 500 | 3.3 | 20 | 20 |  |  | 28 | D0.7 |
| 1N5226A | 500 | 3.3 | 20 | 10 | 0.95 | 25 | 28 | D0.7 |
| 1N5226B | 500 | 3.3 | 20 | 5 | 1 | 25 | 28 | D0.7 |
| 1N5227 | 500 | 3.6 | 20 | 20 |  |  | 24 | DO-7 |
| 1N5227A | 500 | 3.6 | 20 | 10 | 0.95 | 15 | 24 | D0-7 |
| 1N5227B | 500 | 3.6 | 20 | 5 | 1 | 15 | 24 | D0.7 |
| 1N5228 | 500 | 3.9 | 20 | 20 |  |  | 23 | DO-7 |
| 1N5228A | 500 | 3.9 | 20 | 10 | 0.95 | 10 | 23 | D0-7 |
| 1N5228B | 500 | 3.9 | 20 | 5 | 1 | 10 | 23 | D0.7 |
| 1N5229 | 500 | 4.3 | 20 | 20 |  |  | 22 | DO-7 |
| 1N5229A | 500 | 4.3 | 20 | 10 | 0.95 | 5 | 22 | DO-7 |
| 1N5229B | 500 | 4.3 | 20 | 5 | 1 | 5 | 22 | DO.7 |
| 1N5230 | 500 | 4.7 | 20 | 20 |  |  | 19 | DO-7 |
| 1N5230A | 500 | 4.7 | 20 | 10 | 1.9 | 5 | 19 | D0.7 |
| 1N5230B | 500 | 4.7 | 20 | 5 | 2 | 5 | 19 | DO-7 |
| 1N5231 | 500 | 5.1 | 20 | 20 |  |  | 17 | D0.7 |
| 1N5231A | 500 | 5.1 | 20 | 10 | 1.9 | 5 | 17 | DO-7 |
| 1N52318 | 500 | 5.1 | 20 | 5 | 2 | 5 | 17 | D0.7 |
| 1 N5232 | 500 | 5.6 | 20 | 20 |  |  | 11 | DO-7 |

*See package drawings on page 8-14.

## PRODUCT SELECTION GUIDE DIODES AND RECTIFIERS

VOLTAGE REGULATORS (Continued)

| DEVICE <br> TYPE | $\begin{gathered} \mathrm{PD}_{\mathrm{D} @} \mathbf{2 5 ^ { \circ } \mathrm { C }} \\ (\mathrm{~mW}) \end{gathered}$ | $\mathrm{V}_{\mathbf{Z}}$ @ $\mathrm{I}_{\mathbf{Z}}$ |  | $\begin{gathered} \text { TOL } \\ \% \\ \hline \end{gathered}$ | $\mathrm{I}_{\mathrm{R}}$ @ $\mathrm{V}_{\mathrm{R}}$ |  | $\frac{\mathrm{Z}_{\mathrm{Z}} \text { @ } \mathrm{I}_{\mathrm{ZT}}}{\operatorname{MAX} \Omega}$ | PACKAGE* |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | (V) | (mA) |  | (V) | ( $\mu \mathrm{A}$ ) |  |  |
| 1N5232A | 500 | 5.6 | 20 | 10 | 2.9 | 5 | 11 | DO. 7 |
| 1N5232B | 500 | 5.6 | 20 | 5 | 3 | 5 | 11 | DO-7 |
| 1N5233 | 500 | 6 | 20 | 20 |  |  | 7 | DO-7 |
| 1N5233A | 500 | 6 | 20 | 10 | 3.3 | 5 | 7 | DO-7 |
| 1N5233B | 500 | 6 | 20 | 5 | 3.5 | 5 | 7 | D0-7 |
| 1N5234 | 500 | 6.2 | 20 | 20 |  |  | 7 | D0.7 |
| 1N5234A | 500 | 6.2 | 20 | 10 | 3.8 | 5 | 7 | D0.7 |
| 1N5234B | 500 | 6.2 | 20 | 5 | 4 | 5 | 7 | D0. 7 |
| 1N5235 | 500 | 6.8 | 20 | 20 |  |  | 5 | DO-7 |
| 1N5235A | 500 | 6.8 | 20 | 10 | 4.8 | 3 | 5 | D0-7 |
| 1N5235B | 500 | 6.8 | 20 | 5 | 5 | 3 | 5 | DO-7 |
| 1N5236 | 500 | 7.5 | 20 | 20 |  |  | 6 | DO-7 |
| 1N5236A | 500 | 7.5 | 20 | 10 | 5.7 | 3 | 6 | DO. 7 |
| 1N5236B | 500 | 7.5 | 20 | 5 | 6 | 3 | 6 | D0-7 |
| 1N5237 | 500 | 8.2 | 20 | 20 |  |  | 8 | D0.7 |
| 1N5237A | 500 | 8.2 | 20 | 10 | 6.2 | 3 | 8 | D0.7 |
| 1N5237B | 500 | 8.2 | 20 | 5 | 6.5 | 3 | 8 | D0-7 |
| 1N5238 | 500 | 8.7 | 20 | 20 |  |  | 8 | DO-7 |
| 1N5238A | 500 | 8.7 | 20 | 10 | 6.2 | 3 | 8 | DO-7 |
| 1N5238B | 500 | 8.7 | 20 | 5 | 6.5 | 3 | 8 | D0.7 |
| 1N5239 | 500 | 9.1 | 20 | 20 |  |  | 10 | D0. 7 |
| 1N5239A | 500 | 9.1 | 20 | 10 | 6.7 | 3 | 10 | DO-7 |
| 1N5239B | 500 | 9.1 | 20 | 5 | 7 | 3 | 10 | DO-7 |
| 1N5240 | 500 | 10 | 20 | 20 |  |  | 17 | D0-7 |
| 1N5240A | 500 | 10 | 20 | 10 | 7.6 | 3 | 17 | DO.7 |
| 1N5240B | 500 | 10 | 20 | 5 | 8 | 3 | 17 | DO-7 |
| 1N5241 | 500 | 11 | 20 | 20 |  |  | 22 | DO-7 |
| 1N5241A | 500 | 11 | 20 | 10 | 8 | 2 | 22 | D0.7 |
| 1N5241B | 500 | 11 | 20 | 5 | 8.4 | 2 | 22 | DO-7 |
| 1N5242 | 500 | 12 | 20 | 20 |  | 1 | 30 | DO-7 |
| 1N5242A | 500 | 12 | 20 | 10 | 8.7 | 1 | 30 | DO-7 |
| 1N5242B | 500 | 12 | 20 | 5 | 9.1 | 1 | 30 | DO-7 |
| 1N5243 | 500 | 13 | 9.5 | 20 |  |  | 13 | 00-7 |
| 1N5243A | 500 | 13 | 9.5 | 10 | 9.4 | 0.5 | 13 | D0.7 |
| 1N5243B | 500 | 13 | 9.5 | 5 | 9.9 | 0.5 | 13 | D0-7 |
| 1 N5244 | 500 | 14 | 9 | 20 |  |  | 15 | D0-7 |
| 1N5244A | 500 | 14 | 9 | 10 | 9.5 | 0.1 | 15 | DO-7 |
| 1N5244B | 500 | 14 | 9 | 5 | 10 | 0.1 | 15 | DO-7 |
| 1N5245 | 500 | 15 | 8.5 | 20 |  |  | 16 | DO-7 |
| 1N5245A | 500 | 15 | 8.5 | 10 | 10.5 | 0.1 | 16 | D0.7 |
| 1N5245B | 500 | 15 | 8.5 | 5 | 11 | 0.1 | 16 | DO-7 |

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## PRODUCT SELECTION GUIDE DIODES AND RECTIFIERS

VOLTAGE REGULATORS (Continued)

| DEVICE TYPE | $\begin{gathered} \hline P_{D} @ 25^{\circ} \mathrm{C} \\ (\mathrm{~mW}) \end{gathered}$ | $\mathbf{V}_{\mathbf{Z}}$ @ IZT |  | $\begin{gathered} \text { TOL } \\ \% \\ \hline \end{gathered}$ | $\mathbf{I}_{\mathbf{R}}$ @ $\mathrm{V}_{\mathrm{R}}$ |  | $\frac{z_{Z} @ I_{Z T}}{\operatorname{MAX} \Omega}$ | PACKAGE* |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | (V) | (mA) |  | (V) | ( $\mu \mathrm{A}$ ) |  |  |
| 1N5246 | 500 | 16 | 7.8 | 20 |  |  | 17 | DO-7 |
| 1N5246A | 500 | 16 | 7.8 | 10 | 11.4 | 0.1 | 17 | DO-7 |
| 1N5246B | 500 | 16 | 7.8 | 5 | 12 | 0.1 | 17 | DO-7 |
| 1N5247 | 500 | 17 | 7.4 | 20 |  |  | 19 | DO-7 |
| 1N5247A | 500 | 17 | 7.4 | 10 | 12.4 | 0.1 | 19 | DO-7 |
| 1N5247B | 500 | 17 | 7.4 | 5 | 13 | 0.1 | 19 | DO-7 |
| 1 N 5248 | 500 | 18 | 7 | 20 |  |  | 21 | DO-7 |
| 1N5248A | 500 | 18 | 7 | 10 | 13.3 | 0.1 | 21 | DO-7 |
| 1N5248B | 500 | 18 | 7 | 5 | 14 | 0.1 | 21 | DO-7 |
| 1N5249 | 500 | 19 | 6.6 | 20 |  |  | 23 | D0.7 |
| 1N5249A | 500 | 19 | 6.6 | 10 | 13.3 | 0.1 | 23 | DO-7 |
| 1N5249B | 500 | 19 | 6.6 | 5 | 14 | 0.1 | 23 | D0. 7 |
| 1N5250 | 500 | 20 | 6.2 | 20 |  |  | 25 | DO-7 |
| 1N5250A | 500 | 20 | 6.2 | 10 | 14.3 | 0.1 | 25 | DO-7 |
| 1N5250B | 500 | 20 | 6.2 | 5 | 15 | 0.1 | 25 | DO-7 |
| 1N5251 | 500 | 22 | 5.6 | 20 |  |  | 29 | DO-7 |
| 1N5251A | 500 | 22 | 5.6 | 10 | 16.2 | 0.1 | 29 | D0. 7 |
| 1N5251B | 500 | 22 | 5.6 | 5 | 17 | 0.1 | 29 | D0-7 |
| 1N5252 | 500 | 24 | 5.2 | 20 |  |  | 33 | DO-7 |
| 1N5252A | 500 | 24 | 5.2 | 10 | 17.1 | 0.1 | 33 | DO-7 |
| 1N5252B | 500 | 24 | 5.2 | 5 | 18 | 0.1 | 33 | D0. 7 |
| 1N5253 | 500 | 25 | 5 | 20 |  |  | 35 | DO-7 |
| 1N5253A | 500 | 25 | 5 | 10 | 18.1 | 0.1 | 35 | D0-7 |
| 1N5253B | 500 | 25 | 5 | 5 | 19 | 0.1 | 35 | DO-7 |
| 1N5254 | 500 | 27 | 4.6 | 20 |  |  | 41 | DO-7 |
| 1N5254A | 500 | 27 | 4.6 | 10 | 20 | 0.1 | 41 | DO-7 |
| 1N5254B | 500 | 27 | 4.6 | 5 | 21 | 0.1 | 41 | 00.7 |
| 1N5255 | 500 | 28 | 4.5 | 20 |  |  | 44 | DO-7 |
| 1N5255A | 500 | 28 | 4.5 | 10 | 20 | 0.1 | 44 | D0.7 |
| 1N5255B | 500 | 28 | 4.5 | 5 | 21 | 0.1 | 44 | DO.7 |
| 1N5256 | 500 | 30 | 4.2 | 20 |  |  | 49 | DO-7 |
| 1N5256A | 500 | 30 | 4.2 | 10 | 22 | 0.1 | 49 | DO-7 |
| 1N5256B | 500 | 30 | 4.2 | 5 | 23 | 0.1 | 49 | DO-7 |
| 1N5257 | 500 | 33 | 3.8 | 20 |  |  | 58 | DO. 7 |
| 1N5257A | 500 | 33 | 3.8 | 10 | 24 | 0.1 | 58 | DO-7 |
| 1N5257B | 500 | 33 | 3.8 | 5 | 25 | 0.1 | 58 | DO-7 |
| 1N4728 | 1000 | 3.3 | 76 | 10 | 1 | 100 | 10 | DO-41 |
| 1N4728A | 1000 | 3.3 | 76 | 5 | 1 | 100 | 10 | D0-41 |
| 1N4729 | 1000 | 3.6 | 69 | 10 | 1 | 100 | 10 | D0-41 |
| 1N4729A | 1000 | 3.6 | 69 | 5 | 1 | 100 | 10 | D0-41 |
| 1N4730 | 1000 | 3.9 | 64 | 10 | 1 | 50 | 9 | DO-41 |
| 1N4730A | 1000 | 3.9 | 64 | 5 | 1 | 50 | 9 | D0.41 |
| 1 N 4731 | 1000 | 4.3 | 58 | 10 | 1 | 10 | 9 | D0-41 |
| 1N4731A | 1000 | 4.3 | 58 | 5 | 1 | 10 | 9 | D0-41 |
| 1 N4732 | 1000 | 4.7 | 53 | 10 | 1 | 10 | 8 | DO-41 |
| 1N4732A | 1000 | 4.7 | 53 | 5 | 1 | 10 | 8 | D0-41 |
| 1N4733 | 1000 | 5.1 | 49 | 10 | 1 | 10 | 7 | D0-41 |

*See package drawings on page 8-14.

## PRODUCT SELECTION GUIDE DIODES AND RECTIFIERS

## VOLTAGE REGULATORS (Continued)

| DEVICE <br> TYPE | $\begin{gathered} \mathrm{PD}_{\mathrm{D}} \mathrm{25}^{\circ} \mathrm{C} \\ (\mathrm{~mW}) \end{gathered}$ |  |  | $\begin{gathered} \text { TOL } \\ \% \\ \hline \end{gathered}$ | $\mathbf{I}_{\mathbf{R}} \mathrm{V}_{\mathbf{R}}$ |  | $\mathrm{Zz}_{\mathbf{\prime}}$ © $\mathrm{I}_{\mathbf{z}}$ | PACKAGE* |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | (V) | (mA) |  | (V) | ( $\mu \mathrm{A}$ ) | $\operatorname{MAX} \Omega$ |  |
| 1N4733A | 1000 | 5.1 | 49 | 5 | 1 | 10 | 7 | DO-41 |
| 1N4734 | 1000 | 5.6 | 45 | 10 | 2 | 10 | 5 | DO-41 |
| 1N4734A | 1000 | 5.6 | 45 | 5 | 2 | 10 | 5 | D0-41 |
| 1N4735 | 1000 | 6.2 | 41 | 10 | 3 | 10 | 2 | DO-41 |
| 1N4735A | 1000 | 6.2 | 41 | 5 | 3 | 10 | 2 | DO-41 |
| 1N4736 | 1000 | 6.8 | 37 | 10 | 4 | 10 | 3.5 | D0-41 |
| 1N4736A | 1000 | 6.8 | 37 | 5 | 4 | 10 | 3.5 | D0-41 |
| 1N4737 | 1000 | 7.5 | 34 | 10 | 5 | 10 | 4 | DO-41 |
| 1N4737A | 1000 | 7.5 | 34 | 5 | 5 | 10 | 4 | D0-41 |
| 1N4738 | 1000 | 8.2 | 31 | 10 | 6 | 10 | 4.5 | D0.41 |
| 1N4738A | 1000 | 8.2 | 31 | 5 | 6 | 10 | 4.5 | DO. 41 |
| 1N4739 | 1000 | 9.1 | 28 | 10 | 7 | 10 | 5 | DO-41 |
| 1N4739A | 1000 | 9.1 | 28 | 5 | 7 | 10 | 5 | DO-41 |
| 1N4740 | 1000 | 10 | 25 | 10 | 7.6 | 10 | 7 | D0-41 |
| 1N4740A | 1000 | 10 | 25 | 5 | 7.6 | 10 | 7 | D0-41 |
| 1N4741 | 1000 | 11 | 23 | 10 | 8.4 | 5 | 8 | D0.41 |
| 1N4741A | 1000 | 11 | 23 | 5 | 8.4 | 5 | 8 | DO-41 |
| 1 N4742 | 1000 | 12 | 21 | 10 | 9.1 | 5 | 9 | D0.41 |
| 1N4742A | 1000 | 12 | 21 | 5 | 9.1 | 5 | 9 | DO-41 |
| 1N4743 | 1000 | 13 | 19 | 10 | 9.9 | 5 | 10 | DO-41 |
| 1N4743A | 1000 | 13 | 19 | 5 | 9.9 | 5 | 10 | DO-41 |
| 1N4744 | 1000 | 15 | 17 | 10 | 11.4 | 5 | 14 | D0-41 |
| 1N4744A | 1000 | 15 | 17 | 5 | 11.4 | 5 | 14 | DO-41 |
| 1N4745 | 1000 | 16 | 15.5 | 10 | 12.2 | 5 | 16 | DO-41 |
| 1N4745A | 1000 | 16 | 15.5 | 5 | 12.2 | 5 | 16 | DO-41 |
| 1N4746 | 1000 | 18 | 14 | 10 | 13.7 | 5 | 20 | DO-41 |
| 1N4746A | 1000 | 18 | 14 | 5 | 13.7 | 5 | 20 | DO-41 |
| 1N4747 | 1000 | 20 | 12.5 | 10 | 15.2 | 5 | 22 | D0-41 |
| 1N4747A | 1000 | 20 | 12.5 | 5 | 15.2 | 5 | 22 | D0-41 |
| 1 N4748 | 1000 | 22 | 11.5 | 10 | 16.7 | 5 | 23 | DO-41 |
| 1N4748A | 1000 | 22 | 11.5 | 5 | 16.7 | 5 | 23 | D0-41 |
| 1N4749 | 1000 | 24 | 10.5 | 10 | 18.2 | 5 | 25 | D0-41 |
| 1N4749A | 1000 | 24 | 10.5 | 5 | 18.2 | 5 | 25 | DO-41 |
| 1 N 4750 | 1000 | 27 | 9.5 | 10 | 20.6 | 5 | 35 | D0-41 |
| 1N4750A | 1000 | 27 | 9.5 | 5 | 20.6 | 5 | 35 | DO-41. |
| 1N4751 | 1000 | 30 | 8.5 | 10 | 22.8 | 5 | 40 | D0-41 |
| 1N4751A | 1000 | 30 | 8.5 | 5 | 22.8 | 5 | 40 | DO-41 |
| 1N4752 | 1000 | 33 | 7.5 | 10 | 25.1 | 5 | 45 | D0-41 |
| 1N4752A | 1000 | 33 | 7.5 | 5 | 25.1 | 5 | 45 | D0.41 |

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## PRODUCT SELECTION GUIDE <br> DIODE ARRAYS

## DUAL DIODES

| DEVICE TYPE | CIRCUIT | FORWARD CURRENT |  | $V_{B R}$ <br> (V) | $\mathbf{I R}^{\text {@ }} \mathrm{V}_{\mathrm{R}} @ 25^{\circ} \mathrm{C}$ |  | PACKAGE* |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | $I_{F}$ (mA) | $\mathrm{V}_{\mathrm{F}}$ (V) |  | V | $\mu \mathrm{A}$ |  |
| TID17 | COMMON CATHODE | 500 | 1.5 | 60 | 30 | 0.1 | T0-18 |
| TID18 | COMMON CATHODE | 500 | 1.7 | 40 | 15 | 0.1 | TO-18 |
| TID19 | COMMON ANODE | 500 | 1.5 | 60 | 30 | 0.1 | T0.18 |
| TID20 | COMMON ANODE | 500 | 1.7 | 40 | 15 | 0.1 | TO-18 |

## PLASTIC DUAL-IN-LINE PACKAGE

| DEVICE TYPE | CIRCUIT | FORWARD CURRENT |  | $\mathbf{V}_{\text {BR }}$ <br> (V) | $\mathbf{I}_{\mathbf{R}}$ @ $\mathrm{V}_{\mathbf{R}} @ 25^{\circ} \mathrm{C}$ |  | PACKAGE* |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | $I_{F}(\mathrm{~mA})$ | $\mathrm{V}_{\mathrm{F}}(\mathrm{V})$ |  | V | $\mu \mathrm{A}$ |  |
| TID139N | 7 INDEPENDENT DIODES | 500 | 1.3 | 60 | 40 | 0.1 | 14 Lead N |
| TID140N | 7 INDEPENDENT DIODES | 100 | 1.3 | 40 | 20 | 0.05 | 14 Lead N |
| TID141N | DUAL 4-DIODE COMMON CATHODE | 500 | 1.3 | 60 | 40 | 0.1 | 14 Lead N |
| TID142N | DUAL 4-DIODE COMMON CATHODE | 100 | 1.3 | 40 | 20 | 0.05 | 14 Lead N |
| TID143N | DUAL 4-DIODE COMMON ANODE | 500 | 1.3 | 60 | 40 | 0.1 | 14 Lead N |
| TID144N | DUAL 4-DIODE COMMON ANODE | 100 | 1.3 | 40 | 20 | 0.05 | 14 Lead N |
| TID121 | 8-DIODE COMMON CATHODE | 500 | 1.3 | 60 | 40 | 0.1 | 14 Lead N |
| TID122 | 8-DIODE COMMON CATHODE | 500 | 1.5 | 40 | 25 | 0.1 | 14 Lead N |
| TID123 | 8-DIODE COMMON ANODE | 500 | 1.3 | 60 | 40 | 0.1 | 14 Lead N |
| TID124 | 8-DIODE COMMON ANODE | 500 | 1.5 | 40 | 25 | 0.1 | 14 Lead N |
| TID133 | DUAL 8-DIODE (C.C. and C.A.) | 500 | 1.3 | 60 | 40 | 0.1 | 14 Lead N |
| TID134 | DUAL 8-DIODE (C.C. and C.A.) | 500 | 1.5 | 40 | 25 | 0.1 | 14 Lead N |
| TID125 | 16-DIODE (C.C. and C.A.) | 500 | 1.3 | 60 | 40 | 0.1 | 14 Lead N |
| TID126 | 16-DIODE (C.C. and C.A.) | 500 | 1.5 | 40 | 25 | 0.1 | 14 Lead N |
| TID135N | 16-DIODE (C.C. and C.A.) | 500 | 1.3 | 60 | 40 | 0.1 | 14 Lead N |
| TID136N | 16-DIODE (C.C. and C.A.) | 100 | 1.3 | 40 | 20 | 0.05 | 14 Lead N |
| TID129 | DUAL 10-DIODE (C.C. and C.A.) | 500 | 1.3 | 60 | 40 | 0.1 | 14 Lead N |
| TID130 | DUAL 10-DIODE (C.C. and C.A.) | 500 | 1.5 | 40 | 25 | 0.1 | 14 Lead N |

METAL FLAT PACKAGE, $1 / \mathbf{4}^{\prime \prime} \times 1 / \mathbf{8}^{\prime \prime}$

| DEVICE <br> TYPE | CIRCUIT | FORWARD CURRENT |  | $\mathbf{V}_{\mathrm{BR}}$ <br> (V) | $\mathrm{I}_{\mathrm{R}}$ @ $\mathrm{V}_{\mathrm{R}}$ @ $25^{\circ} \mathrm{C}$ |  | PACKAGE* |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | $I_{F}(\mathrm{~mA})$ | $\mathrm{V}_{\mathrm{F}}(\mathrm{V})$ |  | V | $\mu \mathrm{A}$ |  |
| TID139F | 7 INDEPENDENT DIODES | 500 | 1.3 | 60 | 40 | 0.1 | 14 Lead F |
| TID140F | 7 INDEPENDENT DIODES | 100 | 1.3 | 40 | 20 | 0.05 | 14 Lead F |
| TID141F | DUAL 4-DIODE COMMON CATHODE | 500 | 1.3 | 60 | 40 | 0.1 | 10 Lead F |
| TID142F | DUAL 4-DIODE COMMON CATHODE | 100 | 1.3 | 40 | 20 | 0.05 | 10 Lead F |
| TID143F | DUAL 4-DIODE COMMON ANODE | 500 | 1.3 | 60 | 40 | 0.1 | 10 Lead F |
| TID144F | DUAL 4-DIODE COMMON ANODE | 100 | 1.3 | 40 | 20 | 0.05 | 10 Lead F |
| TID21A | 8-DIODE COMMON CATHODE | 500 | 1.3 | 60 | 40 | 0.1 | 10 Lead F |
| TID22A | 8-DIODE COMMON CATHODE | 500 | 1.5 | 40 | 25 | 0.1 | 10 Lead F |
| TID23A | 8-DIODE COMMON ANODE | 500 | 1.3 | 60 | 40 | 0.1 | 10 Lead F |
| TID24A | 8-DIODE COMMON ANODE | 500 | 1.5 | 40 | 25 | 0.1 | 10 Lead F |
| TID131 | DUAL 8-DIODE (C.C. and C.A.) | 500 | 1.3 | 60 | 40 | 0.1 | 14 Lead F |
| TID132 | DUAL 8-DIODE (C.C. and C.A.) | 500 | 1.5 | 40 | 25 | 0.1 | 14 Lead F |
| TID25A | 16-DIODE (C.C. and C.A.) | 500 | 1.3 | 60 | 40 | 0.1 | 10 Lead F |
| TID26A | 16-DIODE (C.C. and C.A.) | 500 | 1.5 | 40 | 25 | 0.1 | 10 Lead F |
| TID29A | DUAL 10-DIODE (C.C. and C.A.) | 500 | 1.3 | 60 | 40 | 0.1 | 14 Lead F |
| TID30A | DUAL 10-DIODE (C.C. and C.A.) | 500 | 1.5 | 40 | 25 | 0.1 | 14 Lead F |

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## PRODUCT SELECTION GUIDE <br> DIODE ARRAYS

CERAMIC FLAT PACKAGE, $1 / 4^{\prime \prime} \times 1 / 4^{\prime \prime}$

| DEVICE <br> TYPE | CIRCUIT | FORWARD CURRENT |  | $V_{B R}$ <br> (V) | $\mathrm{I}_{\mathrm{R}}$ @ $\mathrm{V}_{\mathrm{R}}$ @ $25^{\circ} \mathrm{C}$ |  | PACKAGE* |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | $I_{F}(\mathrm{~mA})$ | $\mathrm{V}_{\mathrm{F}}$ (V) |  | V | $\mu \mathrm{A}$ |  |
| 1N5768 | 8-DIODE COMMON CATHODE | 500 | 1.3 | 60 | 40 | 0.1 | 10 Lead |
| 1N5769 | 8-DIODE COMMON CATHODE | 500 | 1.5 | 40 | 25 | 0.1 | 10 Lead |
| 1N5770 | 8-DIODE COMMON ANODE | 500 | 1.3 | 60 | 40 | 0.1 | 10 Lead |
| 1N5771 | 8-DIODE COMMON ANODE | 500 | 1.5 | 40 | 25 | 0.1 | 10 Lead |
| 1N5774 | DUAL 8-DIODE (C.C. and C.A.) | 500 | 1.3 | 60 | 40 | 0.1 | 14 Lead |
| 1N5775 | DUAL 8-DIODE (C.C. and C.A.) | 500 | 1.5 | 40 | 25 | 0.1 | 14 Lead |
| 1 N5772 | 16-DIODE (C.C. and C.A.) | 500 | 1.3 | 60 | 40 | 0.1 | 10 Lead |
| 1N5773 | 16-DIODE (C.C. and C.A.) | 500 | 1.5 | 40 | 25 | 0.1 | 10 Lead |

MATRICES (PROGRAMMABLE), CERAMIC DUAL-IN-LINE (J) AND METAL FLAT PACKAGE (F)

| DEVICE TYPE | $\begin{aligned} & \text { MATRIX } \\ & \text { SIZE } \end{aligned}$ | $\begin{gathered} t_{r r}(n s) \\ 10-10-1 \mathrm{~mA} \end{gathered}$ | FORWARD CURRENT |  | VBR <br> (V) | $\mathrm{I}_{\mathrm{R}}$ @ $\mathrm{V}_{\mathrm{R}} @ 25^{\circ} \mathrm{C}$ |  | PACKAGE* |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  | $I_{F}(\mathrm{~mA})$ | $V_{F}(\mathbf{V})$ |  | V | $\mu \mathrm{A}$ |  |
| TIDM155J | $5 \times 5$ | 10 | 20 | 1.5 | 45 | 25 | 0.02 | 14 Lead J |
| TIDM255J | $5 \times 5$ | 25 | 20 | 1.7 | 35 | 25 | 0.05 | 14 Lead J |
| TIDM166J | $6 \times 6$ | 10 | 20 | 1.5 | 45 | 25 | 0.02 | 14 Lead J |
| TIDM266J | $6 \times 6$ | 25 | 20 | 1.7 | 35 | 25 | 0.05 | 14 Lead J |
| TIDM168J | $6 \times 8$ | 10 | 20 | 1.5 | 45 | 25 | 0.02 | 14 Lead J |
| TIDM268J | $6 \times 8$ | 25 | 20 | 1.7 | 35 | 25 | 0.05 | 14 Lead J |
| TIDM185J | $8 \times 5$ | 10 | 20 | 1.5 | 45 | 25 | 0.02 | 14 Lead J |
| TIDM285J | $8 \times 5$ | 25 | 20 | 1.7 | 35 | 25 | 0.05 | 14 Lead J |
| TIDM186J | $8 \times 6$ | 10 | 20 | 1.5 | 45 | 25 | 0.02 | 14 Lead J |
| TIDM286J | $8 \times 6$ | 25 | 20 | 1.7 | 35 | 25 | 0.05 | 14 Lead J |
| TIDM155F | $5 \times 5$ | 10 | 20 | 1.5 | 45 | 25 | 0.02 | 14 Lead F |
| TIDM255F | $5 \times 5$ | 25 | 20 | 1.7 | 35 | 25 | 0.05 | 14 Lead F |
| TIDM166F | $6 \times 6$ | 10 | 20 | 1.5 | 45 | 25 | 0.02 | 14 Lead F |
| TIDM266F | $6 \times 6$ | 25 | 20 | 1.7 | 35 | 25 | 0.05 | 14 Lead F |
| TIDM168F | $6 \times 8$ | 10 | 20 | 1.5 | 45 | 25 | 0.02 | 14 Lead F |
| TIDM268F | $6 \times 8$ | 25 | 20 | 1.7 | 35 | 25 | 0.05 | 14 Lead F |
| TIDM185F | $8 \times 5$ | 10 | 20 | 1.5 | 45 | 25 | 0.02 | 14 Lead F |
| TIDM285F | $8 \times 5$ | 25 | 20 | 1.7 | 35 | 25 | 0.05 | 14 Lead F |
| TIDM186F | $8 \times 6$ | 10 | 20 | 1.5 | 45 | 25 | 0.02 | 14 Lead F |
| TIDM286F | $8 \times 6$ | 25 | 20 | 1.7 | 35 | 25 | 0.05 | 14 Lead F |

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## PRODUCT SELECTION GUIDE DIODES AND RECTIFIERS

PACKAGE DRAWINGS

DO-34
DO-35


PP
D0-41


DO-7
DOUBLE-PLUG DIODES


10 LEAD F
14 LEAD F
1/4" X 1/8" METAL FLAT PACKAGES


TO-18

j CERAMIC
n Plastic
TO-116 DUAL-IN-LINE PACKAGES

# Diode Interchangeability 

## DIODE INTERCHANGEABILITY

This list of low-power (generally two watts or less power dissipation in free-air) diodes is designed to assist the design engineer in determining the recommended TI replacement or equivalent for over 5700 diodes when only the device type number is known. Also included is a summary of the significant ratings and electrical characteristics of the referenced types. This interchangeability guide differs from the corresponding transistor lists in this volume in that only JEDEC registered (" 1 N ") types are covered.

In compiling this list, all registered diodes were considered regardless of the semiconductor material used, the diode function, package type, or rated power dissipation. The result was massive. In order to keep the list within manageable size, it was severely edited down by deleting most of the entries for high-power diodes and specialized diodes not having wide-spread application.

Germanium diodes were retained in the list but it should be remembered that all recommended replacements for referenced germanium diodes are silicon diodes and that the replacement suggestions are based on specifications only.

Every effort has been made to ensure the accuracy of each entry. However, TI makes no warranty as to the information furnished and the user assumes all risk in the use thereof.

## KEY TO CLASSIFICATION CODES

```
RE - RECTIFIER
RD - REFERENCE DIODE
SD - SIGNAL DIODE
ZD - REGULATOR (ZENER) DIODE
```


## DIODE INTERCHANGEABILITY

| TYPE NUMBER | $\begin{aligned} & \frac{1}{3} \\ & \frac{7}{6} \\ & \frac{1}{4} \end{aligned}$ |  | 7 <br> REPLACEMENT |  | Ratinges |  |  | CHARACTERISTICS |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  | PD <br> (mW) | $V_{R}$ <br> (V) | (A) | $\begin{array}{ll} \mathbf{I}_{\mathbf{R}} & \bullet \mathbf{V}_{\mathbf{R}} \\ \mu_{\mathbf{A}} & f(\mathbf{V}) \end{array}$ | $\mathbf{V F}_{F}$ IF <br> (V) $/$ (mA) | $\begin{aligned} & I_{T r} \\ & \text { (ms) } \end{aligned}$ | $\mathbf{V}_{\mathbf{Z}}-\mathbf{I}_{\mathbf{z}}$ <br> (V) $/$ (mA) | $\begin{gathered} \text { TOL } \\ \% \end{gathered}$ |
| 1N34 <br> 1N34A <br> in34AS <br> 1N35 | $\begin{aligned} & \mathbf{G} \\ & \mathbf{G} \\ & \mathbf{G} \\ & \mathbf{G} \end{aligned}$ | $\left\lvert\, \begin{aligned} & \text { SD } \\ & \text { SD } \\ & \text { SD } \\ & S D \end{aligned}\right.$ |  | 1N4454 1N4454 1N4148 1N4454 |  | 60 60 75 50 |  | $\begin{aligned} & 30 / 10 \\ & 30 / 10 \\ & 30 / 10 \\ & 10 / 10 \end{aligned}$ | $\begin{aligned} & 1 / 5 \\ & 1 / 5 \\ & 1 / 5 \\ & 1 / 7 \end{aligned}$ |  |  |  |
| IN36 1N38 1N38A IN38B | $\left\lvert\, \begin{aligned} & \mathbf{G} \\ & \mathbf{G} \\ & \mathbf{G} \\ & \mathbf{G} \end{aligned}\right.$ | $\begin{aligned} & \text { SD } \\ & \text { SD } \\ & \text { SD } \\ & \text { SD } \end{aligned}$ |  | 1N4148 <br> 1N4148 <br> 1N4938 <br> 1N4938 |  | 36 100 115 125 |  | $\begin{aligned} & 100 / 25 \\ & 500 / 100 \\ & 500 / 100 \\ & 500 / 100 \end{aligned}$ | $\begin{aligned} & 1 / 4 \\ & 1 / 7 \\ & 1 / 4 \\ & 1 / 4 \end{aligned}$ |  |  |  |
| 1N39 <br> iN39A <br> IN39B <br> 1N40 | $\begin{aligned} & \mathbf{G} \\ & \mathbf{G} \\ & \mathbf{G} \\ & \mathbf{G} \end{aligned}$ | $\begin{aligned} & \text { SD } \\ & \text { SD } \\ & \text { SD } \\ & \text { SD } \end{aligned}$ |  | $\left\{\begin{array}{l} \text { 1N4938 } \\ \text { IN4938 } \\ \text { IN4938 } \\ \text { iN4148 } \end{array}\right.$ |  | $\begin{array}{r} 210 \\ 230 \\ 200 \\ 25 \end{array}$ |  | $\begin{gathered} 100 / 100 \\ 65 / 100 \\ 100 / 100 \\ 35 / 10 \end{gathered}$ | $\begin{gathered} 1 / 3 \\ 1 / 5 \\ 1 / 4 \\ 1.5 / 12 \end{gathered}$ |  |  |  |
| $\begin{aligned} & \text { IN41 } \\ & \text { 1N42 } \\ & \text { 1N43 } \\ & \text { 1N44 } \end{aligned}$ | $\begin{aligned} & \mathbf{G} \\ & \mathbf{G} \\ & \mathbf{G} \\ & \mathbf{G} \end{aligned}$ | $\begin{aligned} & \text { SD } \\ & \text { SD } \\ & \text { SD } \\ & \text { SD } \end{aligned}$ |  | $\begin{aligned} & \text { IN4454 } \\ & \text { 1N4938 } \\ & \text { 1N4148 } \\ & \text { iN4938 } \end{aligned}$ |  | $\begin{array}{r} 25 \\ 115 \\ 70 \\ 115 \end{array}$ |  | $\begin{gathered} 35 / 10 \\ 200 / 5 \\ 1 K / 50 \end{gathered}$ | $\begin{gathered} 1.5 / 12 \\ 1.5 / 12 \\ 1 / 5 \\ 1 / 3 \end{gathered}$ |  |  |  |
| $\begin{aligned} & \text { 1N45 } \\ & \text { 1N46 } \\ & \text { 1N47 } \\ & \text { 1N48 } \end{aligned}$ | $\left\lvert\, \begin{aligned} & G \\ & G \\ & G \\ & G \end{aligned}\right.$ | $\left\|\begin{array}{l} \text { SD } \\ \text { SD } \\ \text { SD } \\ \text { SD } \end{array}\right\|$ |  | 1N4454 <br> 1N4454 <br> 1N4938 <br> 1N4454 |  | 75 60 150 80 |  | $\begin{aligned} & 410 / 50 \\ & 1 M / 50 \\ & 500 / 100 \\ & 833 / 50 \end{aligned}$ | $\begin{aligned} & 1 / 3 \\ & 1 / 3 \\ & 1 / 4 \\ & 1 / 4 \end{aligned}$ |  |  |  |
| $\begin{aligned} & \text { 1N49 } \\ & \text { IN50 } \\ & \text { 1N51 } \\ & \text { 1N52 } \end{aligned}$ | $\begin{aligned} & \mathbf{G} \\ & \mathbf{G} \\ & \mathbf{G} \\ & \mathbf{G} \end{aligned}$ | $\left.\begin{aligned} & \text { SD } \\ & \text { SD } \\ & \text { SD } \\ & \text { SD } \end{aligned} \right\rvert\,$ |  | 1N4148 <br> INA148 <br> 1N4454 <br> iN4454 |  | 75 75 50 80 |  | $\begin{array}{r} 200 / 20 \\ 80 / 20 \\ 1 M / 50 \\ 150 / 50 \end{array}$ | $\begin{aligned} & 1 / 5 \\ & 1 / 5 \\ & 1 / 2.5 \\ & 1 / 4 \end{aligned}$ |  |  |  |
| 1N52A <br> 1N54 <br> 1N54A <br> 1N55 | $\begin{aligned} & \mathbf{G} \\ & \mathbf{G} \\ & \mathbf{G} \\ & \mathbf{G} \end{aligned}$ | $\left\|\begin{array}{c} S D \\ S D \\ S D \\ S D \\ S D \end{array}\right\|$ |  | 1N4454 <br> 1N4148 <br> IN4148 <br> 1N4938 |  | 50 50 50 150 |  | $\begin{array}{r} 100 / 50 \\ 7 / 10 \\ 7 / 10 \\ 800 / 150 \end{array}$ | $\begin{aligned} & 1 / 5 \\ & 1 / 5 \\ & 1 / 5 \\ & 1 / 5 \end{aligned}$ |  |  |  |
| 1N55A <br> 1N55B <br> 1N56 <br> 1N56A | $\begin{aligned} & \mathbf{G} \\ & \mathbf{G} \\ & \mathbf{G} \\ & \mathbf{G} \end{aligned}$ | $\left\|\begin{array}{l} \text { SD } \\ \text { SD } \\ \text { SD } \\ \text { SD } \end{array}\right\|$ |  | 1N4938 <br> 1N4938 <br> 1N4148 <br> 1N4148 |  | $\begin{array}{r} 170 \\ 180 \\ 40 \\ 40 \end{array}$ |  | $\begin{aligned} & 500 / 150 \\ & 500 / 150 \\ & 300 / 30 \\ & 300 / 30 \end{aligned}$ | $\begin{aligned} & 1 / 4 \\ & 1 / 5 \\ & 1 / 15 \\ & 1 / 15 \end{aligned}$ |  |  |  |
| 1N57 <br> 1N57A <br> 1N58 <br> 1N58A | $\begin{aligned} & G \\ & G \\ & G \\ & G \end{aligned}$ | $\begin{aligned} & \text { SD } \\ & \text { SD } \\ & \text { SD } \\ & \text { SD } \end{aligned}$ |  | 1N4454 <br> 1N4454 <br> 1N4938 <br> 1N4938 |  | $\begin{array}{r} 80 \\ 80 \\ 115 \\ 100 \end{array}$ |  | $\begin{aligned} & 500 / 75 \\ & 500 / 75 \\ & 600 / 100 \\ & 600 / 100 \end{aligned}$ | $\begin{aligned} & 1 / 4 \\ & 1 / 4 \\ & 1 / 5 \\ & 1 / 4 \end{aligned}$ |  |  |  |
| 1N59 <br> 1N60 <br> IN60A <br> 1N60C | $\begin{aligned} & \mathbf{G} \\ & \mathbf{G} \\ & \mathbf{G} \\ & \mathbf{G} \end{aligned}$ | $\left\lvert\, \begin{aligned} & S D \\ & S D \\ & S D \\ & S D \\ & S D \end{aligned}\right.$ |  | 1N647 <br> 1N4148 <br> 1N4148 <br> 1N4148 |  | $\begin{array}{r} 280 \\ 40 \\ 40 \\ 50 \end{array}$ |  | $\begin{gathered} 800 / 250 \\ 200 / 10 \\ 60 / 10 \\ 67 / 10 \end{gathered}$ | $\begin{aligned} & 1 / 3 \\ & 1 / 5 \\ & 1 / 5 \\ & 1 / 5 \end{aligned}$ |  |  |  |

## DIODE INTERCHANGEABILITY

| TYPE NUMBER |  |  | $\underset{\text { REPLACEMENT }}{\text { In }}$ | $\begin{gathered} \text { FOR } \\ \text { NEW } \\ \text { DESICN } \end{gathered}$ | $P_{D}$ (mW) | atings <br> $V_{R}$ <br> (V) | (A) | $\begin{gathered} \mathbf{I}_{\mathbf{R}}: \mathbf{V}_{\mathbf{R}} \\ \mu_{\mathrm{A}} \\ \hline \end{gathered}$ |  |  | $\begin{array}{ccc} \mathbf{v}_{\mathbf{z}} & \bullet & \mathbf{z} \\ (\mathrm{V}) & / & (\mathrm{ma}) \end{array}$ | $\left\lvert\, \begin{gathered} \text { TOL } \\ x \end{gathered}\right.$ |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| $\begin{array}{\|l} \hline \text { IN60S } \\ \text { IN61 } \\ \text { IN62 } \\ \text { IN63 } \end{array}$ | $\begin{aligned} & \mathbf{G} \\ & \mathbf{G} \\ & \mathbf{G} \\ & \mathbf{G} \end{aligned}$ | SD |  | 1N4148 <br> 1N4938 <br> 1 N4938 <br> 1N4148 |  | 25 140 140 100 |  | $\begin{gathered} 67 / 10 \\ 300 / 100 \\ 700 / 100 \\ 50 / 50 \end{gathered}$ | $\begin{aligned} & 1 / 5 \\ & 1 / 5 \\ & 1 / 5 \\ & 1 / 4 \end{aligned}$ |  |  |  |
| $\begin{array}{\|l} \text { 1N63A } \\ \text { 1N64 } \\ \text { IN64A } \\ \text { IN65 } \end{array}$ | $\begin{aligned} & \mathbf{G} \\ & \mathbf{G} \\ & \mathbf{G} \\ & \mathbf{G} \end{aligned}$ | $\left\|\begin{array}{l} S D \\ S D \\ S D \\ S D \\ S D \end{array}\right\|$ |  | $\begin{array}{\|l\|l\|} \hline \text { IN4148 } \\ \text { IN4148 } \\ \text { IN4148 } \\ \text { IN4454 } \end{array}$ |  | 100 20 20 80 |  | $\begin{array}{r} 50 / 50 \\ 25 / 10 \\ 25 / 10 \\ 200 / 50 \end{array}$ | $\begin{aligned} & 1 / 4 \\ & 1 / 3 \\ & 1 / 3 \\ & 1 / 2.5 \end{aligned}$ |  |  |  |
| 1N66 <br> IN6OA <br> 1N67 <br> 1N67A | $\begin{aligned} & \mathbf{G} \\ & \mathbf{G} \\ & \mathbf{G} \\ & \mathbf{G} \end{aligned}$ | $\left\|\begin{array}{l} \text { SD } \\ \text { SD } \\ \text { SD } \\ \text { SD } \end{array}\right\|$ |  | in4454 <br> 1N4454 <br> 1N4148 <br> 1N4148 |  | 60 60 92 80 |  | $\begin{aligned} & 50 / 10 \\ & 50 / 10 \\ & 50 / 50 \\ & 50 / 50 \end{aligned}$ | $\begin{aligned} & 1 / 5 \\ & 1 / 5 \\ & 1 / 4 \\ & 1 / 4 \end{aligned}$ |  |  |  |
| 1N68 <br> 1N68A <br> 1N69 <br> 1N69A | $\begin{aligned} & \mathbf{G} \\ & \mathbf{G} \\ & \mathbf{G} \\ & \mathbf{G} \end{aligned}$ | $\begin{aligned} & \mathrm{SD} \\ & \mathrm{SD} \\ & \mathrm{SD} \\ & \mathrm{SD} \\ & \mathrm{SD} \end{aligned}$ |  | 1N4938 <br> 1N4938 <br> 1N4454 <br> 1N4454 |  | 100 100 75 75 |  | $\begin{gathered} 625 / 100 \\ 625 / 100 \\ 30 / 10 \\ 30 / 10 \end{gathered}$ | $\begin{aligned} & 1 / 5 \\ & 1 / 5 \\ & 1 / 5 \\ & 1 / 5 \end{aligned}$ |  |  |  |
|  | $\begin{aligned} & \mathbf{G} \\ & \mathbf{G} \\ & \mathbf{G} \\ & \mathbf{G} \end{aligned}$ | $\left.\begin{array}{\|l\|} \hline \text { SD } \\ \text { SD } \\ \text { SD } \\ \text { SD } \end{array} \right\rvert\,$ |  | 1N4938 IN4148 <br> 1N4454 |  | $\begin{array}{r} 120 \\ 100 \\ 40 \\ 70 \end{array}$ |  | $\begin{array}{r} 25 / 10 \\ 25 / 10 \\ 300 / 30 \\ 50 / 10 \end{array}$ | $\begin{gathered} 1 / 3 \\ 1 / 3 \\ 1 / 15 \\ 1.5 / 15 \end{gathered}$ |  |  |  |
| $\begin{array}{\|l\|} \text { 1N74 } \\ \text { 1N75 } \\ \text { 1N81 } \\ \text { 1N81A } \end{array}$ | $\left\lvert\, \begin{aligned} & G \\ & G \\ & G \\ & G \end{aligned}\right.$ | $\begin{array}{\|l\|} \hline \text { SD } \\ \text { SD } \\ \text { SD } \\ \text { SD } \end{array}$ |  | 1N4148 1N4938 1N4148 1N4148 |  | 75 125 50 40 |  | 50/10 <br> 50/50 <br> 10/10 <br> 10/10 | $\begin{gathered} 1.5 / 15 \\ 1 / 2.5 \\ 1 / 3 \\ 1 / 3 \end{gathered}$ |  |  |  |
| $\begin{array}{\|l\|l\|} \text { 1N83 } \\ \text { 1N84 } \\ \text { 1N86 } \\ \text { 1N87 } \end{array}$ | $\begin{aligned} & \mathbf{G} \\ & \mathbf{G} \\ & \mathbf{G} \\ & \mathbf{G} \end{aligned}$ | $\left\|\begin{array}{l} \mathrm{SD} \\ \mathrm{SD} \\ \mathrm{SD} \\ \mathrm{SD} \end{array}\right\|$ |  | 1N647 <br> 1N4148 <br> 1N4148 <br> 1N4148 |  | $\begin{array}{r} 375 \\ 25 \\ 70 \\ 23 \end{array}$ |  | $\begin{array}{r} 30 / 60 \\ 750 / 15 \\ 50 / 10 \\ 30 / 1.5 \end{array}$ | $\begin{gathered} 1 / 5 \\ 1 / 60 \\ 1 / 4 \\ .25 / .1 \end{gathered}$ |  |  |  |
| 1N87A in87s in87t 1N88 |  | $\begin{array}{\|l\|} \text { SD } \\ \text { SD } \\ \text { SD } \\ \text { SD } \end{array}$ |  | IN4148 <br> IN4148 <br> 1N4148 <br> 1N4938 |  | 23 25 25 85 |  | $\begin{gathered} 10 / 1.5 \\ 220 / 2 \\ 30 / 10 \\ 75 / 100 \end{gathered}$ | $\begin{gathered} .25 / .1 \\ 1 / 5 \\ 1 / 5 \\ 1 / 2.5 \end{gathered}$ |  |  |  |
| $\begin{aligned} & \text { INB9 } \\ & \text { IN90 } \\ & \text { IN91 } \\ & \text { IN92 } \end{aligned}$ |  | $\begin{array}{\|l\|} \hline \mathrm{SD} \\ \mathrm{SD} \\ \mathrm{RE} \\ \hline \mathrm{RE} \\ \hline \end{array}$ |  | 1N4454 <br> 1N4454 <br> 1N4002 <br> 1N4003 |  | $\begin{array}{r} 80 \\ 60 \\ 100 \\ 200 \end{array}$ |  | $\begin{aligned} & 100 / 50 \\ & 500 / 50 \\ & 1 / 100 \\ & 2 / 200 \end{aligned}$ | $\begin{aligned} & 1 / 3.5 \\ & 1 / 5 \\ & .5 / 150 \\ & .5 / 100 \end{aligned}$ |  |  |  |
| $\begin{aligned} & \text { IN93 } \\ & \text { 1N94 } \\ & \text { iN95 } \\ & \text { IN96 } \end{aligned}$ | $\left\lvert\, \begin{aligned} & \mathbf{G} \\ & \mathbf{G} \\ & \mathbf{G} \\ & \mathbf{G} \end{aligned}\right.$ | $\left\|\begin{array}{l} R E \\ R E \\ \mathrm{RD} \\ \mathrm{SD} \end{array}\right\|$ |  | in4004 in 4004 1N4148 in447 |  | $\begin{array}{r} 300 \\ 380 \\ 60 \\ 60 \end{array}$ |  | $\begin{gathered} 1.3 / 300 \\ .8 / 380 \\ 500 / 50 \\ 500 / 50 \end{gathered}$ | $\begin{aligned} & .5 / 80 \\ & .7 / 500 \\ & 1 / 10 \\ & 1 / 20 \end{aligned}$ |  |  |  |


| TYPE Mumest | $\frac{3}{3}$ | $\left\|\begin{array}{l} \frac{7}{6} \\ \frac{3}{3} \\ \frac{2}{6} \\ \frac{3}{3} \\ 3 \end{array}\right\|$ | TI | $\begin{aligned} & \text { FOR } \\ & \text { NEW } \\ & \text { DESYN } \end{aligned}$ | ratines |  |  | CHARACTERISTICS |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  | $\begin{gathered} P_{D} \\ (\mathrm{~mW}) \end{gathered}$ | $\mathbf{V}_{\mathbf{R}}$ (V) | I <br> (A) | $\begin{array}{ll} \mathbf{I}_{\mathbf{R}} & \mathbf{V}_{\mathbf{R}} \\ \mu \mathbf{A} & / \mathbf{V}) \end{array}$ | $\begin{array}{ll} \mathbf{V F}_{\mathrm{F}} & \text { if } \\ \text { (V) } & / \mathrm{mA}) \end{array}$ | $\begin{gathered} \mathrm{inr} \\ \mathrm{~ns}) \end{gathered}$ | $\mathbf{V}_{\mathbf{z}}$ - $\mathbf{l z}_{\mathbf{z}}$ <br> (V) $/$ (mA) | $\begin{aligned} & \text { TOL } \\ & \% \end{aligned}$ |
| IN96A <br> 1N97 <br> 1N97A <br> 1N98 | $\left\lvert\, \begin{aligned} & \mathbf{G} \\ & \mathbf{G} \\ & \mathbf{G} \\ & \mathbf{G} \end{aligned}\right.$ | $\begin{aligned} & \text { SD } \\ & \text { SD } \\ & \text { SD } \\ & \text { SD } \end{aligned}$ |  | 1N4148 <br> 1N4148 <br> 1N4447 <br> IN4454 |  | 60 80 92 80 |  | $\begin{aligned} & 500 / 50 \\ & 100 / 50 \\ & 100 / 50 \\ & 100 / 50 \end{aligned}$ | $\begin{aligned} & 1 / 40 \\ & 1 / 10 \\ & 1 / 20 \\ & 1 / 20 \end{aligned}$ |  |  |  |
| 1N98A 1N99 <br> 1N99A <br> 1N100 | $\left\lvert\, \begin{aligned} & G \\ & G \\ & G \\ & G \end{aligned}\right.$ | $\begin{aligned} & \text { SD } \\ & \text { SD } \\ & \text { SD } \\ & \text { SD } \end{aligned}$ |  | 1N4448 <br> 1N4148 <br> iN4454 <br> 1N4447 |  | 80 80 92 100 |  | $\begin{array}{r} 100 / 50 \\ 50 / 50 \\ 50 / 50 \\ 50 / 50 \end{array}$ | $\begin{aligned} & 1 / 40 \\ & 1 / 10 \\ & 1 / 20 \\ & 1 / 20 \end{aligned}$ |  |  |  |
| INIOOA <br> 1N1OI <br> 1N102 <br> 1N103 | $\mathfrak{G}$ | $\begin{aligned} & \text { SD } \\ & \text { SD } \\ & \text { SD } \\ & \text { SD } \end{aligned}$ |  | 1N4448 <br> IN4938 <br> 1N4938 <br> IN4488 |  | 80 150 125 20 |  | $\begin{gathered} 50 / 50 \\ 10 / \\ 3 / 25 \\ 750 / 15 \end{gathered}$ | $\begin{aligned} & 1 / 40 \\ & 1 / 10 \\ & 1 / 15 \\ & 1 / 30 \end{aligned}$ |  |  |  |
| $\begin{aligned} & \text { IN104 } \\ & \text { IN106 } \\ & \text { IN107 } \\ & \text { IN108 } \end{aligned}$ | $\begin{aligned} & G \\ & G \\ & G \\ & G \end{aligned}$ | $\left\|\begin{array}{l} \text { SD } \\ \text { SD } \\ \text { SD } \\ \text { SD } \end{array}\right\|$ |  | $\begin{aligned} & \text { IN4448 } \\ & \text { 1N647 } \\ & \text { T1D31 } \\ & \text { 1N4448 } \end{aligned}$ |  | 25 300 10 50 |  | $\begin{gathered} 750 / 15 \\ 70 / 300 \\ 200 / 10 \\ 200 / 50 \end{gathered}$ | $\begin{aligned} & 1 / 30 \\ & 1 / 20 \\ & 1 / 150 \\ & 1 / 50 \end{aligned}$ |  |  |  |
| 1N111 <br> 1N112 <br> 1N113 <br> 1N114 | $\begin{aligned} & \mathbf{G} \\ & \mathbf{G} \\ & \mathbf{G} \\ & \mathbf{G} \end{aligned}$ | $\left.\begin{aligned} & \text { sD } \\ & \text { sD } \\ & \text { sD } \\ & \text { so } \end{aligned} \right\rvert\,$ |  | 1N4148 <br> 1N4148 <br> 1N4454 <br> iN4454 |  | 70 70 70 70 |  | $\begin{aligned} & 25 / 10 \\ & 50 / 10 \\ & 25 / 50 \\ & 50 / 50 \end{aligned}$ | $\begin{aligned} & 1 / 5 \\ & 1 / 5 \\ & 1 / 2.5 \\ & 1 / 2.5 \end{aligned}$ |  |  |  |
| IN115 <br> 1N116 <br> 1N116A <br> 1N117 | $\begin{aligned} & \mathbf{G} \\ & \mathbf{G} \\ & \mathbf{G} \\ & \mathbf{G} \end{aligned}$ | $\left\lvert\, \begin{aligned} & \text { SD } \\ & \text { SD } \\ & \text { SD } \\ & \text { SD } \end{aligned}\right.$ |  | 1N4454 incess iN4454 1N4454 |  | $\begin{aligned} & 70 \\ & 60 \\ & 70 \\ & 60 \end{aligned}$ |  | $\begin{aligned} & 100 / 50 \\ & 100 / 50 \\ & 100 / 50 \\ & 100 / 50 \end{aligned}$ | $\begin{aligned} & 1 / 2.5 \\ & 1 / 5 \\ & 1 / 10 \\ & 1 / 10 \end{aligned}$ |  |  |  |
| 1N117A <br> 1N1 18 <br> 1N118A <br> 1N119 | $\begin{aligned} & \mathbf{G} \\ & \mathbf{G} \\ & \mathbf{G} \\ & \mathbf{G} \end{aligned}$ | $\left\lvert\, \begin{aligned} & \text { SD } \\ & \text { SD } \\ & \text { SD } \\ & \text { SD } \end{aligned}\right.$ |  | IN4454 1N454 IN4448 INA148 |  | 70 60 60 60 |  | 100/50 <br> 100/50 <br> 100/50 | $\begin{aligned} & 1 / 20 \\ & 1 / 20 \\ & 1 / 40 \\ & 1 / 5 \end{aligned}$ | 500 |  |  |
| 1N120 <br> IN126 <br> 1N126A <br> iNI 27 | $\begin{aligned} & \mathbf{G} \\ & \mathbf{G} \\ & \mathbf{G} \\ & \mathbf{G} \end{aligned}$ | $\left\|\begin{array}{l} \text { SD } \\ \text { SD } \\ \text { SD } \\ \text { SD } \end{array}\right\|$ |  | 1N4148 <br> INAI48 <br> 1N4148 <br> 1N4938 |  | $\begin{array}{r} 60 \\ 75 \\ 75 \\ 125 \end{array}$ |  | $\begin{aligned} & 850 / 50 \\ & 850 / 50 \\ & 300 / 50 \end{aligned}$ | $\begin{aligned} & 1 / 5 \\ & 1 / 5 \\ & 1 / 5 \\ & 1 / 3 \end{aligned}$ | 500 |  |  |
| $\begin{aligned} & \text { 1N127A } \\ & \text { 1N128 } \\ & \text { 1N128A } \\ & \text { 1N132 } \end{aligned}$ | $\begin{aligned} & \mathbf{G} \\ & \mathbf{G} \\ & \mathbf{G} \\ & \mathbf{G} \end{aligned}$ | $\left.\begin{array}{\|c\|} \text { SD } \\ \text { SD } \\ \text { SD } \\ \text { SD } \end{array} \right\rvert\,$ |  | 1N4938 <br> 1N4148 <br> 1N4148 <br> 1N4148 |  | $\begin{array}{r} 125 \\ 50 \\ 40 \\ 25 \end{array}$ |  | $\begin{array}{r} 300 / 50 \\ 10 / 10 \\ 10 / 10 \\ 500 / 50 \end{array}$ | $\begin{aligned} & 1 / 3 \\ & 1 / 3 \\ & 1 / 3 \end{aligned}$ |  |  |  |
| 1N133 <br> 1N135 <br> IN137A <br> IN1378 | $\begin{aligned} & G \\ & G \\ & S \\ & S \end{aligned}$ | $\left\|\begin{array}{l} \text { SD } \\ \text { SD } \\ \text { SD } \\ \text { SD } \end{array}\right\|$ |  | INA148 <br> INA148 <br> IN483 <br> IN483 |  | $\begin{array}{r} 5 \\ 75 \\ 36 \\ 36 \end{array}$ |  | $\begin{aligned} & 300 / 5 \\ & 850 / 50 \\ & .03 / 20 \\ & .03 / 20 \end{aligned}$ | $\begin{aligned} & .5 / 3 \\ & 1 / 5 \\ & 1 / 3 \\ & 1 / 20 \end{aligned}$ |  |  |  |

## DIODE INTERCHANGEABILITY

| TYPE NUMBER |  |  | Tin | $\begin{aligned} & \text { FOR } \\ & \text { NEW } \\ & \text { DESIGN } \end{aligned}$ | ratines |  |  | CHARACTERISTICS |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  | PD <br> (mW) | $\begin{aligned} & \mathbf{V}_{\mathbf{R}} \\ & (\mathbf{V}) \end{aligned}$ | I <br> (A) | $\begin{array}{ll} \mathbf{I}_{\mathbf{R}} & \oplus \mathbf{V}_{\mathbf{R}} \\ \mu \mathbf{A} & /(\mathbf{V}) \end{array}$ | $V_{F}$ IF <br> (V) $\quad /(\mathrm{mA})$ | $\begin{aligned} & t_{\mathrm{Vr}} \\ & (\mathrm{~ns}) \end{aligned}$ | $\mathbf{V Z}_{\mathbf{Z}}$. $\mathbf{z}$ <br> (V) / (mA) | $\left.\right\|^{\mathrm{TOL}}$ |
| IN138A <br> 1N1388 <br> IN139 <br> IN140 | $\begin{aligned} & S \\ & S \\ & G \\ & G \end{aligned}$ | $\begin{aligned} & \left\|\begin{array}{l} \text { SD } \\ \text { SD } \\ S D \\ S D \end{array}\right\| \end{aligned}$ |  | 1N483 <br> 1N483 <br> 1N4148 <br> iN4448 |  | 18 18 40 70 |  | $.01 / 10$ <br> $.01 / 10$ <br> . $5 \mathrm{M} / 50$ <br> 300/50 | $\begin{aligned} & 1 / 5 \\ & 1 / 40 \\ & 1 / 20 \\ & 1 / 40 \end{aligned}$ |  |  |  |
| IN141 <br> iN142 <br> 1N143 <br> IN144 | $\begin{aligned} & \mathbf{G} \\ & \mathbf{G} \\ & \mathbf{G} \\ & \mathbf{G} \end{aligned}$ | $\left\lvert\, \begin{aligned} & \text { SD } \\ & \text { SD } \\ & \text { SD } \\ & \text { SD } \end{aligned}\right.$ |  | 1N4148 <br> 1N4938 <br> 1N4938 <br> IN4454 |  | 70 100 100 30 |  | $\begin{aligned} & 50 / 50 \\ & 100 / 100 \\ & 100 / 100 \\ & 200 / 20 \end{aligned}$ | $\begin{aligned} & 1 / 20 \\ & 1 / 5 \\ & 1 / 40 \\ & 1 / 100 \end{aligned}$ |  |  |  |
| 1N145 <br> 1N151 <br> 1N152 <br> 1N153 | $\begin{aligned} & G \\ & G \\ & G \\ & G \end{aligned}$ | $\begin{aligned} & S D \\ & R E \\ & R E \\ & R E \end{aligned}$ |  | 1N4449 |  | 30 100 200 300 | .5 .5 .5 | 100/10 | $\begin{aligned} & 1 / 40 \\ & .7 / \\ & .7 / \\ & .7 / \end{aligned}$ |  |  |  |
| $\begin{aligned} & 1 N 158 \\ & \text { 1N175 } \\ & \text { 1N190 } \\ & \text { IN191 } \end{aligned}$ | $\begin{aligned} & \mathbf{G} \\ & \mathbf{G} \\ & \mathbf{G} \\ & \mathbf{G} \end{aligned}$ | $\left\|\begin{array}{l} \mathrm{RE} \\ \mathrm{SD} \\ \mathrm{SD} \\ \mathrm{SD} \end{array}\right\|$ |  | 1N4938 1N4148 |  | 380 125 3 90 | . 5 | $\begin{aligned} & 800 / \\ & 50 / 50 \end{aligned}$ $800 /$ | $\begin{aligned} & 1.4 / \\ & 5 / 1 \\ & .75 / 10 \\ & 1 / 5 \end{aligned}$ | 500 |  |  |
| 1N192 <br> iN193 <br> 1N194 <br> 1N194A | $\begin{aligned} & \mathbf{G} \\ & \mathbf{S} \\ & \mathbf{S} \\ & \mathbf{S} \end{aligned}$ | $\begin{aligned} & \text { SD } \\ & \text { SD } \\ & \text { SD } \\ & \text { SD } \end{aligned}$ |  | 1N4148 <br> IN4148 <br> 1N4148 <br> 1N4148 |  | 70 40 50 40 |  | $\begin{aligned} & 40 / 40 \\ & 60 / 40 \\ & 10 / 40 \end{aligned}$ | $\begin{aligned} & 1 / 5 \\ & 2 / 1 \\ & 2 / 1.5 \\ & 1 / 1 \end{aligned}$ | $\begin{aligned} & 500 \\ & 500 \\ & 100 \\ & 200 \end{aligned}$ |  |  |
| IN195 1N196 1N198 IN198A | $\begin{aligned} & \mathbf{S} \\ & \mathrm{S} \\ & G \\ & G \end{aligned}$ | $\begin{array}{\|l\|} \text { SD } \\ \text { SD } \\ \text { SD } \\ \text { SD } \end{array}$ |  | 1N4148 <br> 1N4148 <br> 1N4148 <br> 1N4148 |  | 50 50 80 80 |  | $\begin{aligned} & 80 / 40 \\ & 40 / 50 \\ & 10 / 10 \\ & 50 / 50 \end{aligned}$ | $\begin{aligned} & 2 / 2 \\ & 2 / 1 \\ & 1 / 4 \\ & 1 / 4 \end{aligned}$ | $\begin{aligned} & 100 \\ & 100 \end{aligned}$ |  |  |
| 1N198B <br> 1N198M <br> 1N225 <br> 1N225A | $\begin{aligned} & \mathbf{G} \\ & \mathbf{G} \\ & \mathbf{S} \\ & \mathbf{S} \end{aligned}$ | SD <br> SD <br> ZD <br> ZD |  | 1N4454 1N4148 | $\begin{aligned} & 150 \\ & 150 \end{aligned}$ | $\begin{array}{r} 100 \\ 80 \end{array}$ |  | $\begin{aligned} & 50 / 50 \\ & 75 / 10 \end{aligned}$ | $\begin{aligned} & 1 / 4 \\ & 1 / 4 \end{aligned}$ | 300 | $\begin{aligned} & 8.75 / .2 \\ & 8.75 / .2 \end{aligned}$ | $\begin{array}{r} 10 \\ 5 \end{array}$ |
| 1N226 <br> 1N226A <br> 1N227 <br> 1N227A | $\begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}$ | $\left\|\begin{array}{l} \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \end{array}\right\|$ |  |  | $\begin{aligned} & 150 \\ & 150 \\ & 150 \\ & 150 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 10.5 / .2 \\ & 10.5 / .2 \\ & 12.8 / .2 \\ & 12.8 / .2 \end{aligned}$ | $\begin{array}{r} 10 \\ 5 \\ 10 \\ 5 \end{array}$ |
| 1N228 <br> IN228A <br> 1N229 <br> IN229A | $\left\lvert\, \begin{aligned} & \mathbf{S} \\ & \mathbf{S} \\ & \mathbf{S} \\ & \mathbf{s} \end{aligned}\right.$ | $\left\|\begin{array}{l} \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \end{array}\right\|$ |  |  | $\begin{aligned} & 150 \\ & 150 \\ & 150 \\ & 150 \end{aligned}$ |  |  |  |  |  | $\begin{array}{r} 15.7 / .2 \\ 15.7 / .2 \\ 19 / .2 \\ 19 / .2 \end{array}$ | 10 5 10 5 |
| $\begin{aligned} & \text { 1 N230 } \\ & \text { 1 N230A } \\ & \text { IN231 } \\ & \text { 1N231A } \end{aligned}$ | $\left\lvert\, \begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}\right.$ | $\begin{aligned} & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \end{aligned}$ |  |  | $\begin{aligned} & 150 \\ & 150 \\ & 150 \\ & 150 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 23.5 / .2 \\ & 23.5 / .2 \\ & 28.5 / .2 \\ & 28.5 / .2 \end{aligned}$ | $\begin{array}{r} 10 \\ 5 \\ 10 \\ 5 \end{array}$ |


| TYPE MUMOER | $\begin{aligned} & \text { 震 } \\ & \frac{\mathbf{V}}{3} \end{aligned}$ | $\begin{aligned} & z \\ & \frac{3}{2} \\ & \frac{3}{3} \\ & \frac{3}{3} \\ & \frac{3}{3} \end{aligned}$ | $\frac{\text { II }}{\text { REMACEMENT }}$ | $\begin{aligned} & \text { FOR } \\ & \text { NEW } \\ & \text { DESIGN } \end{aligned}$ | RATINOS |  |  | CHARACTERISTICS |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  |  | (V) | 1 <br> (A) | $\begin{array}{ll} \mathbf{L} & \mathbf{V}_{\mathrm{R}} \\ \mu \mathrm{~A} & /(\mathbf{V}) \end{array}$ | $\mathbf{V F}_{F}$ - $\mathbf{I f}_{\mathbf{F}}$ <br> (V) $/$ (mA) | $\begin{gathered} \mathbf{t}_{\boldsymbol{r}} \\ \mathrm{n} s) \end{gathered}$ | $\mathbf{V}_{\mathbf{Z}}-\mathbf{Z}_{\mathbf{2}}$ <br> (V) $/$ ( mA ) | TOL \% |
| $\begin{aligned} & \text { 1 N232 } \\ & \text { 1 N232A } \\ & \text { 1N233 } \\ & \text { iN233A } \end{aligned}$ | $\begin{aligned} & 5 \\ & s \\ & s \\ & s \end{aligned}$ | $\begin{aligned} & \mathrm{ZD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \end{aligned}$ |  |  | $\begin{aligned} & 150 \\ & 150 \\ & 150 \\ & 150 \end{aligned}$ |  |  |  |  |  | $\begin{array}{r} 34.5 / .2 \\ 34.5 / .2 \\ 41 / .2 \\ 41 / .2 \end{array}$ | $\begin{array}{r} 10 \\ 5 \\ 10 \\ 5 \end{array}$ |
| $\begin{array}{\|l} \text { 1N234 } \\ \text { 1N234A } \\ \text { 1N235 } \\ \text { 1N235A } \end{array}$ | $\begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}$ | $\left\|\begin{array}{l} \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \end{array}\right\|$ |  |  | $\begin{aligned} & 150 \\ & 150 \\ & 150 \\ & 150 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 48 / .2 \\ & 48 / .2 \\ & 58 / .2 \\ & 58 / .2 \end{aligned}$ | $\begin{array}{r} 10 \\ 5 \\ 10 \\ 5 \end{array}$ |
| $\begin{aligned} & \text { 1N236 } \\ & \text { 1N237 } \\ & \text { 1N238 } \\ & \text { 1N239 } \end{aligned}$ | $\begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}$ | $\left\lvert\, \begin{aligned} & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \end{aligned}\right.$ |  |  | $\begin{aligned} & 150 \\ & 150 \\ & 150 \\ & 150 \end{aligned}$ |  |  |  |  |  | $\begin{array}{r} 71 / .2 \\ 88 / .2 \\ 105 / .2 \\ 128 / .2 \end{array}$ | $\begin{aligned} & 10 \\ & 10 \\ & 10 \\ & 10 \end{aligned}$ |
| $\begin{aligned} & \text { 1N248 } \\ & \text { IN248A } \\ & \text { 1N2488 } \\ & \text { IN248C } \end{aligned}$ | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\begin{aligned} & R E \\ & R E \\ & R E \\ & R E \\ & R E \end{aligned}$ |  |  |  | $\begin{aligned} & 50 \\ & 50 \\ & 50 \\ & 39 \end{aligned}$ | $\begin{aligned} & 10 \\ & 20 \\ & 20 \\ & 20 \end{aligned}$ | 5M/ <br> 5M/ <br> 5M/ <br> 4M/ | $\begin{aligned} & 1.5 / \\ & 1.5 / \\ & 1.5 / \\ & 1.2 / \end{aligned}$ |  |  |  |
| $\begin{aligned} & \text { 1N249 } \\ & \text { 1N249A } \\ & \text { 1N2498 } \\ & \text { 1N249C } \end{aligned}$ | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\begin{array}{\|l\|} \mathbf{R E} \\ \mathrm{RE} \\ \mathrm{RE} \\ \mathrm{RE} \end{array}$ |  |  |  | $\begin{aligned} & 100 \\ & 100 \\ & 100 \\ & 110 \end{aligned}$ | $\begin{aligned} & 10 \\ & 20 \\ & 20 \\ & 20 \end{aligned}$ | 5M/ <br> 5M/ <br> 5M/ <br> 4M/ | $\begin{aligned} & 1.5 / \\ & 1.5 / \\ & 1.5 / \\ & 1.2 / \end{aligned}$ |  |  |  |
| $\begin{array}{\|l\|} \text { 1N250 } \\ \text { 1N250A } \\ \text { 1N250B } \\ \text { 1N250C } \end{array}$ | $\left[\begin{array}{l} s \\ s \\ s \\ s \end{array}\right.$ | $\begin{aligned} & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \end{aligned}$ |  |  |  | $\begin{aligned} & 200 \\ & 200 \\ & 200 \\ & 210 \end{aligned}$ | $\begin{aligned} & 10 \\ & 20 \\ & 20 \\ & 20 \end{aligned}$ | $\begin{aligned} & 5 M / \\ & 5 M / \\ & 5 M / \\ & 3 M / \end{aligned}$ | $\begin{aligned} & 1.5 / \\ & 1.5 / \\ & 1.5 / \\ & 1.2 / \end{aligned}$ |  |  |  |
| $\begin{aligned} & \text { 1N251 } \\ & \text { 1N251A } \\ & \text { 1N252 } \\ & \text { 1N252A } \end{aligned}$ | $\begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}$ | $\left\|\begin{array}{l} \text { SD } \\ \text { SD } \\ \text { SD } \\ \text { SD } \end{array}\right\|$ | 1N251 | $\begin{aligned} & \text { 1N4938 } \\ & \text { 1N914 } \\ & \text { 1N4938 } \end{aligned}$ |  | $\begin{array}{r} 30 \\ 125 \\ 20 \\ 125 \end{array}$ |  | $\begin{gathered} 100 / 10 \\ 10 / 10 \\ .1 / 5 \\ 10 / 10 \end{gathered}$ | $\begin{aligned} & 1 / 5 \\ & 1 / 5 \\ & 1 / 10 \\ & 1 / 5 \end{aligned}$ | $\begin{aligned} & 150 \\ & 150 \\ & 150 \\ & 150 \end{aligned}$ |  |  |
| IN265 <br> 1N266 <br> IN267 <br> IN268 | $\left\lvert\, \begin{aligned} & \mathbf{G} \\ & \mathbf{G} \\ & \mathbf{G} \\ & \mathbf{G} \end{aligned}\right.$ | $\left\|\begin{array}{l} S D \\ S D \\ S D \\ S D \\ S D \end{array}\right\|$ |  | 1N4148 <br> 1N4148 <br> 1N4148 <br> INA148 |  | 80 50 30 30 |  | 30M/60 <br> 30M/30 <br> $50 \mathrm{~m} / 10$ <br> 850/30 | $\begin{aligned} & 1 / 4 \\ & 1 / 5 \\ & 1 / 5 \\ & 1 / 2.5 \end{aligned}$ |  |  |  |
| 1N270 <br> IN273 <br> 1N276 <br> 1N277 | $\begin{aligned} & G \\ & G \\ & \mathbf{G} \\ & \mathbf{G} \end{aligned}$ | $\left\|\begin{array}{l} \text { SD } \\ \text { SD } \\ \text { SD } \\ \text { SD } \end{array}\right\|$ |  | TID31 <br> INAMS <br> 1N4454 <br> 1N4938 |  | $\begin{array}{r} 80 \\ 30 \\ 50 \\ 150 \end{array}$ |  | $\begin{array}{r} 100 / 50 \\ 20 / 20 \\ 100 / 50 \\ 75 / 10 \end{array}$ | $\begin{aligned} & 1 / 200 \\ & 1 / 100 \\ & 1 / 40 \\ & 1 / 100 \end{aligned}$ | $\begin{aligned} & 300 \\ & 300 \\ & 300 \end{aligned}$ |  |  |
| $\begin{aligned} & \text { 1N277M } \\ & \text { 1N278 } \\ & \text { 1N279 } \\ & \text { 1N281 } \end{aligned}$ | $\begin{aligned} & \mathbf{G} \\ & \mathbf{G} \\ & \mathbf{G} \\ & \mathbf{G} \end{aligned}$ | $\left\|\begin{array}{l} \text { SD } \\ \text { SD } \\ \text { SD } \\ \text { SD } \end{array}\right\|$ |  | 1 N448 <br> 1N4446 <br> 1 N4448 <br> 1N4488 |  | $\begin{array}{r} 100 \\ 50 \\ 30 \\ 60 \end{array}$ |  | $\begin{array}{r} 75 / 10 \\ 125 / 50 \\ 200 / 20 \\ 30 / 10 \end{array}$ | $\begin{aligned} & 1 / 100 \\ & 1 / 20 \\ & 1 / 100 \\ & 1 / 100 \end{aligned}$ | $\begin{aligned} & 300 \\ & 300 \end{aligned}$ |  |  |

## DIODE INTERCHANGEABILITY

| TYPE NUMBER |  |  | $\pi$ REPLACEMENT | $\begin{gathered} \text { FOR } \\ \text { NEW } \\ \text { DESIGN } \end{gathered}$ | PD (mW) | atings <br> $V_{R}$ <br> (V) | (A) | $\begin{array}{ll} I_{\mathbf{R}} & V_{\mathbf{R}} \\ \mu_{\mathrm{A}} & (\mathbf{V}) \end{array}$ | $\mathbf{V}_{\mathrm{F}} \mathrm{I}_{\mathrm{F}}$ <br> (V) $/$ (mA) | RISTIC <br> ${ }^{\prime} \mathrm{rr}$ <br> (ns) | $\begin{array}{ccc} v_{z} & \mathrm{lz} \\ (\mathrm{~V}) & /(\mathrm{mA}) \end{array}$ | $\begin{gathered} \text { TOL } \\ \% \end{gathered}$ |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| $\begin{array}{\|l} \hline \text { 1N282 } \\ \text { 1N283 } \\ \text { 1N287 } \\ \text { 1N288 } \end{array}$ | $\begin{aligned} & \mathbf{G} \\ & \mathbf{G} \\ & \mathbf{G} \\ & \mathbf{G} \end{aligned}$ | $\left\lvert\, \begin{aligned} & \text { SD } \\ & \text { SD } \\ & \text { SD } \\ & \text { SD } \end{aligned}\right.$ |  | $\begin{aligned} & \text { IN4449 } \\ & \text { TID33 } \\ & \text { IN4148 } \\ & \text { IN4148 } \end{aligned}$ |  | 15 20 60 85 |  | $\begin{array}{r} 20 / 10 \\ 20 / 10 \\ 1 \mathrm{M} / 50 \\ 350 / 50 \end{array}$ | $\begin{aligned} & 1 / 40 \\ & 1 / 200 \\ & 1 / 20 \\ & 1 / 40 \end{aligned}$ |  |  |  |
| $\begin{aligned} & \text { in289 } \\ & \text { iN290 } \\ & \text { iN291 } \\ & \text { iN292 } \end{aligned}$ | $\begin{aligned} & \mathbf{G} \\ & \mathbf{G} \\ & \mathbf{G} \\ & \mathbf{G} \end{aligned}$ | $\left\|\begin{array}{l} \text { SD } \\ \text { SD } \\ \text { SD } \\ S D \end{array}\right\|$ |  | $\begin{aligned} & \text { 1N4148 } \\ & \text { 1N4938 } \\ & \text { 1N4938 } \\ & \text { 1N4448 } \end{aligned}$ |  | $\begin{array}{r} 85 \\ 120 \\ 120 \\ 75 \end{array}$ |  | $50 / 50$ $100 / 100$ 100/100 200/50 | $\begin{aligned} & 1 / 20 \\ & 1 / 5 \\ & 1 / 40 \\ & 1 / 100 \end{aligned}$ |  |  |  |
| $\begin{aligned} & \text { 1N294 } \\ & \text { 1N294A } \\ & \text { 1N295 } \\ & \text { 1N295A } \end{aligned}$ | $\begin{aligned} & \mathbf{G} \\ & \mathbf{G} \\ & \mathbf{G} \\ & \mathbf{G} \end{aligned}$ | $\left\|\begin{array}{l} \text { SD } \\ \text { SD } \\ \text { SD } \\ \text { SD } \end{array}\right\|$ |  | 1N4148 <br> 1N4148 <br> 1N4148 <br> 1N4148 |  | 60 60 40 40 |  | $\begin{array}{r} 10 / 10 \\ 10 / 10 \\ 200 / 10 \\ 200 / 10 \end{array}$ | $\begin{aligned} & 1 / 5 \\ & 1 / 5 \end{aligned}$ |  |  |  |
| 1N295S <br> 1N295X <br> 1N296 <br> iN297 | $\left\lvert\, \begin{aligned} & G \\ & G \\ & G \\ & G \end{aligned}\right.$ | $\left\|\begin{array}{l} S D \\ S D \\ S D \\ S D \end{array}\right\|$ |  | 1N4148 <br> IN4148 <br> 1N4148 <br> 1N4148 |  | 30 30 40 80 |  | $\begin{aligned} & 800 / 30 \\ & 385 / 24 \\ & 200 / \\ & 10 / 5 \end{aligned}$ | $\begin{aligned} & 1 / 6.5 \\ & 1 / 4.5 \\ & 1 / 3.5 \end{aligned}$ |  |  |  |
| IN297A 1N298 IN298A IN299 | $\begin{aligned} & \mathbf{G} \\ & \mathbf{G} \\ & \mathbf{G} \\ & \mathbf{G} \end{aligned}$ | $\left\|\begin{array}{l} S D \\ S D \\ S D \\ S D \\ S D \end{array}\right\|$ |  | 1N4148 <br> IN4148 <br> IN4148 <br> IN4305 |  | $\begin{aligned} & 80 \\ & 70 \\ & 70 \end{aligned}$ |  | $\begin{gathered} 10 / 5 \\ 250 / 40 \\ 10 / 5 \\ 200 / 6 \end{gathered}$ | $\begin{aligned} & 1 / 3.5 \\ & 2 / 30 \\ & 2 / 30 \\ & .5 / 3 \end{aligned}$ |  |  |  |
| 1N300 <br> in300A <br> IN300B <br> 1N301 | $\left\lvert\, \begin{aligned} & \mathrm{s} \\ & \mathrm{~s} \\ & \mathrm{~s} \\ & \mathrm{~s} \end{aligned}\right.$ | $\left\|\begin{array}{l} S D \\ S D \\ S D \\ S D \\ S D \end{array}\right\|$ |  | $\left\lvert\, \begin{aligned} & \text { 1N482 } \\ & \text { 1N482 } \\ & \text { 1N482 } \\ & \text { 1N457 } \end{aligned}\right.$ |  | 15 15 15 70 |  | $\begin{aligned} & 1 N / 10 \\ & 1 N / 10 \\ & 1 N / 10 \\ & .01 / 10 \end{aligned}$ | $\begin{aligned} & 1 / 15 \\ & 1 / 30 \\ & 1 / 50 \\ & 1 / 5 \end{aligned}$ |  |  |  |
| in301A <br> 1N301B <br> 1N302 <br> iN302A | $\begin{aligned} & \mathrm{s} \\ & \mathrm{~s} \\ & \mathrm{~s} \\ & \mathrm{~s} \end{aligned}$ | $\left.\begin{aligned} & \mathrm{SD} \\ & \mathrm{SD} \\ & \mathrm{SD} \\ & \mathrm{SD} \\ & \mathrm{SD} \end{aligned} \right\rvert\,$ |  | 1N457 <br> 1N457 <br> 1N645 <br> 1N645 |  | $\begin{array}{r} 70 \\ 70 \\ 225 \\ 225 \end{array}$ |  | $\begin{array}{r} .01 / 10 \\ .01 / 10 \\ .1 / 10 \\ .1 / 10 \end{array}$ | $\begin{aligned} & 1 / 18 \\ & 1 / 50 \\ & 1 / 1 \\ & 1 / 5 \end{aligned}$ |  |  |  |
| 1N3028 1N303 1N303A 1N303B | $\left\lvert\, \begin{aligned} & \mathrm{s} \\ & \mathrm{~s} \\ & \mathrm{~s} \\ & \mathrm{~s} \end{aligned}\right.$ | $\left\|\begin{array}{l} \text { SD } \\ \text { SD } \\ \text { SD } \\ \text { SD } \end{array}\right\|$ |  | 1N645 <br> 1N458 <br> 1 N484 <br> 1N484 |  | $\begin{aligned} & 225 \\ & 125 \\ & 125 \\ & 125 \end{aligned}$ |  | $\begin{aligned} & .01 / 10 \\ & .01 / 10 \\ & .01 / 10 \\ & .01 / 10 \end{aligned}$ | $\begin{aligned} & 1 / 20 \\ & 1 / 3 \\ & 1 / 12 \\ & 1 / 50 \end{aligned}$ |  |  |  |
| in304 1N305 1N306 IN307 | $\begin{aligned} & s \\ & G \\ & G \\ & G \end{aligned}$ | $\begin{aligned} & \text { SD } \\ & \text { SD } \\ & \text { SD } \\ & \text { SD } \end{aligned}$ |  | 1N4148 <br> 1N4607 <br> IN4607 <br> IN4938 |  | $\begin{array}{r} 55 \\ 60 \\ 15 \\ 125 \end{array}$ |  | $\begin{aligned} & 2 / 10 \\ & 2 / 10 \\ & 2 / 10 \\ & 5 / 10 \end{aligned}$ | $\begin{aligned} & 1.5 / 2 \\ & .8 / 100 \\ & .8 / 100 \\ & 1 / 100 \end{aligned}$ |  |  |  |
| IN308 IN309 IN310 1N312 | $\begin{aligned} & \mathbf{G} \\ & \mathbf{G} \\ & \mathbf{G} \\ & \mathbf{G} \end{aligned}$ | $\begin{aligned} & \text { SD } \\ & \text { SD } \\ & \text { SD } \\ & \text { SD } \end{aligned}$ |  | 1N4607 <br> 1N4148 <br> 1N4148 <br> 1N4448 |  | $\begin{array}{r} 8 \\ 40 \\ 100 \\ 50 \end{array}$ |  | $\begin{aligned} & 500 / 8 \\ & 100 / 20 \\ & 20 / 20 \\ & 50 / 50 \end{aligned}$ | $\begin{aligned} & 1 / 300 \\ & 1 / 100 \\ & 1 / 15 \\ & 1 / 30 \end{aligned}$ |  |  |  |

## DIODE INTERCHANGEABILITY

| TVPE Number |  |  | TI REPLACEMENT | $\begin{aligned} & \text { FOR } \\ & \text { NEW } \\ & \text { DESVCN } \end{aligned}$ | RATINGS |  |  | CHARACTERISTICS |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  | $\begin{gathered} P_{D} \\ (\mathrm{~mW}) \end{gathered}$ | $\begin{aligned} & \mathbf{V}_{\mathbf{R}} \\ & (\mathbf{V}) \end{aligned}$ | I <br> (A) | $\begin{array}{ll} \mathbf{I}_{\mathbf{R}} & \mathbf{V}_{\mathbf{R}} \\ \mu_{\mathrm{A}} & / \mathbf{V}) \end{array}$ | $\begin{aligned} & \mathbf{V}_{F}: F_{F} \\ & (\mathrm{~V}) \\ & \hline(\mathrm{mA}) \end{aligned}$ | $\begin{aligned} & i_{r r} \\ & \text { (ns) } \end{aligned}$ | $\mathbf{V}_{\mathbf{z}}$ - $\mathbf{z}$ <br> (V) $/$ (mA) | $\begin{gathered} 10 x \\ x \end{gathered}$ |
| $\begin{aligned} & \text { 1N313 } \\ & \text { 1N314 } \\ & \text { 1N315 } \\ & \text { 1N315A } \end{aligned}$ | $\begin{aligned} & \mathbf{G} \\ & \mathbf{G} \\ & \mathbf{G} \\ & \mathbf{G} \end{aligned}$ | SD SD RE RE |  | 1N4148 <br> 1N4148 <br> iNaOO4 <br> 1N4003 |  | $\begin{array}{r} 100 \\ 75 \\ 300 \\ 200 \end{array}$ | $\begin{array}{r} .075 \\ .1 \end{array}$ | $\begin{gathered} 10 / 20 \\ 50 / 10 \\ 300 / 300 \\ 160 / 200 \end{gathered}$ | $\begin{gathered} 1 / 20 \\ 1 / 15 \\ .48 / 100 \\ .48 / 100 \end{gathered}$ |  |  |  |
| $\begin{aligned} & \text { 1N316 } \\ & \text { iN316A } \\ & \text { 1N317 } \\ & \text { 1N317A } \end{aligned}$ | $\left\lvert\, \begin{aligned} & \mathbf{s} \\ & \mathbf{S} \\ & \mathbf{S} \\ & \mathbf{s} \end{aligned}\right.$ | $\begin{aligned} & R E \\ & R E \\ & R E \\ & R E \\ & R E \end{aligned}$ |  | 1N645 <br> 1N645 <br> iN645 <br> 1N645 |  | $\begin{array}{r} 50 \\ 50 \\ 100 \\ 100 \end{array}$ | $\begin{array}{r} .25 \\ .2 \\ .2 \\ .2 \end{array}$ | $\begin{array}{r} 300 / 50 \\ 1 / 50 \\ 300 / 100 \\ 1 / 100 \end{array}$ | $\begin{array}{r} 2 / 400 \\ .60 / 400 \\ 2 / 400 \\ .6 / 400 \end{array}$ |  |  |  |
| 1N318 <br> IN318A <br> 1N319 <br> 1N319A | $\left\lvert\, \begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}\right.$ | $\begin{aligned} & R E \\ & R E \\ & R E \\ & R E \end{aligned}$ |  | 1 N645 <br> 1N645 <br> 1N646 <br> 1N646 |  | $\begin{aligned} & 200 \\ & 200 \\ & 350 \\ & 350 \end{aligned}$ | $\begin{aligned} & .2 \\ & .2 \\ & .2 \\ & .2 \end{aligned}$ | $\begin{array}{r} 300 / 200 \\ 1 / 200 \\ 300 / 350 \\ 1 / 350 \end{array}$ | $\begin{array}{r} 2 / 400 \\ .6 / 400 \\ 2 / 300 \\ .6 / 400 \end{array}$ |  |  |  |
| $\begin{aligned} & \text { IN320 } \\ & \text { 1N320A } \\ & \text { IN321 } \\ & \text { IN32IA } \end{aligned}$ | $\left\lvert\, \begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}\right.$ | $\begin{aligned} & R E \\ & R E \\ & R E \\ & R E \end{aligned}$ |  | 1N648 <br> 1N648 <br> in4007 <br> iN4007 |  | $\begin{aligned} & 500 \\ & 500 \\ & 850 \\ & 850 \end{aligned}$ | $\begin{array}{r} .2 \\ .2 \\ .25 \\ .25 \end{array}$ | $\begin{array}{r} 300 / 500 \\ 2 / 500 \\ 300 / 850 \\ 2 / 850 \end{array}$ | $\begin{aligned} & 2 / 400 \\ & .6 / 400 \\ & .6 / 400 \\ & .6 / 400 \end{aligned}$ |  |  |  |
| $\begin{aligned} & \text { IN322 } \\ & \text { IN322A } \\ & \text { IN323 } \\ & \text { IN323A } \end{aligned}$ | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\begin{aligned} & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \end{aligned}$ |  | IN4007 in4007 IN4001 1N4001 |  | $\begin{aligned} & 1 K \\ & 1 K \\ & 50 \\ & 50 \end{aligned}$ | $\begin{array}{r} .25 \\ .25 \\ .4 \\ .4 \end{array}$ | $\begin{array}{r} 300 / 1 K \\ 2 / 1 K \\ 300 / 50 \\ 1 / 50 \end{array}$ | $\begin{array}{r} .6 / 400 \\ .6 / 400 \\ 2 / 650 \\ .6 / 650 \end{array}$ |  |  |  |
| $\begin{aligned} & \text { 1N324 } \\ & \text { 1N324A } \\ & \text { 1N325 } \\ & \text { 1N325A } \end{aligned}$ | $\begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{S} \\ & \mathbf{s} \end{aligned}$ | $\begin{aligned} & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \end{aligned}$ |  | $\begin{aligned} & \text { IN4002 } \\ & \text { 1N4002 } \\ & \text { 1N4003 } \\ & \text { iN4003 } \end{aligned}$ |  | $\begin{aligned} & 100 \\ & 100 \\ & 200 \\ & 200 \end{aligned}$ | $\begin{aligned} & .4 \\ & .4 \\ & .4 \\ & .4 \end{aligned}$ | $\begin{array}{r} 300 / 100 \\ 1 / 100 \\ 300 / 200 \\ 1 / 200 \end{array}$ | $\begin{aligned} & 2 / 650 \\ & .6 / 650 \\ & 2 / 650 \\ & .6 / 650 \end{aligned}$ |  |  |  |
| $\begin{aligned} & \text { 1N326 } \\ & \text { 1N326A } \\ & \text { 1N327 } \\ & \text { IN327A } \end{aligned}$ | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\left.\begin{array}{\|} \mathrm{RE} \\ \mathrm{RE} \\ \mathrm{RE} \\ \mathrm{RE} \end{array} \right\rvert\,$ |  | 1N4004 1N4004 1N4005 iN4005 |  | $\begin{aligned} & 350 \\ & 350 \\ & 500 \\ & 500 \end{aligned}$ | $\begin{aligned} & .4 \\ & .4 \\ & .4 \\ & .4 \end{aligned}$ | $\begin{array}{r} 300 / 350 \\ 1 / 350 \\ 300 / 500 \\ 1 / 500 \end{array}$ | $\begin{array}{r} 2 / 650 \\ .6 / 650 \\ 2 / 650 \\ .6 / 650 \end{array}$ |  |  |  |
| $\begin{aligned} & \text { 1N328 } \\ & \text { 1N328A } \\ & \text { 1N329 } \\ & \text { 1N329A } \end{aligned}$ | $\left\{\begin{array}{l} s \\ s \\ s \\ s \end{array}\right.$ | $\left.\begin{array}{\|} \mathbf{R E} \\ \mathbf{R E} \\ \mathbf{R E} \\ \mathbf{R E} \end{array} \right\rvert\,$ |  | $\begin{aligned} & \text { 1N4007 } \\ & \text { IN4007 } \\ & \text { 1N4007 } \\ & \text { 1N4007 } \end{aligned}$ |  | $\begin{array}{r} 850 \\ 850 \\ 1 K \\ 1 K \end{array}$ | $\begin{aligned} & .4 \\ & .4 \\ & .4 \\ & .4 \end{aligned}$ | $\begin{gathered} 300 / 850 \\ 2 / 850 \\ 10 / 1 K \\ 2 M / 1 K \end{gathered}$ | $\begin{array}{r} 1.2 / 650 \\ .6 / 650 \\ 1.2 / 650 \\ .6 / 650 \end{array}$ |  |  |  |
| $\begin{aligned} & \text { 1N330 } \\ & \text { 1N331 } \\ & \text { 1N332 } \\ & \text { 1N333 } \end{aligned}$ | $\begin{aligned} & s \\ & s \\ & s \\ & s \\ & s \end{aligned}$ | SD <br> SD <br> RE <br> RE |  | 1N456 <br> 1N458 |  | $\begin{array}{r} 32 \\ 16 \\ 400 \\ 400 \end{array}$ | . 4 | $\begin{aligned} & .03 / 20 \\ & .01 / 10 \end{aligned}$ | $\begin{aligned} & 1 / 3 \\ & 1 / 5 \\ & 2 / 800 \\ & 2 / 400 \end{aligned}$ |  |  |  |
| 1N334 <br> IN335 <br> iN336 <br> 1N337 | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\begin{aligned} & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \end{aligned}$ |  |  |  | $\begin{aligned} & 300 \\ & 300 \\ & 200 \\ & 200 \end{aligned}$ | .4 .2 .4 .2 |  | $\begin{aligned} & 2 / 400 \\ & 2 / 400 \\ & 2 / 800 \\ & 2 / 400 \end{aligned}$ |  |  |  |

TEXAS INSTRRUMENTS<br>INCORPORATED<br>POST OFFICE BOX 3012 - DALLAS. TEXAS 75222

| TYPE NUMBER |  | \| | $\begin{gathered} \text { TI } \\ \text { REPLACEMENT } \end{gathered}$ |  | $\begin{gathered} P_{D} \\ (\mathrm{~mW}) \end{gathered}$ | tings <br> $\mathbf{V}_{\mathbf{R}}$ <br> (V) | I <br> (A) | $\begin{array}{ll} \mathbf{I}_{\mathbf{R}} & \mathbf{V}_{\mathbf{R}} \\ \mu_{\mathrm{A}} & / \mathrm{V}) \end{array}$ | $\mathbf{V}_{\mathbf{F}} \cdot \mathbf{I F}_{\mathbf{F}}$ <br> (V) $/$ (mA) |  | $\mathbf{V z}_{\mathbf{z}}$ - $\mathbf{l z}_{\mathbf{z}}$ <br> (V) $/$ (mA) | $\left.\right\|^{\text {rot }}$ |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| $\begin{array}{\|l\|} \hline \text { IN338 } \\ \text { 1N339 } \\ \text { IN340 } \\ \text { IN341 } \end{array}$ | $\begin{aligned} & \mathrm{S} \\ & \mathrm{~S} \\ & \mathrm{~S} \\ & \mathrm{~s} \end{aligned}$ | $\begin{aligned} & \mathbf{R E} \\ & \mathbf{R E} \\ & \mathbf{R E} \\ & \mathbf{R E} \end{aligned}$ |  |  |  | 100 100 100 400 | 1 .4 .2 .4 |  | $\begin{aligned} & 2 / 1 A \\ & 2 / 800 \\ & 2 / 400 \\ & 2 / 800 \end{aligned}$ |  |  |  |
| $\begin{aligned} & \text { 1N342 } \\ & \text { 1N343 } \\ & \text { 1N344 } \\ & \text { IN345 } \end{aligned}$ | $\begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}$ | $\begin{aligned} & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \end{aligned}$ |  |  |  | 400 300 300 200 | .2 .4 .2 .4 |  | $\begin{aligned} & 2 / 400 \\ & 2 / 800 \\ & 2 / 800 \\ & 2 / 800 \end{aligned}$ |  |  |  |
| $\begin{aligned} & \text { 1N346 } \\ & \text { 1N347 } \\ & \text { IN348 } \\ & \text { 1N349 } \end{aligned}$ | $\left\lvert\, \begin{aligned} & 5 \\ & 5 \\ & 5 \\ & 5 \end{aligned}\right.$ | $\begin{aligned} & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \end{aligned}$ |  |  |  | 200 100 100 100 | .2 1 .4 .2 |  | $\begin{aligned} & 2 / 400 \\ & 2 / 1 A \\ & 2 / 800 \\ & 2 / 400 \end{aligned}$ |  |  |  |
| $\begin{aligned} & \text { 1N350 } \\ & \text { 1N351 } \\ & \text { IN352 } \\ & \text { IN353 } \end{aligned}$ | $\begin{aligned} & s \\ & s \\ & s \\ & s \\ & s \end{aligned}$ | $\begin{aligned} & \text { SD } \\ & \text { SD } \\ & \text { SD } \\ & \text { SD } \end{aligned}$ |  | 1N457 <br> 1N484 <br> 1N485 <br> 1N646 |  | $\begin{array}{r} 70 \\ 120 \\ 170 \\ 250 \end{array}$ |  | $\begin{aligned} & .03 / 60 \\ & .03 / 100 \\ & .05 / 150 \\ & .1 / 200 \end{aligned}$ | $\begin{aligned} & 1 / 20 \\ & 1 / 20 \\ & 1 / 20 \\ & 1 / 20 \end{aligned}$ |  |  |  |
| $\begin{aligned} & \text { IN354 } \\ & \text { IN355 } \\ & \text { IN359 } \\ & \text { IN359A } \end{aligned}$ | $\begin{aligned} & \mathbf{S} \\ & \mathbf{G} \\ & \mathbf{S} \\ & \mathbf{S} \end{aligned}$ | $\begin{aligned} & \mathrm{SD} \\ & \mathrm{SD} \\ & \mathrm{RE} \\ & \mathrm{RE} \end{aligned}$ |  | 1N647 <br> 1N4148 <br> IN4001 <br> 1 N4001 |  | $\begin{array}{r} 325 \\ 100 \\ 50 \\ 50 \end{array}$ | $\begin{array}{r} .15 \\ .15 \end{array}$ | $\begin{gathered} .1 / 300 \\ 5 / 5 \\ 250 / 50 \\ 1 / 50 \end{gathered}$ | $\begin{aligned} & 1 / 20 \\ & 1 / 4 \\ & 2 / 200 \\ & .6 / 250 \end{aligned}$ |  |  |  |
| 1N360 <br> IN360A <br> 1N361 <br> 1N361A | $\left\lvert\, \begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}\right.$ | $\begin{aligned} & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \end{aligned}$ |  | $\begin{aligned} & \text { IN4002 } \\ & \text { IN4002 } \\ & \text { IN4003 } \\ & \text { 1N4003 } \end{aligned}$ |  | $\begin{aligned} & 100 \\ & 100 \\ & 200 \\ & 200 \end{aligned}$ | $\begin{array}{r} .1 \\ .15 \\ .1 \\ .15 \end{array}$ | $\begin{array}{r} 250 / 100 \\ 1 / 100 \\ 250 / 200 \\ 1 / 200 \end{array}$ | $\begin{array}{r} 2 / 200 \\ .6 / 250 \\ 2 / 200 \\ .6 / 250 \end{array}$ |  |  |  |
| $\begin{aligned} & 1 \text { N362 } \\ & 1 N 362 A \\ & \text { 1N363 } \\ & \text { 1N363A } \end{aligned}$ | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\begin{aligned} & R E \\ & R E \\ & \text { RE } \\ & \text { RE } \\ & \hline \end{aligned}$ |  | 1N4004 1N4004 IN4005 iN4005 |  | $\begin{aligned} & 350 \\ & 350 \\ & 500 \\ & 500 \end{aligned}$ | $\begin{array}{r} .1 \\ .15 \\ .1 \\ .15 \end{array}$ | $\begin{array}{r} 250 / 300 \\ 1 / 350 \\ 250 / 500 \\ 2 / 500 \end{array}$ | $\begin{aligned} & 2 / 200 \\ & .6 / 250 \\ & 2 / 200 \\ & .6 / 250 \end{aligned}$ |  |  |  |
| IN364 1N364A 1N365 1N365A | S | $\begin{aligned} & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \end{aligned}$ |  | 1N4007 <br> 1N4007 <br> 1N4007 <br> 1N4007 |  | $\begin{array}{r} 850 \\ 850 \\ 1 K \\ 1 K \end{array}$ | $\begin{array}{r} .1 \\ .15 \\ .15 \\ .15 \end{array}$ | $\begin{gathered} 250 / 850 \\ 2 / 850 \\ 250 / 1 K \\ 2 / 1 K \end{gathered}$ | $\begin{array}{r} 1.2 / 200 \\ .6 / 200 \\ 1.2 / 200 \\ .6 / 200 \end{array}$ |  |  |  |
| 1N368 <br> 1N368A <br> 1N370 <br> 1N371 | $\left\lvert\, \begin{aligned} & G \\ & G \\ & S \\ & S \end{aligned}\right.$ | $\left\|\begin{array}{l} \mathrm{RE} \\ \mathrm{RE} \\ \mathrm{ZD} \\ \mathrm{ZD} \end{array}\right\|$ |  | 1N4003 1N4003 | $\begin{aligned} & 200 \\ & 200 \end{aligned}$ | $\begin{aligned} & 200 \\ & 200 \end{aligned}$ | $\begin{aligned} & .1 \\ & .1 \end{aligned}$ |  | $\begin{array}{r} .48 / 100 \\ .48 / 100 \end{array}$ |  | $\begin{aligned} & 1.8 / 20 \\ & 2.4 / 20 \end{aligned}$ | $\begin{aligned} & 20 \\ & 15 \end{aligned}$ |
| $\begin{aligned} & \text { 1N372 } \\ & \text { IN373 } \\ & \text { 1N374 } \\ & \text { 1N375 } \end{aligned}$ | $\mathbf{s}$ | $\left.\begin{aligned} & \mathrm{ZD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \end{aligned} \right\rvert\,$ |  |  | $\begin{aligned} & 200 \\ & 200 \\ & 200 \\ & 200 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 2.9 / 15 \\ & 3.5 / 10 \\ & 4.1 / 5 \\ & 4.1 / 5 \end{aligned}$ | $\begin{array}{r} 15 \\ 10 \\ 10 \\ 5 \end{array}$ |

Texas Instruments
INCORPORATED
POST OFFICE BOX 5012 - DALLAS, TEXAS 75222

| TYPE NUMBER |  |  | 11 replacement |  | RATINGS |  |  | CHARACTERISTICS |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  |  | $\mathbf{V}_{\mathrm{R}}$ <br> (V) | 1 <br> (A) | $\begin{array}{ll} \mathbf{I}_{\mathbf{R}} & \mathbf{V}_{\mathbf{R}} \\ \mu \mathbf{A} & / \mathbf{V}) \end{array}$ | $\mathbf{V}_{F}$ - $\mathbf{I F}_{F}$ <br> (V) $/$ (mA) | Int <br> (ns) | $\mathbf{V}_{\mathbf{z}}$ - $\mathbf{z}$ <br> (V) $/$ (mA) | $\begin{aligned} & \text { TOL } \\ & \% \end{aligned}$ |
| $\begin{aligned} & \text { 1N376 } \\ & \text { IN377 } \\ & \text { 1N378 } \\ & \text { 1N379 } \end{aligned}$ | $\left\lvert\, \begin{aligned} & \mathbf{S} \\ & \mathbf{S} \\ & \mathbf{S} \\ & \mathbf{S} \end{aligned}\right.$ | $\left\|\begin{array}{l} \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{sD} \end{array}\right\|$ |  | IN705A <br> IN706A <br> 1N707A <br> 1N4448 | $\begin{aligned} & 200 \\ & 200 \\ & 200 \end{aligned}$ | 8.2 |  | .5/8.2 | 1/35 |  | $\begin{gathered} 4.95 / 5 \\ 5.9 / 5 \\ 7.15 / .2 \end{gathered}$ | $\begin{aligned} & 5 \\ & 5 \\ & 5 \end{aligned}$ |
| 1N380 <br> 1N381 <br> 1N382 <br> 1N383 | $\left\lvert\, \begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}\right.$ | $\begin{aligned} & \text { SD } \\ & \text { SD } \\ & \text { SD } \\ & \text { SD } \end{aligned}$ |  | 1N4448 1N4488 IN4448 1N4448 |  | 10 12 15 18 |  | $\begin{aligned} & .5 / 10 \\ & .5 / 12 \\ & .5 / 15 \\ & .1 / 18 \end{aligned}$ | $\begin{aligned} & 1 / 30 \\ & 1 / 23 \\ & 1 / 17 \\ & 1 / 12 \end{aligned}$ |  |  |  |
| $\begin{aligned} & \text { IN384 } \\ & \text { 1N385 } \\ & \text { 1N386 } \\ & \text { IN387 } \end{aligned}$ | $\begin{aligned} & s \\ & s \\ & s \\ & s \\ & s \end{aligned}$ | $\left\|\begin{array}{l} S D \\ S D \\ S D \\ S D \end{array}\right\|$ |  | 1N4148 <br> 1N4148 <br> 1N4148 <br> 1 N4148 |  | 22 27 33 39 |  | $\begin{aligned} & .1 / 22 \\ & .1 / 27 \\ & .1 / 33 \\ & .1 / 39 \end{aligned}$ | $\begin{aligned} & 1 / 9 \\ & 1 / 7 \\ & 1 / 5.5 \\ & 1 / 4.5 \end{aligned}$ |  |  |  |
| $\begin{aligned} & \text { 1N388 } \\ & \text { 1N389 } \\ & \text { 1N390 } \\ & \text { 1N391 } \end{aligned}$ | $\begin{aligned} & \mathbf{S} \\ & \mathbf{S} \\ & \mathbf{S} \\ & \mathbf{S} \end{aligned}$ | $\begin{aligned} & \text { SD } \\ & \text { SD } \\ & \text { SD } \\ & \text { SD } \end{aligned}$ |  | 1N4148 <br> iN4148 <br> 1N4148 <br> 1N4148 |  | 47 56 68 82 |  | $\begin{aligned} & .1 / 47 \\ & .1 / 56 \\ & 1 / 68 \\ & 1 / 82 \end{aligned}$ | $\begin{aligned} & 1 / 3.5 \\ & 1 / 2.7 \\ & 1 / 2 \\ & 1 / 1.5 \end{aligned}$ |  |  |  |
| 1N392 <br> iN393 <br> 1N394 <br> 1N417 | $\begin{aligned} & \mathbf{S} \\ & \mathbf{S} \\ & \mathbf{S} \\ & \mathbf{G} \end{aligned}$ | $\begin{aligned} & \text { SD } \\ & \text { SD } \\ & \text { SD } \\ & \text { SD } \end{aligned}$ |  | 1N4148 1N4938 <br> 1N4938 <br> 1N4448 |  | $\begin{array}{r} 100 \\ 120 \\ 150 \\ 60 \end{array}$ |  | $\begin{array}{r} 1 / 100 \\ 1 / 120 \\ 5 / 150 \\ 120 / 80 \end{array}$ | $\begin{aligned} & 1 / 1.2 \\ & 1 / .9 \\ & 1 / .7 \\ & 1 / 50 \end{aligned}$ | 300 |  |  |
| 1N418 <br> 1N419 <br> IN429 <br> IN430 | $\begin{aligned} & \mathbf{G} \\ & \mathbf{G} \\ & \mathbf{S} \\ & \mathbf{S} \end{aligned}$ | $\begin{aligned} & \text { SD } \\ & \text { SD } \\ & R D \\ & R D \\ & R D \end{aligned}$ |  | $\begin{aligned} & \text { IN4148 } \\ & \text { TID32 } \end{aligned}$ | $\begin{aligned} & 200 \\ & 250 \end{aligned}$ | 60 80 |  | $\begin{aligned} & 120 / 60 \\ & 180 / 80 \end{aligned}$ | $\begin{aligned} & 1 / 7 \\ & 1 / 125 \end{aligned}$ | $\begin{aligned} & 300 \\ & 300 \end{aligned}$ | $\begin{aligned} & 6.2 / 7.5 \\ & 8.4 / 10 \end{aligned}$ | 5 |
| $\begin{aligned} & \text { IN430A } \\ & \text { IN4308 } \\ & \text { IN431 } \\ & \text { IN432 } \end{aligned}$ | $\left\lvert\, \begin{aligned} & s \\ & S \\ & s \\ & s \end{aligned}\right.$ | $\begin{array}{\|l\|} \text { RD } \\ \text { RD } \\ \text { SD } \\ \text { SD } \end{array}$ |  | $\begin{aligned} & \text { 1N4938 } \\ & \text { 1N4148 } \end{aligned}$ | $\begin{aligned} & 250 \\ & 250 \end{aligned}$ | 68 40 |  | $\begin{array}{r} 1 / 68 \\ 3 M / 10 \end{array}$ | $\begin{gathered} .55 / 15 \\ 1 / 1 \end{gathered}$ | 3 | $\begin{aligned} & 8.4 / 10 \\ & 8.4 / 10 \end{aligned}$ | $\begin{aligned} & 5 \\ & 5 \end{aligned}$ |
| $\begin{aligned} & \text { 1N432A } \\ & \text { 1N432B } \\ & \text { 1N433 } \\ & \text { 1N433A } \end{aligned}$ | $\left\lvert\, \begin{aligned} & 5 \\ & 5 \\ & 5 \\ & 5 \end{aligned}\right.$ | $\left\lvert\, \begin{aligned} & \text { SD } \\ & \text { SD } \\ & \text { SD } \\ & \text { SD } \end{aligned}\right.$ |  | IN4446 <br> 1N4448 <br> IN4938 <br> IN4938 |  | $\begin{array}{r} 40 \\ 40 \\ 145 \\ 145 \end{array}$ |  | $3 M / 10$ <br> 3M/10 <br> 7M/100 <br> 7M/100 | $\begin{aligned} & 1 / 20 \\ & 1 / 50 \\ & 1 / 3 \\ & 1 / 10 \end{aligned}$ | 3 3 3 3 |  |  |
| $\begin{aligned} & \text { 1N433B } \\ & \text { 1N434 } \\ & \text { 1N434A } \\ & \text { 1N434B } \end{aligned}$ | $\left\lvert\, \begin{aligned} & 5 \\ & s \\ & 5 \\ & 5 \end{aligned}\right.$ | $\begin{aligned} & \text { SD } \\ & \text { SD } \\ & \text { SD } \\ & \text { SD } \end{aligned}$ |  | 1N4938 <br> IN4938 <br> 1 N4938 <br> IN4938 |  | $\begin{aligned} & 145 \\ & 180 \\ & 180 \\ & 180 \end{aligned}$ |  | 7M/100 <br> 2M/150 <br> 7M/150 <br> 2M/150 | $\begin{aligned} & 1 / 50 \\ & 1 / 2 \\ & 1 / 7 \\ & 1 / 2 \end{aligned}$ | 3 3 3 3 |  |  |
| 1N435 <br> 1N440 <br> 1N440B <br> IN441 | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\begin{aligned} & \mathrm{SD} \\ & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \end{aligned}$ |  | $\begin{aligned} & \text { 1N4148 } \\ & \text { 1N4002 } \\ & \text { IN4002 } \\ & \text { 1N4003 } \end{aligned}$ |  | $\begin{array}{r} 40 \\ 100 \\ 100 \\ 200 \end{array}$ | $\begin{array}{r} .3 \\ .75 \\ .3 \end{array}$ | $\begin{array}{r} 300 / 30 \\ .3 / 100 \\ .3 / 100 \\ .75 / 200 \end{array}$ | $\begin{aligned} & 1.5 / 300 \\ & 1.5 / 750 \\ & 1.5 / 300 \end{aligned}$ |  |  |  |

## DIODE INTERCHANGEABILITY

| TYPE NUMBER |  |  | II REPLACEMENT |  |  | tines <br> $\mathbf{V}_{\mathbf{R}}$ <br> (V) | I <br> (A) | $\begin{array}{ll} \mathbf{I}_{\mathbf{R}} & \mathbf{V}_{\mathbf{R}} \\ \mu \mathbf{A} & /(\mathbf{V}) \end{array}$ | $\mathbf{V F}_{F} \cdot \mathbf{I}_{F}$ <br> (V) $/$ (mA) | Elistic <br> $t_{r}$ <br> (ns) | $\mathbf{V}_{\mathbf{z}}$ - $\mathbf{z}$ <br> (V) $/$ (mA) | $\left\lvert\, \begin{gathered} \mathrm{rol} \\ \% \end{gathered}\right.$ |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 1N4L1B <br> 1N442 <br> 1N442B <br> 1N443 | $\begin{aligned} & 5 \\ & 5 \\ & 5 \\ & 5 \end{aligned}$ | RE <br> RE <br> RE <br> RE |  | 1N4003 iN4004 1N4004 IN4004 |  | $\begin{aligned} & 200 \\ & 300 \\ & 300 \\ & 400 \end{aligned}$ | $\begin{array}{r} .75 \\ .3 \\ .75 \\ .3 \end{array}$ | $\begin{array}{r} .75 / 200 \\ 1 / 300 \\ 1 / 300 \\ 1.5 / 400 \end{array}$ | $\begin{aligned} & 1.5 / 750 \\ & 1.5 / 300 \\ & 1.5 / 750 \\ & 1.5 / 300 \end{aligned}$ |  |  |  |
| 1N4438 <br> 1N444 <br> 1N444B <br> 1N445 | $\begin{aligned} & \mathrm{s} \\ & \mathrm{~s} \\ & \mathrm{~s} \\ & \mathrm{~s} \end{aligned}$ | $\begin{aligned} & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \end{aligned}$ |  | IN4004 <br> 1N4005 <br> 1N4005 <br> 1N4005 |  | $\begin{aligned} & 400 \\ & 500 \\ & 500 \\ & 600 \end{aligned}$ | $\begin{array}{r} .75 \\ .3 \\ .75 \\ .3 \end{array}$ | 1.5/400 <br> 1.7/500 <br> 1.7/500 <br> 2.0/600 | $\begin{aligned} & 1.5 / 750 \\ & 1.5 / 300 \\ & 1.5 / 750 \\ & 1.5 / 300 \end{aligned}$ |  |  |  |
| 1N445B <br> 1N447 <br> 1 N448 <br> 1N449 | $\begin{aligned} & \mathrm{S} \\ & \mathrm{G} \\ & \mathrm{G} \\ & \mathrm{G} \end{aligned}$ | $\begin{aligned} & \text { RE } \\ & \text { SD } \\ & \text { SD } \\ & \text { SD } \end{aligned}$ |  | 1N4005 IN4449 IN4449 1N4151 |  | $\begin{array}{r} 600 \\ 40 \\ 100 \\ 40 \end{array}$ | . 75 | $\begin{aligned} & 2.0 / 600 \\ & 20 / 10 \\ & 30 / 30 \\ & 30 / 30 \end{aligned}$ | $\begin{gathered} 1.5 / 750 \\ 1 / 25 \\ 1 / 25 \\ 1 / 50 \end{gathered}$ |  |  |  |
| $\begin{aligned} & \text { IN450 } \\ & \text { IN451 } \\ & \text { IN452 } \\ & \text { IN453 } \end{aligned}$ | $\begin{aligned} & G \\ & G \\ & G \\ & G \end{aligned}$ | $\begin{array}{\|l\|} \hline S D \\ \text { SD } \\ \text { SD } \\ \text { SD } \end{array}$ |  | 1N4151 <br> 1N4938 <br> 1N4448 <br> 1N4938 |  | $\begin{array}{r} 100 \\ 150 \\ 35 \\ 115 \end{array}$ |  | $\begin{gathered} 50 / 50 \\ 150 / 150 \\ 30 / 30 \\ 30 / 30 \end{gathered}$ | $\begin{aligned} & 1 / 50 \\ & 1 / 50 \\ & 1 / 100 \\ & 1 / 100 \end{aligned}$ |  |  |  |
| INA54 <br> IN455 <br> 1N456 <br> IN456A | $\begin{aligned} & \mathbf{G} \\ & \mathbf{G} \\ & \mathbf{S} \\ & \mathbf{S} \end{aligned}$ | $\begin{aligned} & \text { SD } \\ & \text { SD } \\ & \text { SD } \\ & \text { SD } \end{aligned}$ | IN456 <br> IN456A | TID33 <br> 1N4607 | - | 58 35 30 30 |  | $\begin{array}{r} 50 / 50 \\ 30 / 30 \\ 25 \mathrm{~N} / 25 \\ 25 \mathrm{~N} / 25 \end{array}$ | $\begin{aligned} & 1 / 200 \\ & 1 / 300 \\ & 1 / 40 \\ & 1 / 100 \end{aligned}$ |  |  |  |
| 1N457 <br> 1N457A <br> IN457M <br> 1N458 | $\begin{aligned} & \mathrm{S} \\ & \mathrm{~S} \\ & \mathrm{~S} \\ & \mathrm{~s} \end{aligned}$ | SD <br> SD <br> SD <br> SD | 1N457 <br> 1N457A <br> 1N457 <br> 1N458 |  |  | $\begin{array}{r} 70 \\ 70 \\ 80 \\ 150 \end{array}$ |  | $\begin{aligned} & 25 N / 60 \\ & 25 N / 60 \\ & 25 N / 60 \\ & 25 N / 125 \end{aligned}$ | $\begin{aligned} & 1 / 20 \\ & 1 / 100 \\ & 1 / 20 \\ & 1 / 2 \end{aligned}$ |  |  |  |
| 1N458A <br> IN458M <br> 1N459 <br> 1N459A | $\begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}$ | SD SD SD SD | INA58A <br> 1 N458 <br> 1N459 <br> 1N459A |  |  | $\begin{aligned} & 150 \\ & 175 \\ & 200 \\ & 200 \end{aligned}$ |  | $\begin{aligned} & 25 N / 125 \\ & 25 N / 125 \\ & 25 N / 175 \\ & 25 N / 175 \end{aligned}$ | $\begin{aligned} & 1 / 100 \\ & 1 / 7 \\ & 1 / 3 \\ & 1 / 100 \end{aligned}$ |  |  |  |
| 1N459M <br> IN460 <br> 1N460A <br> 1N4608 | $\begin{aligned} & 5 \\ & 5 \\ & 5 \\ & 5 \end{aligned}$ | $\begin{aligned} & \text { SD } \\ & \text { SD } \\ & \text { SD } \\ & \text { SD } \end{aligned}$ | 1N459 | 1N4148 <br> 1N4148 <br> iN4448 |  | 230 90 90 90 |  | $\begin{gathered} 25 N / 175 \\ 10 / 75 \\ 10 / 75 \\ 10 / 75 \end{gathered}$ | $\begin{aligned} & 1 / 3 \\ & 1 / 5 \\ & 1 / 15 \\ & 1 / 50 \end{aligned}$ | 20 20 20 |  |  |
| 1N461 <br> 1N461A <br> 1N462 <br> IN462A | $\begin{aligned} & 5 \\ & 5 \\ & 5 \\ & 5 \end{aligned}$ | $\begin{aligned} & \text { SD } \\ & \text { SD } \\ & \text { SD } \\ & \text { SD } \end{aligned}$ | IN461 <br> IN461A <br> 1 N462 <br> 1N462A |  |  | 35 30 80 70 |  | $\begin{aligned} & .5 / 25 \\ & .5 / 25 \\ & .5 / 60 \\ & .5 / 60 \end{aligned}$ | $\begin{aligned} & 1 / 15 \\ & 1 / 100 \\ & 1 / 5 \\ & 1 / 100 \end{aligned}$ |  |  |  |
| 1 N463 <br> 1N463A <br> iN464 <br> 1N464A | $\begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}$ | $\left\|\begin{array}{l} \mathrm{SD} \\ \mathrm{SD} \\ \mathrm{SD} \\ \mathrm{SD} \end{array}\right\|$ | IN463 <br> 1N463A <br> in464 <br> 1N464A |  |  | $\begin{aligned} & 230 \\ & 200 \\ & 175 \\ & 150 \end{aligned}$ |  | $\begin{aligned} & .5 / 175 \\ & .5 / 175 \\ & .5 / 125 \\ & .5 / 125 \end{aligned}$ | $\begin{aligned} & 1 / 1 \\ & 1 / 100 \\ & 1 / 3 \\ & 1 / 100 \end{aligned}$ |  |  |  |


| TYPE Mumber |  | $\begin{aligned} & \frac{3}{0} \\ & \frac{3}{3} \\ & \frac{3}{3} \end{aligned}$ |  | $\begin{aligned} & \text { FOR } \\ & \text { Maw } \\ & \text { Desich } \end{aligned}$ |  | TMNOS <br> $\mathbf{V}_{\mathbf{R}}$ <br> (V) | I <br> (A) | $\begin{array}{ll} \mathbf{I}_{\mathbf{R}} & \mathbf{V}_{\mathrm{R}} \\ \mu \mathrm{~A} & /(\mathrm{V}) \end{array}$ | $\mathbf{V F}_{F}$ - $\mathbf{F}_{\mathbf{F}}$ <br> (V) $/$ (mA) |  | $\mathbf{V}_{\mathbf{Z}}$ - $\mathbf{z}$ <br> (V) / (ma) | $\begin{aligned} & \text { TOX } \\ & \times \end{aligned}$ |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 1N465 <br> 1N465A <br> iN4658 <br> 1N466 | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\left.\begin{aligned} & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \end{aligned} \right\rvert\,$ |  | 1N746 | $\begin{aligned} & 250 \\ & 250 \\ & 250 \\ & 250 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 2.6 / 5 \\ & 2.6 / 5 \\ & 2.6 / 5 \\ & 3.5 / 5 \end{aligned}$ | 10 5 1 10 |
| IN466A <br> 1N466B <br> 1N467 <br> 1N467A | $\left\lvert\, \begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}\right.$ | $\left\lvert\, \begin{aligned} & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \end{aligned}\right.$ |  | IN746A <br> 1N748 <br> IN748A | $\begin{aligned} & 250 \\ & 250 \\ & 250 \\ & 250 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 3.5 / 5 \\ & 3.5 / 5 \\ & 4.1 / 5 \\ & 4.1 / 5 \end{aligned}$ | 5 1 10 5 |
| 1NC678 <br> 1N468 <br> 1N468A <br> 1N4688 | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\begin{aligned} & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \end{aligned}$ |  | $\left\lvert\, \begin{aligned} & \text { IN750 } \\ & \text { IN750A } \end{aligned}\right.$ | $\begin{aligned} & 250 \\ & 250 \\ & 250 \\ & 250 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 4.1 / 5 \\ & 4.9 / 5 \\ & 4.9 / 5 \\ & 4.9 / 5 \end{aligned}$ | 1 10 5 1 |
| $\begin{aligned} & \text { IN469 } \\ & \text { IN469A } \\ & \text { IN4698 } \\ & \text { IN470 } \end{aligned}$ | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\left\lvert\, \begin{aligned} & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \end{aligned}\right.$ |  | $\left\lvert\, \begin{aligned} & \text { 1N752 } \\ & \text { 1N752A } \\ & \text { iN754 } \end{aligned}\right.$ | $\begin{aligned} & 250 \\ & 250 \\ & 250 \\ & 250 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 5.8 / 5 \\ & 5.8 / 5 \\ & 5.8 / 5 \\ & 7.1 / 5 \end{aligned}$ | 10 5 1 10 |
| IN470A <br> INATOB <br> 1N471 <br> IN471A |  | $\begin{aligned} & \mathrm{zo} \\ & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \end{aligned}$ |  | 1N751A | $\begin{aligned} & 250 \\ & 250 \\ & 200 \\ & 200 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 7.1 / 5 \\ & 7.1 / 5 \\ & 3.5 / 5 \\ & 3.5 / 5 \end{aligned}$ | 5 1 10 5 |
| $\begin{aligned} & \text { INA718 } \\ & \text { 1NA72 } \\ & \text { 1NA72A } \\ & \text { 1NA728 } \end{aligned}$ | $\left\lvert\, \begin{aligned} & 5 \\ & 5 \\ & 5 \\ & 5 \end{aligned}\right.$ | $\begin{aligned} & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \end{aligned}$ |  | * | $\begin{aligned} & 200 \\ & 200 \\ & 200 \\ & 200 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 3.5 / 5 \\ & 4.1 / 5 \\ & 4.1 / 5 \\ & 4.1 / 5 \end{aligned}$ | 1 10 5 1 |
| $\begin{aligned} & \text { 1N473 } \\ & \text { 1N473A } \\ & \text { 1N473B } \\ & \text { 1N474 } \end{aligned}$ | $\begin{aligned} & 5 \\ & 5 \\ & 5 \\ & 5 \end{aligned}$ | $\left\|\begin{array}{l} \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \end{array}\right\|$ |  |  | $\begin{aligned} & 200 \\ & 200 \\ & 200 \\ & 200 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 4.9 / 5 \\ & 4.9 / 5 \\ & 4.9 / 5 \\ & 5.8 / 5 \end{aligned}$ | 10 5 1 10 |
| $\begin{aligned} & \text { 1N474A } \\ & \text { 1N474B } \\ & \text { 1N475 } \\ & \text { 1N475A } \end{aligned}$ | $\left\lvert\, \begin{aligned} & 5 \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\left\|\begin{array}{l} \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \end{array}\right\|$ |  |  | $\begin{aligned} & 200 \\ & 200 \\ & 200 \\ & 200 \end{aligned}$ |  |  |  |  |  | 5.8/5 <br> 5.8/5 <br> 7.1/5 <br> 7.1/5 | 5 1 10 5 |
| $\begin{aligned} & \text { 1N4758 } \\ & \text { 1N476 } \\ & \text { 1N477 } \\ & \text { 1N478 } \end{aligned}$ | $\begin{aligned} & \mathbf{S} \\ & \mathbf{G} \\ & \mathbf{G} \\ & \mathbf{G} \end{aligned}$ | $\left\lvert\, \begin{aligned} & 2 D \\ & \text { SD } \\ & \text { SD } \\ & \text { SD } \end{aligned}\right.$ |  | $\begin{aligned} & 1 N 4148 \\ & 1 N 4148 \\ & 1 N 4148 \end{aligned}$ | 200 | $\begin{aligned} & 90 \\ & 90 \\ & 90 \end{aligned}$ |  | $\begin{aligned} & 180 / 75 \\ & 180 / 75 \\ & 155 / 75 \end{aligned}$ | $\begin{aligned} & 1 / 3 \\ & 1 / 3 \\ & 1 / 5 \end{aligned}$ |  | 7.1/5 | 1 |
| $\begin{aligned} & \text { 1N479 } \\ & \text { IN480 } \\ & \text { IN482 } \\ & \text { 1N482A } \end{aligned}$ | $\left\lvert\, \begin{aligned} & \mathbf{G} \\ & \mathbf{G} \\ & \mathbf{S} \\ & \mathbf{S} \end{aligned}\right.$ | $\left\|\begin{array}{l} S D \\ S D \\ S D \\ S D \end{array}\right\|$ | 1N482 <br> IN482A | 1N4148 1N4148 |  | $\begin{aligned} & 90 \\ & 60 \\ & 36 \\ & 36 \end{aligned}$ |  | $\begin{array}{r} 155 / 75 \\ .25 / 30 \\ 25 N / 30 \end{array}$ | $\begin{gathered} 1 / 5 \\ 1 / 5 \\ 1.1 / 100 \\ 1 / 100 \end{gathered}$ | 500 |  |  |

## DIODE INTERCHANGEABILITY



| TYPENUMBER |  |  | $\pi$ | $\begin{aligned} & \text { FOR } \\ & \text { NEW } \\ & \text { DESKON } \end{aligned}$ | ratings |  |  | Characteristics |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  | $\begin{gathered} \mathrm{PD}_{\mathrm{D}} \\ (\mathrm{~mW}) \end{gathered}$ | $\mathbf{V}_{\mathbf{R}}$ <br> (V) | (A) | $\begin{array}{ll} L_{R} & v_{R} \\ \mu_{\mathrm{A}} & /(\mathrm{V}) \end{array}$ | $\begin{array}{cc} \mathbf{v}_{\mathbf{F}} & \mathbf{l}_{\mathbf{F}} \\ \text { (V) } & 1 \mathrm{~mA}) \end{array}$ | ${ }^{4}$ <br> (ms) | $\mathbf{V z}_{z}$ - $\mathbf{z}$ <br> (V) $/$ (mA) | $\begin{gathered} \text { rol } \\ x \end{gathered}$ |
| $\begin{aligned} & \text { INS12 } \\ & \text { iNS13 } \\ & \text { INS14 } \\ & \text { INS15 } \end{aligned}$ | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | RE RE RE RE RE |  |  |  | $\begin{aligned} & 100 \\ & 200 \\ & 300 \\ & 400 \end{aligned}$ | 1 1 1 1 | $\begin{aligned} & 500 / \\ & 500 / \\ & 500 / \\ & 250 / \end{aligned}$ | $\begin{aligned} & 1.2 / \\ & 1.2 / \\ & 1.2 / \\ & 1.2 / \end{aligned}$ |  |  |  |
| 1N516 iN517 iN518 1N519 | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\begin{aligned} & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \end{aligned}$ |  |  |  | $\begin{array}{r} 600 \\ 800 \\ 1 K \\ 50 \end{array}$ | $\begin{array}{r} 1 \\ 1 \\ 1 \\ 1.25 \end{array}$ | $\begin{aligned} & 250 / \\ & 250 / \\ & 250 / \\ & 500 / \end{aligned}$ | $\begin{aligned} & 1.2 / \\ & 1.2 / \\ & 1.2 / \\ & 1.2 / \end{aligned}$ |  |  |  |
| $\begin{aligned} & \text { IN520 } \\ & \text { iN521 } \\ & \text { iN522 } \\ & \text { iN523 } \end{aligned}$ | $\left\lvert\, \begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}\right.$ | $\left.\begin{aligned} & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \end{aligned} \right\rvert\,$ |  |  |  | $\begin{aligned} & 100 \\ & 200 \\ & 300 \\ & 400 \end{aligned}$ | $\begin{aligned} & 1.25 \\ & 1.25 \\ & 1.25 \\ & 1.25 \end{aligned}$ | $\begin{aligned} & 500 / \\ & 500 / \\ & 500 / \\ & 250 \prime \end{aligned}$ | $\begin{aligned} & 1.2 / \\ & 1.2 / \\ & 1.2 / \\ & 1.2 / \end{aligned}$ |  |  |  |
| $\begin{aligned} & \text { 1N524 } \\ & \text { 1N55 } \\ & \text { 1N526 } \\ & \text { iN527 } \end{aligned}$ | $\left\lvert\, \begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{G} \end{aligned}\right.$ | $\begin{array}{\|l\|} \hline \mathbf{R E} \\ \mathbf{R E} \\ \mathbf{R E} \\ \mathbf{R E} \\ \mathbf{S D} \end{array}$ |  | 1N4305 |  | $\begin{array}{r} 600 \\ 800 \\ 1 K \\ 10 \end{array}$ | $\begin{aligned} & 1.25 \\ & 1.25 \\ & 1.25 \end{aligned}$ | $\begin{aligned} & 250 / \\ & 250 / \\ & 250 / \\ & 50 / 10 \end{aligned}$ | $\begin{gathered} 1.2 / \\ 1.2 / \\ 1.2 / \\ .3 / 1 \end{gathered}$ |  |  |  |
| in530 IN531 iN532 in533 | $\begin{aligned} & \mathrm{s} \\ & \mathrm{~s} \\ & \mathrm{~s} \\ & \mathrm{~s} \end{aligned}$ | $\begin{aligned} & \mathbf{R E} \\ & \mathbf{R E} \\ & \mathbf{R E} \\ & \mathbf{R E} \\ & \mathbf{R E} \end{aligned}$ |  | 1 N4002 <br> 1N4003 <br> 1N4004 <br> iN4004 |  | $\begin{aligned} & 100 \\ & 200 \\ & 300 \\ & 400 \end{aligned}$ | $\begin{aligned} & .3 \\ & .3 \\ & .3 \\ & .3 \end{aligned}$ | $\begin{array}{r} 3 / 100 \\ 7.5 / 200 \\ 10 / 300 \\ 15 / 400 \end{array}$ | $\begin{aligned} & 2 / 300 \\ & 2 / 300 \\ & 2 / 300 \\ & 2 / 300 \end{aligned}$ |  |  |  |
| $\begin{array}{\|l\|l} \text { IN534 } \\ \text { iN535 } \\ \text { IN536 } \\ \text { IN537 } \end{array}$ | $\begin{aligned} & \hline s \\ & s \\ & s \\ & s \\ & s \end{aligned}$ | $\left.\begin{aligned} & \mathbf{R E} \\ & \mathbf{R E} \\ & \mathbf{R E} \\ & \mathbf{R E} \end{aligned} \right\rvert\,$ |  | IN400S <br> IN4005 <br> IN4001 <br> iN4002 |  | $\begin{array}{r} 500 \\ 600 \\ 50 \\ 100 \end{array}$ | $\begin{array}{r} .3 \\ .3 \\ .75 \\ .75 \end{array}$ | $\begin{aligned} & 17 / 500 \\ & 20 / 600 \\ & 10 / 50 \\ & 10 / 100 \end{aligned}$ | $\begin{aligned} & 2 / 300 \\ & 2 / 300 \\ & 1 / 500 \\ & 1 / 500 \end{aligned}$ |  |  |  |
| $\begin{array}{\|l\|l\|} \text { 1N538 } \\ \text { 1N539 } \\ \text { iN540 } \\ \text { iN541 } \end{array}$ | $\left\lvert\, \begin{aligned} & \mathbf{S} \\ & \mathbf{S} \\ & \mathbf{S} \\ & \mathbf{G} \end{aligned}\right.$ | $\left\lvert\, \begin{aligned} & R E \\ & R E \\ & R E \\ & S D \end{aligned}\right.$ |  | 1N4003 <br> 1N4004 <br> INHOO4 <br> 1N4305 |  | $\begin{array}{r} 200 \\ 300 \\ 400 \\ 30 \end{array}$ | $\begin{aligned} & .75 \\ & .75 \\ & .75 \end{aligned}$ | $\begin{aligned} & 10 / 200 \\ & 10 / 300 \\ & 10 / 400 \\ & 18 / 10 \end{aligned}$ | $\begin{aligned} & 1 / 500 \\ & 1 / 500 \\ & 1 / 500 \\ & .3 / .1 \end{aligned}$ |  |  |  |
| $\begin{aligned} & \text { 1N542 } \\ & \text { 1NSA3 } \\ & \text { 1N543A } \\ & \text { IN544 } \end{aligned}$ | $\begin{aligned} & \mathbf{G} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{S} \end{aligned}$ | $\begin{array}{\|c\|} \hline \mathrm{SD} \\ \mathrm{RE} \\ \mathrm{RE} \\ \mathrm{RE} \\ \mathrm{RE} \end{array}$ |  | 1N4305 |  | $\begin{array}{r} 30 \\ 1.2 \mathrm{~K} \\ 1.2 \mathrm{~K} \\ 1 \mathrm{~K} \end{array}$ | $\begin{aligned} & .005 \\ & .025 \\ & .015 \end{aligned}$ | $\begin{aligned} & 18 / 10 \\ & 100 / \\ & 100 / \\ & 100 / \end{aligned}$ | $\begin{gathered} .3 / 1 \\ 10 / \\ 8 / \\ 10 / \end{gathered}$ |  |  |  |
| $\left\lvert\, \begin{aligned} & \text { 1N544A } \\ & \text { 1N547 } \\ & \text { 1N548 } \\ & \text { 1N549 } \end{aligned}\right.$ | $\left\lvert\, \begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}\right.$ | $\left.\begin{aligned} & \mathbf{R E} \\ & \mathbf{R E} \\ & \mathbf{R E} \\ & \mathbf{R E} \end{aligned} \right\rvert\,$ |  | $\left\lvert\, \begin{aligned} & \text { IN4005 } \\ & \text { IN4007 } \end{aligned}\right.$ |  | $\begin{array}{r} 1 K \\ 600 \\ 900 \\ 1.2 \mathrm{~K} \end{array}$ | $\begin{array}{r} .075 \\ .75 \\ .3 \\ .3 \end{array}$ | 100/ <br> 500/600 <br> 500/900 | $\begin{aligned} & 10 / \\ & 1.1 / 250 \\ & 1.1 / 300 \\ & 1.1 / 300 \end{aligned}$ |  |  |  |
| $\begin{array}{\|l\|l\|} \hline \text { IN550 } \\ \text { 1N551 } \\ \text { 1N552 } \\ \text { IN553 } \end{array}$ | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\begin{aligned} & \mathbf{R E} \\ & \mathbf{R E} \\ & \mathbf{R E} \\ & \mathbf{R E} \\ & \mathbf{R E} \end{aligned}$ |  |  |  | 100 200 300 400 | .5 .5 .5 .5 |  | $\begin{aligned} & 1.5 / \\ & 1.5 / \\ & 1.5 / \\ & 1.5 / \end{aligned}$ |  |  |  |


| TYPE NUMBER | 录 学 3 |  | 11 REPLACEMENT | $\begin{aligned} & \text { FOR } \\ & \text { NEW } \\ & \text { DESIGN } \end{aligned}$ | $\begin{aligned} & P_{D} \\ & (\mathrm{~mW}) \end{aligned}$ | ATINES <br> $\mathbf{V}_{\mathbf{R}}$ <br> (V) | I <br> (A) | $\begin{array}{ll} \mathrm{I}_{\mathrm{R}} & \mathrm{~V}_{\mathrm{R}} \\ \mu \mathrm{~A} & /(\mathrm{V}) \end{array}$ | $\mathbf{V F}_{F}$ IF <br> (V) / (mA) | $t_{r r}$ <br> (ns) | $\mathbf{V}_{\mathbf{Z}} \mathbf{I z}_{\mathbf{z}}$ <br> (V) / (mA) | TOA <br> \% |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| $\begin{aligned} & \text { 1N554 } \\ & \text { 1N555 } \\ & \text { 1N560 } \\ & \text { IN561 } \end{aligned}$ | $\begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}$ | $\begin{aligned} & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \end{aligned}$ |  | 1N4006 <br> 1N4007 |  | $\begin{array}{r} 500 \\ 600 \\ 800 \\ 1 K \end{array}$ | $\begin{array}{r} .5 \\ .5 \\ .75 \\ .75 \end{array}$ | $\begin{aligned} & 5 / \\ & 15 / 800 \\ & 20 / 1 \mathrm{~K} \end{aligned}$ | $\begin{aligned} & 1.5 / \\ & 1.5 / \\ & 1.1 / 500 \\ & 1.1 / 500 \end{aligned}$ |  |  |  |
| $\begin{aligned} & \text { IN562 } \\ & \text { 1N563 } \\ & \text { 1N568 } \\ & \text { 1N567 } \end{aligned}$ | $\left\lvert\, \begin{aligned} & \mathbf{S} \\ & \mathbf{S} \\ & \mathbf{G} \\ & \mathbf{G} \end{aligned}\right.$ | $\begin{aligned} & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{SD} \\ & \mathrm{SD} \end{aligned}$ |  | $\begin{array}{\|l\|} \hline 1 \mathrm{~N} 4938 \\ \text { 1N4938 } \end{array}$ |  | $\begin{array}{r} 800 \\ 1 K \\ 220 \\ 125 \end{array}$ | $.4$ | $\begin{gathered} 15 / 800 \\ 20 / 1 K \\ 200 / 200 \\ 150 / 100 \end{gathered}$ | $\begin{gathered} 1.8 / 400 \\ 1.8 / 400 \\ 1 / 20 \\ 1 / 150 \end{gathered}$ |  |  |  |
| $\begin{aligned} & \text { 1N568 } \\ & \text { IN569 } \\ & \text { 1N570 } \\ & \text { 1N571 } \end{aligned}$ | $\begin{aligned} & G \\ & G \\ & \mathbf{G} \\ & G \end{aligned}$ | $\begin{aligned} & \mathrm{SD} \\ & \mathrm{SD} \\ & \mathrm{RE} \\ & \mathrm{RE} \end{aligned}$ |  | 1N4305 1N4305 <br> TID33 |  | $\begin{array}{r} 50 \\ 25 \\ 1.5 \mathrm{~K} \\ 15 \end{array}$ | $\begin{array}{r} .75 \\ .2 \end{array}$ | $\begin{aligned} & 100 / 5 \\ & 50 / 10 \\ & 50 / 1.5 \mathrm{~K} \\ & 100 / 15 \end{aligned}$ | $\begin{aligned} & .32 / 5 \\ & .5 / 250 \\ & 10 / \\ & 1 / 200 \end{aligned}$ |  |  |  |
| $\begin{aligned} & \text { 1N584 } \\ & \text { 1N588 } \\ & \text { 1N589 } \\ & \text { iN590 } \end{aligned}$ | $\begin{aligned} & G \\ & \mathbf{G} \\ & \mathbf{S} \\ & \mathbf{S} \end{aligned}$ | $\begin{aligned} & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \end{aligned}$ |  |  |  | $\begin{array}{r} 380 \\ 1.5 \mathrm{~K} \\ 1.5 \mathrm{~K} \\ 1.5 \mathrm{~K} \end{array}$ |  | $\begin{aligned} & 100 / \\ & 100 / \\ & 100 / \end{aligned}$ | $\begin{gathered} .15 / 400 \\ 1.7 / 100 \\ 1.7 / 250 \\ 8 / 75 \end{gathered}$ |  |  |  |
| 1N591 <br> IN596 <br> IN597 <br> 1N598 | $\begin{aligned} & \mathrm{s} \\ & \mathrm{~s} \\ & \mathrm{~s} \\ & \mathrm{~s} \end{aligned}$ | $\begin{aligned} & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \end{aligned}$ |  | 1N4005 1N4006 1N4007 |  | $\begin{array}{r} 1.5 K \\ 600 \\ 800 \\ 1 K \end{array}$ | $\begin{aligned} & .15 \\ & .15 \\ & .15 \end{aligned}$ | $\begin{aligned} & 100 / \\ & 25 / 600 \\ & 25 / 800 \\ & 25 / 1 K \end{aligned}$ | $\begin{aligned} & 8 / 75 \\ & 3 / 170 \\ & 3 / 170 \\ & 3 / 170 \end{aligned}$ |  |  |  |
| 1N599 <br> IN599A <br> 1 N600 <br> IN600A | $\begin{aligned} & \mathbf{s} \\ & \mathbf{S} \\ & \mathbf{s} \\ & \mathbf{S} \end{aligned}$ | $\begin{aligned} & R E \\ & R E \\ & R E \\ & R E \end{aligned}$ |  | 1N4001 1N4001 1N4002 1N4002 |  | $\begin{array}{r} 50 \\ 50 \\ 100 \\ 100 \end{array}$ | $\begin{aligned} & .3 \\ & .3 \\ & .3 \\ & .3 \end{aligned}$ | $\begin{array}{r} 25 / 50 \\ 1 / 50 \\ 25 / 100 \\ 1 / 100 \end{array}$ | $\begin{aligned} & 1.5 / 200 \\ & 1.5 / 400 \\ & 1.5 / 200 \\ & 1.5 / 400 \end{aligned}$ |  |  |  |
| 1N601 <br> 1N601A <br> IN602 <br> 1N602A | $\begin{aligned} & \mathrm{s} \\ & \mathrm{~s} \\ & \mathrm{~s} \\ & \mathrm{~s} \end{aligned}$ | $\begin{aligned} & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \end{aligned}$ |  | 1N4003 1N4003 IN4003 in4003 |  | $\begin{aligned} & 150 \\ & 150 \\ & 200 \\ & 200 \end{aligned}$ | $\begin{aligned} & .3 \\ & .3 \\ & .3 \\ & .3 \end{aligned}$ | $\begin{array}{r} 25 / 150 \\ 1 / 150 \\ 25 / 200 \\ 1 / 200 \end{array}$ | $\begin{aligned} & 1.5 / 200 \\ & 1.5 / 400 \\ & 1.5 / 200 \\ & 1.5 / 400 \end{aligned}$ |  |  |  |
| 1N603 <br> 1N603A <br> IN604 <br> 1N604A | $\begin{aligned} & \mathbf{s} \\ & \mathbf{S} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}$ | $\begin{aligned} & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \end{aligned}$ |  | 1N4004 1N4004 IN4004 1N4004 |  | $\begin{aligned} & 300 \\ & 300 \\ & 400 \\ & 400 \end{aligned}$ | $\begin{aligned} & .3 \\ & .3 \\ & .3 \\ & .3 \end{aligned}$ | $\begin{array}{r} 25 / 300 \\ 1 / 300 \\ 25 / 400 \\ 1.5 / 400 \end{array}$ | $\begin{aligned} & 1.5 / 200 \\ & 1.5 / 400 \\ & 1.5 / 200 \\ & 1.5 / 400 \end{aligned}$ |  |  |  |
| 1N605 <br> 1N605A <br> IN606 <br> 1N606A | $\begin{aligned} & \mathbf{s} \\ & s \\ & s \\ & s \end{aligned}$ | $\begin{aligned} & R E \\ & R E \\ & R E \\ & R E \\ & R E \end{aligned}$ |  | IN4005 <br> IN4005 <br> 1N4005 <br> 1N4005 |  | $\begin{aligned} & 500 \\ & 500 \\ & 600 \\ & 600 \end{aligned}$ | $\begin{aligned} & .3 \\ & .3 \\ & .3 \\ & .3 \end{aligned}$ | $\begin{array}{r} 25 / 500 \\ 2.0 / 500 \\ 25 / 600 \\ 2.5 / 600 \end{array}$ | $\begin{aligned} & 1.5 / 200 \\ & 1.5 / 400 \\ & 1.5 / 200 \\ & 1.5 / 400 \end{aligned}$ |  |  |  |
| 1N607 <br> 1N607A <br> 1 N608 <br> 1N608A | $\left\lvert\, \begin{aligned} & 5 \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\left.\begin{array}{\|c\|} \hline R E \\ \mathbf{R E} \\ \mathrm{RE} \\ \mathrm{RE} \end{array} \right\rvert\,$ |  |  |  | $\begin{array}{r} 50 \\ 50 \\ 100 \\ 100 \end{array}$ | $\begin{aligned} & .8 \\ & .8 \\ & .8 \\ & .8 \end{aligned}$ | $\begin{gathered} 25 / 50 \\ 1 / 50 \\ 25 / 100 \\ 1 / 100 \end{gathered}$ | $\begin{aligned} & 1.5 / 200 \\ & 1.5 / 400 \\ & 1.5 / 200 \\ & 1.5 / 400 \end{aligned}$ |  |  |  |


| TYPE NUMEER |  |  | REPLACEMENT | $\begin{gathered} \text { FOR } \\ \text { NEW } \\ \text { DESIGN } \end{gathered}$ | RATINGS |  |  | CHARACTERISTICS |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  | PD (mW) | $V_{R}$ <br> (V) | I <br> (A) | $\begin{array}{ll} \mathbf{I}_{\mathbf{R}} & \oplus \mathbf{V}_{\mathbf{R}} \\ \mu \mathbf{A} & /(\mathbf{V}) \end{array}$ | $\mathbf{V F}_{F}$ - $\mathbf{F}$ <br> (V) $/$ (mA) | $\mathbf{t}_{\mathbf{r}}$ (ns) | $\mathbf{V}_{\mathbf{Z}} \oplus \mathbf{I z}_{\mathbf{z}}$ <br> (V) $/$ (mA) | $\begin{gathered} \text { TOL } \\ \% \end{gathered}$ |
| 1N609 <br> IN609A <br> 1N610 <br> IN610A | $\left\lvert\, \begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}\right.$ | $\begin{aligned} & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \end{aligned}$ |  |  |  | $\begin{aligned} & 150 \\ & 150 \\ & 200 \\ & 200 \end{aligned}$ | $\begin{aligned} & .8 \\ & .8 \\ & .8 \\ & .8 \end{aligned}$ | $\begin{array}{r} 25 / 150 \\ 1 / 150 \\ 25 / 200 \\ 1 / 200 \end{array}$ | $\begin{aligned} & 1.5 / 200 \\ & 1.5 / 400 \\ & 1.5 / 200 \\ & 1.5 / 400 \end{aligned}$ |  |  |  |
| IN611 <br> 1N611A <br> 1N612 <br> IN612A | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\begin{aligned} & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \end{aligned}$ |  |  |  | $\begin{aligned} & 300 \\ & 300 \\ & 400 \\ & 400 \end{aligned}$ | $\begin{aligned} & .8 \\ & .8 \\ & .8 \\ & .8 \end{aligned}$ | $\begin{array}{r} 25 / 300 \\ 1 / 300 \\ 25 / 400 \\ 1.5 / 400 \end{array}$ | $\begin{aligned} & 1.5 / 200 \\ & 1.5 / 400 \\ & 1.5 / 200 \\ & 1.5 / 400 \end{aligned}$ |  |  |  |
| 1N613 <br> 1N613A <br> IN614 <br> 1N614A | $\begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}$ | $\begin{aligned} & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \end{aligned}$ |  |  |  | $\begin{aligned} & 500 \\ & 500 \\ & 600 \\ & 600 \end{aligned}$ | $\begin{aligned} & .8 \\ & .8 \\ & .8 \\ & .8 \end{aligned}$ | $\begin{array}{r} 25 / 500 \\ 2 / 500 \\ 25 / 600 \\ 2.5 / 600 \end{array}$ | $\begin{aligned} & 1.5 / 200 \\ & 1.5 / 400 \\ & 1.5 / 200 \\ & 1.5 / 400 \end{aligned}$ |  |  |  |
| 1N615 1N616 1N617 1No18 | $\begin{aligned} & \mathbf{G} \\ & \mathbf{G} \\ & \mathbf{G} \\ & \mathbf{G} \end{aligned}$ | $\begin{aligned} & \text { RE } \\ & \text { SD } \\ & \text { SD } \\ & \text { SD } \end{aligned}$ |  | 1N4004 <br> 1N4148 <br> 1N4148 <br> 1N4148 |  | $\begin{array}{r} 300 \\ 30 \\ 90 \\ 90 \end{array}$ |  | $\begin{gathered} 1 M / 300 \\ 18 / 1.5 \\ 11 / 10 \\ 7 / 10 \end{gathered}$ | $\begin{aligned} & 175 \\ & 1 / 8 \\ & 1 / 3 \\ & 1 / 5 \end{aligned}$ |  |  |  |
| $\begin{array}{\|l\|} \hline \text { 1N619 } \\ \text { 1N622 } \\ \text { 1N625 } \\ \text { 1N625A } \end{array}$ | $\left\lvert\, \begin{aligned} & \mathbf{S} \\ & \mathbf{S} \\ & \mathbf{S} \\ & \mathbf{S} \end{aligned}\right.$ | $\begin{aligned} & \text { SD } \\ & \text { SD } \\ & \text { SD } \\ & \text { SD } \end{aligned}$ | 1N625 | 1N4148 1N4938 <br> 1N4148 |  | 30 150 30 20 |  | $\begin{gathered} .08 / 10 \\ .16 / 150 \\ 1 / 20 \\ .1 / 20 \end{gathered}$ | $\begin{gathered} 1 / 3 \\ 1 / 7 \\ 1.5 / 4 \\ 1.5 / 10 \end{gathered}$ | $\begin{array}{r} 1 U \\ 500 \end{array}$ |  |  |
| $\begin{aligned} & \text { 1N625M } \\ & \text { 1N626 } \\ & \text { 1N626A } \\ & \text { 1N626M } \end{aligned}$ | $\left[\begin{array}{l} s \\ s \\ s \\ s \end{array}\right.$ | $\begin{aligned} & \text { SD } \\ & \text { SD } \\ & \text { SD } \\ & \text { SD } \end{aligned}$ | $\begin{aligned} & \text { 1N625 } \\ & \text { IN626 } \\ & \text { iN626 } \end{aligned}$ | 1N4148 |  | 30 50 35 50 |  | $\begin{array}{r} 1 / 20 \\ 1 / 20 \\ .1 / 35 \\ 1 / 35 \end{array}$ | $\begin{aligned} & 1.5 / 4 \\ & 1.5 / 4 \\ & 1.5 / 1 \\ & 1.5 / 4 \end{aligned}$ | $\begin{array}{r} 10 \\ 10 \\ 500 \\ 10 \end{array}$ |  |  |
| $\begin{aligned} & \text { IN627 } \\ & \text { IN627A } \\ & \text { IN628 } \\ & \text { iN628A } \end{aligned}$ | $\left\lvert\, \begin{aligned} & \mathbf{s} \\ & \mathbf{S} \\ & \mathbf{S} \\ & \mathbf{s} \end{aligned}\right.$ | $\begin{aligned} & \text { SD } \\ & \text { SD } \\ & \text { SD } \\ & \text { SD } \end{aligned}$ | in627 | $\begin{aligned} & \text { IN4938 } \\ & \text { 1N4938 } \end{aligned}$ |  | $\begin{array}{r} 100 \\ 75 \\ 150 \\ 125 \end{array}$ |  | $\begin{gathered} 1 / 20 \\ .1 / 75 \\ 1 / 20 \\ .1 / 125 \end{gathered}$ | $\begin{aligned} & 1.5 / 4 \\ & 1.5 / 10 \\ & 1.5 / 4 \\ & 1.5 / 10 \end{aligned}$ | $\begin{array}{r} 1 U \\ 500 \\ 1 U \\ 500 \end{array}$ |  |  |
| $\begin{aligned} & \text { IN629 } \\ & \text { IN629A } \\ & \text { IN631 } \\ & \text { IN632 } \end{aligned}$ | $\left\lvert\, \begin{aligned} & S \\ & S \\ & G \\ & G \end{aligned}\right.$ | $\left\|\begin{array}{l} S D \\ S D \\ S D \\ S D \\ S D \end{array}\right\|$ | 1N629 | 1N4938 <br> 1N4148 <br> 1N4148 |  | 200 175 60 60 |  | $\begin{gathered} 1 / 20 \\ .1 / 175 \\ 120 / 80 \end{gathered}$ | $\begin{aligned} & 1.5 / 4 \\ & 1.5 / 10 \\ & 3.5 / 50 \\ & 1.0 / 7 \end{aligned}$ | $\begin{array}{r} 10 \\ 500 \\ 300 \\ 300 \end{array}$ |  |  |
| $\begin{aligned} & \text { 1N633 } \\ & \text { 1N634 } \\ & \text { IN635 } \\ & \text { 1N636 } \end{aligned}$ | $\begin{aligned} & \mathbf{G} \\ & \mathbf{G} \\ & \mathbf{G} \\ & \mathbf{G} \end{aligned}$ | $\left\|\begin{array}{l} S D \\ S D \\ S D \\ S D \\ S D \end{array}\right\|$ |  | 1N4938 <br> 1N4938 <br> iN4938 <br> 1N4448 |  | $\begin{array}{r} 90 \\ 125 \\ 175 \\ 50 \end{array}$ |  | $\begin{gathered} 35 / 30 \\ 175 / 150 \\ 10 / 10 \end{gathered}$ | $\begin{aligned} & 1 / 125 \\ & 1 / 50 \\ & 1 / 50 \\ & 1 / 2.5 \end{aligned}$ | 300 |  |  |
| 1N643 <br> 1N643A <br> 1N643M <br> 1N645 | $\begin{aligned} & \mathbf{S} \\ & \mathbf{s} \\ & \mathbf{S} \\ & \mathbf{S} \end{aligned}$ | $\begin{aligned} & \text { SD } \\ & \text { SD } \\ & \text { SD } \\ & \text { SD } \end{aligned}$ | $\begin{aligned} & \text { 1N643 } \\ & \text { 1N643 } \\ & \text { 1N643 } \\ & \text { 1N645 } \end{aligned}$ |  |  | $\begin{aligned} & 200 \\ & 200 \\ & 200 \\ & 275 \end{aligned}$ |  | $\begin{array}{r} 1 / 100 \\ 1 / 100 \\ 15 / 100 \\ .2 / 225 \end{array}$ | $\begin{aligned} & 1 / 10 \\ & 1 / 100 \\ & 1 / 1 \\ & 1 / 400 \end{aligned}$ | $\begin{aligned} & 300 \\ & 300 \\ & 300 \end{aligned}$ |  |  |

## DIODE INTERCHANGEABILITY

| TYPE NUMBER | $\begin{aligned} & \frac{Z}{3} \\ & \frac{1}{6} \\ & \frac{3}{k} \end{aligned}$ |  | II REPLACEMENT |  | ratines |  |  | CHARACTERISTICS |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  |  | $\mathbf{V}_{\mathbf{R}}$ <br> (V) | $\mathbf{I}$ <br> (A) | $\begin{array}{ll} \mathbf{I}_{\mathbf{R}} & \mathbf{V}_{\mathrm{R}} \\ \mu \mathbf{A} & / \mathbf{V}) \end{array}$ | $\mathbf{V F}_{F}$ - $\mathbf{F}$ <br> (V) $/$ (mA) | $\begin{aligned} & \mathbf{t}_{\mathrm{rr}} \\ & (\mathrm{~ns}) \end{aligned}$ | $\mathbf{V}_{\mathbf{Z}}$ - $\mathbf{I z}_{\mathbf{2}}$ <br> (V) $/$ (mA) |  |
| 1N645A <br> 1N645B <br> iN645] <br> 1N646 | $\begin{aligned} & 5 \\ & s \\ & s \\ & s \end{aligned}$ | $\begin{aligned} & \text { SD } \\ & S D \\ & S D \\ & S D \end{aligned}$ | 1N645A <br> 1N646 | $\begin{aligned} & \text { 1N645A } \\ & \text { IN645A } \end{aligned}$ |  | 275 225 250 360 |  | $\begin{array}{r} 50 N / 225 \\ 25 N / 225 \\ 25 N / 250 \\ .2 / 300 \end{array}$ | $\begin{aligned} & 1 / 400 \\ & 1 / 400 \\ & 1 / 400 \\ & 1 / 400 \end{aligned}$ |  |  |  |
| 1N647 <br> 1N648 <br> 1N649 <br> 1N658 | $\begin{aligned} & \mathrm{s} \\ & \mathrm{~s} \\ & \mathrm{~s} \\ & \mathrm{~s} \end{aligned}$ | $\begin{aligned} & \text { SD } \\ & \text { SD } \\ & \text { SD } \\ & \text { SD } \end{aligned}$ | 1N647 <br> 1 N648 <br> 1N649 <br> 1 N658 |  |  | $\begin{aligned} & 480 \\ & 600 \\ & 720 \\ & 120 \end{aligned}$ |  | $\begin{array}{r} .2 / 400 \\ .2 / 500 \\ .2 / 600 \\ 50 \mathrm{~N} / 40 \end{array}$ | $\begin{aligned} & 1 / 400 \\ & 1 / 400 \\ & 1 / 400 \\ & 1 / 100 \end{aligned}$ | 300 |  |  |
| $\begin{aligned} & \text { IN658A } \\ & \text { IN659 } \\ & \text { IN659A } \\ & \text { IN660 } \end{aligned}$ | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\begin{aligned} & \text { SD } \\ & \text { SD } \\ & \text { SD } \\ & \text { SD } \end{aligned}$ | 1N659 <br> 1N660 |  |  | $\begin{array}{r} 120 \\ 60 \\ 60 \\ 120 \end{array}$ |  | $\begin{array}{r} 30 N / 50 \\ 5 / 50 \\ 30 N / 50 \\ 5 / 100 \end{array}$ | $\begin{aligned} & 1 / 100 \\ & 1 / 6 \\ & 1 / 10 \\ & 1 / 6 \end{aligned}$ | $\begin{aligned} & 300 \\ & 300 \\ & 300 \\ & 300 \end{aligned}$ |  |  |
| ING6OA <br> I N661 <br> IN661A <br> 1N662 | $\begin{aligned} & \mathrm{s} \\ & \mathrm{~S} \\ & \mathrm{~s} \\ & \mathrm{~s} \end{aligned}$ | $\begin{aligned} & \text { SD } \\ & \text { SD } \\ & \text { SD } \\ & \text { SD } \end{aligned}$ | 1N661 <br> 1N662 | $\begin{aligned} & 1 \text { N660 } \\ & 1 \text { N661 } \end{aligned}$ |  | $\begin{array}{r} 120 \\ 240 \\ 240 \\ 80 \end{array}$ |  | $\begin{array}{r} 30 N / 100 \\ 10 / 200 \\ 30 \mathrm{~N} / 200 \\ 1 / 50 \end{array}$ | $\begin{aligned} & 1 / 10 \\ & 1 / 6 \\ & 1 / 10 \\ & 1 / 10 \end{aligned}$ | $\begin{aligned} & 300 \\ & 300 \\ & 300 \\ & 500 \end{aligned}$ |  |  |
| 1N662A <br> 1 N663 <br> IN663A <br> IN663M | $\begin{aligned} & \mathrm{s} \\ & \mathrm{~S} \\ & \mathrm{~s} \\ & \mathrm{~s} \end{aligned}$ | $\begin{array}{\|l\|} \hline S D \\ S D \\ S D \\ S D \end{array}$ | 1 N663 | $\begin{aligned} & \text { IN662 } \\ & \text { 1N663 } \\ & \text { 1N663 } \end{aligned}$ |  | 80 80 80 100 |  | $\begin{array}{r} 5 / 75 \\ .1 / 75 \\ .1 / 75 \end{array}$ | $\begin{aligned} & 1 / 100 \\ & 1 / 100 \\ & 1 / 100 \\ & 1 / 100 \end{aligned}$ | $\begin{aligned} & 500 \\ & 500 \\ & 300 \\ & 300 \end{aligned}$ |  |  |
| IN664 <br> 1N665 <br> 1N666 <br> 1N667 | $\begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & s \\ & s \end{aligned}$ | $\begin{aligned} & \mathrm{ZD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \end{aligned}$ |  | $\begin{aligned} & \text { 1N756A } \\ & \text { 1N759A } \\ & \text { 1N965B } \\ & \text { 1N967B } \end{aligned}$ | $\begin{aligned} & 250 \\ & 250 \\ & 250 \\ & 250 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 8.2 / 10 \\ & 12 / 10 \\ & 15 / 5 \\ & 18 / 5 \end{aligned}$ | 5 5 5 5 |
| 1N668 <br> 1N669 <br> 1N670 <br> 1N671 | $\begin{aligned} & \mathbf{s} \\ & \mathbf{S} \\ & \mathrm{s} \\ & \mathrm{~s} \end{aligned}$ | $\begin{aligned} & \mathrm{ZD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \end{aligned}$ |  | 1N969B 1N971B | $\begin{aligned} & 250 \\ & 250 \\ & 250 \\ & 250 \end{aligned}$ |  |  |  |  |  | $\begin{gathered} 22 / 5 \\ 27 / 5 \\ 68 / 1 \\ 100 / 1 \end{gathered}$ | 5 5 1 1 |
| 1N672 <br> 1N673 <br> iN674 <br> 1N675 | $\begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}$ | $\begin{aligned} & \mathrm{ZD} \\ & \mathrm{SD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \end{aligned}$ |  | $\begin{aligned} & \text { IN647 } \\ & \text { IN750 } \\ & \text { IN753A } \end{aligned}$ | $\begin{aligned} & 250 \\ & 250 \\ & 250 \end{aligned}$ | 400 |  | 1/300 | 1/250 |  | $\begin{aligned} & 150 / 1 \\ & 4.7 / 20 \\ & 6.2 / 20 \end{aligned}$ | $\begin{array}{r} 1 \\ 10 \\ 5 \end{array}$ |
| 1N676 <br> 1N677 <br> 1N678 <br> 1N679 | $\begin{aligned} & \mathbf{s} \\ & s \\ & s \\ & s \end{aligned}$ | $\begin{aligned} & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \end{aligned}$ |  | 1 N645 <br> 1N645 <br> 1N645 <br> IN645 |  | $\begin{aligned} & 100 \\ & 100 \\ & 200 \\ & 200 \end{aligned}$ | $\begin{aligned} & .2 \\ & .4 \\ & .2 \\ & .4 \end{aligned}$ | $\begin{aligned} & 1 / 100 \\ & 1 / 100 \\ & 1 / 200 \\ & 1 / 200 \end{aligned}$ | $\begin{aligned} & 1 / 400 \\ & 1 / 400 \\ & 1 / 400 \\ & 1 / 400 \end{aligned}$ |  |  |  |
| 1N681 <br> 1N682 <br> 1 N683 <br> 1N684 | $\left\lvert\, \begin{aligned} & 5 \\ & 5 \\ & 5 \\ & 5 \end{aligned}\right.$ | $\begin{aligned} & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \end{aligned}$ |  | 1N646 <br> 1N646 <br> 1N647 <br> 1N647 |  | $\begin{aligned} & 300 \\ & 300 \\ & 400 \\ & 400 \end{aligned}$ | $\begin{aligned} & .075 \\ & .150 \\ & .075 \\ & .150 \end{aligned}$ | $\begin{aligned} & 200 / 300 \\ & 200 / 300 \\ & 200 / 400 \\ & 200 / 400 \end{aligned}$ | $\begin{aligned} & 1 / 200 \\ & 1 / 400 \\ & 1 / 200 \\ & 1 / 400 \end{aligned}$ |  |  |  |

## DIODE INTERCHANGEABILITY

|  | z | $\begin{array}{\|c} 7 \\ \hline \end{array}$ |  |  | Ratinges |  |  | CHARACTERISTICS |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| $\begin{aligned} & \text { TYPE } \\ & \text { MUMBER } \end{aligned}$ | $\frac{\text { 䨤 }}{2}$ |  | TI | $\begin{aligned} & \text { FOR } \\ & \text { NEW } \\ & \text { DESTGN } \end{aligned}$ | $\begin{gathered} P_{D} \\ (\mathrm{~mW}) \end{gathered}$ | $\mathbf{V}_{\mathbf{R}}$ <br> (V) | I <br> (A) | $\begin{array}{ll} \mathbf{l}_{\mathrm{R}} & \mathbf{V}_{\mathrm{R}} \\ \mu \mathrm{~A} & /(\mathrm{V}) \end{array}$ | $\mathbf{V F}_{F}$ - $\mathbf{F}_{\mathbf{F}}$ <br> (V) $/$ (mA) | $\begin{gathered} I_{r r} \\ (n s) \end{gathered}$ | $\begin{array}{lc} \mathbf{V}_{\mathbf{Z}} & \subset \mathbf{Z} \\ (\mathrm{V}) & / \mathrm{mA}) \end{array}$ | TOL <br> * |
| 1N685 1N686 1N687 1N689 | $\begin{aligned} & \mathbf{S} \\ & \mathbf{s} \\ & \mathbf{S} \\ & \mathbf{s} \end{aligned}$ | $\left\lvert\, \begin{aligned} & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \end{aligned}\right.$ |  | iN648 <br> 1N648 <br> 1N649 <br> IN649 |  | $\begin{aligned} & 500 \\ & 500 \\ & 600 \\ & 600 \end{aligned}$ | $\begin{aligned} & .075 \\ & .150 \\ & .075 \\ & .150 \end{aligned}$ | $\begin{aligned} & 200 / 500 \\ & 200 / 500 \\ & 200 / 500 \\ & 200 / 600 \end{aligned}$ | $\begin{aligned} & 1 / 200 \\ & 1 / 400 \\ & 1 / 200 \\ & 1 / 400 \end{aligned}$ |  |  |  |
| 1N690 <br> IN691 <br> 1N692 <br> 1N693 | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\left\lvert\, \begin{aligned} & \text { SD } \\ & \text { SD } \\ & \text { SD } \\ & \text { SD } \end{aligned}\right.$ |  | 1N4607 <br> 1N4607 <br> 1N4607 <br> 1N4607 |  | 36 80 100 130 |  | $\begin{aligned} & .25 / 30 \\ & .25 / 60 \\ & .25 / 90 \\ & .25 / 120 \end{aligned}$ | $\begin{aligned} & 1 / 400 \\ & 1 / 400 \\ & 1 / 400 \\ & 1 / 400 \end{aligned}$ | $\begin{aligned} & 800 \\ & 800 \\ & 800 \\ & 800 \end{aligned}$ |  |  |
| 1N695 <br> 1N695A <br> IN696 <br> 1N697 | $\begin{aligned} & G \\ & G \\ & S \\ & S \end{aligned}$ | $\begin{aligned} & \text { SD } \\ & \text { SD } \\ & \text { SD } \\ & \text { SD } \end{aligned}$ |  | 1N4148 <br> 1N4148 <br> iN4148 <br> 1N4607 |  | 20 25 30 120 |  | $\begin{array}{r} 2 / 10 \\ 2 / 10 \\ 15 \mathrm{~N} / 20 \\ 2 / 50 \end{array}$ | $\begin{gathered} 1 / 100 \\ .5 / 10 \\ 1 / 10 \\ 1.1 / 400 \end{gathered}$ | $\begin{array}{r} 300 \\ 300 \\ 5 \\ 100 \end{array}$ |  |  |
| 1N698 <br> 1 N699 <br> iN701 <br> 1N702 | $\begin{aligned} & \mathbf{G} \\ & \mathbf{G} \\ & \mathbf{S} \\ & \mathbf{S} \end{aligned}$ | $\begin{aligned} & \text { SD } \\ & \text { SD } \\ & \text { ZD } \\ & \text { ZD } \end{aligned}$ | 1N702 | $\begin{aligned} & \text { IN4305 } \\ & \text { 1N4448 } \\ & \text { IN758A } \end{aligned}$ | $\begin{array}{r} 250 \\ 250 \end{array}$ | 15 105 |  | $\begin{array}{r} 1 / 1.5 \\ 250 / 75 \end{array}$ | $\begin{aligned} & .21 / 1 \\ & 1 / 100 \end{aligned}$ | $\begin{aligned} & 500 \\ & 300 \end{aligned}$ | $\begin{gathered} 10.5 / 10 \\ 2.6 / 5 \end{gathered}$ | $\begin{array}{r} 5 \\ 20 \end{array}$ |
| $\begin{array}{\|l} \text { 1 N702A } \\ \text { 1N703 } \\ \text { IN703A } \\ \text { 1N704 } \end{array}$ | $\left\lvert\, \begin{aligned} & \mathbf{S} \\ & \mathbf{S} \\ & \mathbf{S} \\ & \mathbf{s} \end{aligned}\right.$ | $\left\lvert\, \begin{aligned} & \mathrm{ZD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \end{aligned}\right.$ | 1N702A <br> 1N703 <br> IN703A <br> 1N704 |  | $\begin{aligned} & 250 \\ & 250 \\ & 250 \\ & 250 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 2.6 / 5 \\ & 3.5 / 5 \\ & 3.5 / 5 \\ & 4.1 / 5 \end{aligned}$ | 5 20 5 20 |
| 1N704A <br> 1N705 <br> 1N705A <br> 1N706 | $\begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}$ | $\left\|\begin{array}{l} \mathrm{ZD} \\ \mathrm{ZD} \\ \mathrm{ZD} \\ \mathrm{ZD} \end{array}\right\|$ | 1N704A <br> iN705 <br> IN705A <br> 1N706 |  | 250 250 250 250 |  |  |  |  |  | $\begin{aligned} & 4.4 / 5 \\ & 4.8 / 5 \\ & 4.8 / 5 \\ & 5.8 / 5 \end{aligned}$ | 5 20 5 20 |
| $\begin{aligned} & \text { 1 N706A } \\ & \text { IN707 } \\ & \text { IN707A } \\ & \text { IN708 } \end{aligned}$ | $\begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}$ | $\left\|\begin{array}{l} \mathrm{ZD} \\ \mathrm{ZD} \\ \mathrm{ZD} \\ \mathrm{ZD} \end{array}\right\|$ | $\begin{aligned} & \text { IN706A } \\ & \text { IN707 } \\ & \text { IN707A } \\ & \text { IN708 } \end{aligned}$ |  | $\begin{aligned} & 250 \\ & 250 \\ & 250 \\ & 250 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 5.8 / 5 \\ & 7.1 / 5 \\ & 7.1 / 5 \\ & 5.6 / 25 \end{aligned}$ | 5 20 5 10 |
| $\begin{aligned} & \text { 1N708A } \\ & \text { IN708B } \\ & \text { 1 N709 } \\ & \text { IN709A } \end{aligned}$ | $\begin{aligned} & 5 \\ & 5 \\ & 5 \\ & 5 \end{aligned}$ | $\left\|\begin{array}{l} \mathrm{zD} \\ \mathrm{ZD} \\ \mathrm{ZD} \\ \mathrm{zD} \end{array}\right\|$ | $\begin{aligned} & \text { 1N708A } \\ & \text { IN708 } \\ & \text { IN709 } \\ & \text { IN709A } \end{aligned}$ |  | $\begin{aligned} & 250 \\ & 250 \\ & 250 \\ & 250 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 5.6 / 25 \\ & 5.6 / 25 \\ & 6.2 / 25 \\ & 6.2 / 25 \end{aligned}$ | 5 20 10 5 |
| $\begin{array}{\|l} 1 \mathrm{IN709B} \\ \text { IN710 } \\ \text { IN710A } \\ \text { 1N710B } \end{array}$ | $\left\lvert\, \begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{S} \\ & \mathbf{s} \end{aligned}\right.$ | $\left\lvert\, \begin{aligned} & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \end{aligned}\right.$ | $\left\{\begin{array}{l} \text { IN709 } \\ \text { IN710 } \\ \text { 1N710A } \\ \text { IN710 } \end{array}\right.$ |  | 250 250 250 250 |  |  | - |  |  | $\begin{aligned} & 6.2 / 25 \\ & 6.8 / 25 \\ & 6.8 / 25 \\ & 6.8 / 25 \end{aligned}$ | 20 10 5 20 |
| $\begin{aligned} & \text { 1N711 } \\ & \text { 1N711A } \\ & \text { 1N711B } \\ & \text { 1N712 } \end{aligned}$ | $\left\lvert\, \begin{aligned} & \mathbf{S} \\ & \mathbf{S} \\ & \mathbf{S} \\ & \mathbf{S} \end{aligned}\right.$ | $\begin{aligned} & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \end{aligned}$ | $\left\{\begin{array}{l} \text { 1N711 } \\ \text { 1N71 1A } \\ \text { 1N711 } \\ \text { 1N712 } \end{array}\right.$ |  | $\begin{aligned} & 250 \\ & 250 \\ & 250 \\ & 250 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 7.5 / 25 \\ & 7.5 / 25 \\ & 7.5 / 25 \\ & 8.2 / 25 \end{aligned}$ | 10 5 20 10 |

## DIODE INTERCHANGEABILTTY



| $\begin{gathered} \text { TYPE } \\ \text { numeer } \end{gathered}$ |  | $\begin{gathered} \frac{3}{2} \\ \frac{5}{5} \\ \frac{5}{5} \\ 8 \end{gathered}$ | II | FORNEWDESNON | Ratines |  |  | CHARACTERISTICS |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  |  | $\mathbf{V}_{\mathrm{R}}$ <br> (V) | 1 <br> (A) | $\begin{array}{cc} \mathbf{R}_{\mathbf{R}} & \bullet \mathbf{V}_{\mathrm{R}} \\ \mu \mathbf{N} & /(\mathrm{V}) \end{array}$ | $\begin{array}{cc} V_{F} & \mathbf{I F}_{f} \\ \text { (V) } & /(\mathrm{mA}) \end{array}$ | $\begin{aligned} & \mathrm{ir} \\ & \text { (ns) } \end{aligned}$ | $\mathbf{V}_{\mathbf{z}}$ - $\mathbf{z}$ <br> (V) / (mA) | $\begin{gathered} \text { rot } \\ \% \end{gathered}$ |
| 1N725 <br> 1N726 <br> 1N726A <br> 1N7268 | $\begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}$ | 20 1 <br> 20 1 <br> 20 1 <br> 20 1 | 1N725 <br> 1N726 <br> 1N726A <br> iN726 |  | $\begin{aligned} & 250 \\ & 250 \\ & 250 \\ & 250 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 30 / 4 \\ & 33 / 4 \\ & 33 / 4 \\ & 33 / 4 \end{aligned}$ | 20 10 5 20 |
| 1N727 <br> 1N727A <br> 1N7278 <br> 1N728 | $\left\lvert\, \begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}\right.$ | $\begin{aligned} & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \end{aligned}$ |  |  | $\begin{aligned} & 250 \\ & 250 \\ & 250 \\ & 250 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 36 / 4 \\ & 36 / 4 \\ & 36 / 4 \\ & 39 / 4 \end{aligned}$ | $\begin{array}{r} 10 \\ 5 \\ 20 \\ 10 \end{array}$ |
| 1N728A <br> 1N7288 <br> 1N729 <br> 1N729A | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\begin{aligned} & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \end{aligned}$ |  |  | $\begin{aligned} & 250 \\ & 250 \\ & 250 \\ & 250 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 39 / 4 \\ & 39 / 4 \\ & 43 / 4 \\ & 43 / 4 \end{aligned}$ | $\begin{array}{r} 5 \\ 20 \\ 10 \\ 5 \end{array}$ |
| $\begin{aligned} & \text { IN729B } \\ & \text { IN730 } \\ & \text { IN730A } \\ & \text { IN730: } \end{aligned}$ | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\left.\begin{aligned} & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \end{aligned} \right\rvert\,$ |  |  | $\begin{aligned} & 250 \\ & 250 \\ & 250 \\ & 250 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 43 / 4 \\ & 47 / 4 \\ & 47 / 4 \\ & 47 / 4 \end{aligned}$ | $\begin{array}{r} 20 \\ 10 \\ 5 \\ 20 \end{array}$ |
| $\begin{aligned} & \text { 1N731 } \\ & \text { iN731A } \\ & \text { 1N7318 } \\ & \text { 1N732 } \end{aligned}$ | $\begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}$ | $\left.\begin{aligned} & z 0 \\ & z 0 \\ & z 0 \\ & z D \end{aligned} \right\rvert\,$ |  |  | $\begin{aligned} & 250 \\ & 250 \\ & 250 \\ & 250 \end{aligned}$ | - |  |  |  |  | $51 / 4$ <br> 51/4 <br> 51/4 <br> 56/4 | $\begin{array}{r} 10 \\ 5 \\ 20 \\ 10 \end{array}$ |
| $\begin{aligned} & \text { 1N732A } \\ & \text { iN732B } \\ & \text { 1N733 } \\ & \text { 1N733A } \end{aligned}$ | $\begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}$ | $\left.\begin{aligned} & z D \\ & z D \\ & z D \\ & z D \end{aligned} \right\rvert\,$ |  |  | $\begin{aligned} & 250 \\ & 250 \\ & 250 \\ & 250 \end{aligned}$ | . |  | $\cdots$ |  |  | $\begin{aligned} & 56 / 4 \\ & 56 / 4 \\ & 62 / 2 \\ & 62 / 2 \end{aligned}$ | 5 20 10 5 |
| $\begin{aligned} & \text { 1N733B } \\ & \text { IN734 } \\ & \text { 1N734A } \\ & \text { 1N734B } \end{aligned}$ | $\begin{aligned} & 5 \\ & 5 \\ & 5 \\ & 5 \end{aligned}$ | $\begin{aligned} & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zo} \end{aligned}$ |  |  | $\begin{aligned} & 250 \\ & 250 \\ & 250 \\ & 250 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 62 / 2 \\ & 68 / 2 \\ & 68 / 2 \\ & 68 / 2 \end{aligned}$ | 20 10 5 20 |
| IN735 <br> 1N735A <br> iN7358 <br> 1N736 | $\left\lvert\, \begin{aligned} & 5 \\ & 5 \\ & 5 \\ & 5 \end{aligned}\right.$ | $\left\|\begin{array}{l} z 0 \\ z 0 \\ z 0 \\ z 0 \end{array}\right\|$ |  |  | $\begin{aligned} & 250 \\ & 250 \\ & 250 \\ & 250 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 75 / 2 \\ & 75 / 2 \\ & 75 / 2 \\ & 82 / 2 \end{aligned}$ | 10 5 20 10 |
| 1N736A <br> 1N7368 <br> 1N737 <br> 1N737A | $\begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}$ | $\left\lvert\, \begin{aligned} & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \end{aligned}\right.$ |  |  | $\begin{aligned} & 250 \\ & 250 \\ & 250 \\ & 250 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 82 / 2 \\ & 82 / 2 \\ & 91 / 1 \\ & 91 / 1 \end{aligned}$ | 5 20 10 5 |
| 1N7378 <br> 1N738 <br> IN738A <br> 1N7388 | $\begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}$ | $\begin{aligned} & \mathbf{z D} \\ & \mathbf{z D} \\ & \mathbf{z D} \\ & \mathbf{Z D} \end{aligned}$ |  |  | $\begin{aligned} & 250 \\ & 250 \\ & 250 \\ & 250 \end{aligned}$ |  |  |  |  |  | $\begin{array}{r} 91 / 1 \\ 100 / 1 \\ 100 / 1 \\ 100 / 1 \end{array}$ | 20 10 5 20 |


| TYPE NUMBER | $\begin{aligned} & \frac{1}{k} \\ & \frac{1}{\mathbb{W}} \\ & \frac{2}{3} \end{aligned}$ |  | 7 REPLACEMENT | $\begin{aligned} & \text { FOR } \\ & \text { NEW } \\ & \text { DESIGN } \end{aligned}$ | RAtings |  |  | CHARACTERISTICS |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  | $\begin{aligned} & P_{D} \\ & (\mathrm{~mW}) \end{aligned}$ | $\mathbf{V}_{\mathbf{R}}$ <br> (V) | I <br> (A) | $\begin{array}{ll} \mathbf{I}_{\mathbf{R}} & \mathbf{V}_{\mathbf{R}} \\ \mu \mathrm{A} & / \mathbf{V}) \end{array}$ | $\begin{array}{ccc} \mathbf{V}_{\mathbf{F}} & \mathbf{I}_{\mathbf{F}} \\ (\mathbf{V}) & /(\mathrm{mA}) \end{array}$ | $\begin{aligned} & t_{r r} \\ & \text { (ns) } \end{aligned}$ | $\begin{array}{lc} \mathbf{V}_{\mathbf{z}} \oplus & \mathrm{z} \\ (\mathrm{~V}) & / \mathrm{mA}) \end{array}$ | $\begin{gathered} \mathrm{TOL} \\ \% \end{gathered}$ |
| $\begin{aligned} & \text { 1N739 } \\ & \text { lN739A } \\ & \text { 1N739B } \\ & \text { 1N740 } \end{aligned}$ | $\begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}$ | $\begin{aligned} & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \end{aligned}$ |  |  | $\begin{aligned} & 250 \\ & 250 \\ & 250 \\ & 250 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 110 / 1 \\ & 110 / 1 \\ & 110 / 1 \\ & 120 / 1 \end{aligned}$ | $\begin{array}{r} 10 \\ 5 \\ 20 \\ 10 \end{array}$ |
| $\begin{aligned} & \text { IN740A } \\ & \text { 1N740B } \\ & \text { 1N741 } \\ & \text { IN741A } \end{aligned}$ | $\begin{aligned} & 5 \\ & 5 \\ & 5 \\ & 5 \end{aligned}$ | $\left\lvert\, \begin{aligned} & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \end{aligned}\right.$ |  |  | $\begin{aligned} & 250 \\ & 250 \\ & 250 \\ & 250 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 120 / 1 \\ & 120 / 1 \\ & 130 / 1 \\ & 130 / 1 \end{aligned}$ | 5 20 10 5 |
| $\begin{aligned} & \text { IN741B } \\ & \text { IN742 } \\ & \text { IN742A } \\ & \text { IN742B } \end{aligned}$ | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\begin{aligned} & \mathrm{ZD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \end{aligned}$ |  |  | $\begin{aligned} & 250 \\ & 250 \\ & 250 \\ & 250 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 130 / 1 \\ & 150 / 1 \\ & 150 / 1 \\ & 150 / 1 \end{aligned}$ | $\begin{array}{r} 20 \\ 10 \\ 5 \\ 20 \end{array}$ |
| 1N743 <br> 1N743A <br> 1N743B <br> IN744 | $\begin{aligned} & \mathrm{s} \\ & \mathrm{~s} \\ & \mathrm{~S} \\ & \mathrm{~s} \end{aligned}$ | $\left\|\begin{array}{l} \mathrm{ZD} \\ \mathrm{ZD} \\ \mathrm{ZD} \\ \mathrm{ZD} \end{array}\right\|$ |  |  | $\begin{aligned} & 250 \\ & 250 \\ & 250 \\ & 250 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 160 / 1 \\ & 160 / 1 \\ & 160 / 1 \\ & 180 / 1 \end{aligned}$ | $\begin{array}{r} 10 \\ 5 \\ 20 \\ 10 \end{array}$ |
| $\begin{aligned} & \text { 1N744A } \\ & \text { 1N744B } \\ & \text { 1N745 } \\ & \text { IN745A } \end{aligned}$ | $\begin{aligned} & \mathbf{S} \\ & \mathbf{S} \\ & \mathbf{S} \\ & \mathbf{S} \end{aligned}$ | $\begin{aligned} & \mathrm{ZD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \end{aligned}$ |  |  | $\begin{aligned} & 250 \\ & 250 \\ & 250 \\ & 250 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 180 / 1 \\ & 180 / 1 \\ & 200 / 1 \\ & 200 / 1 \end{aligned}$ | $\begin{array}{r} 5 \\ 20 \\ 10 \\ 5 \end{array}$ |
| 1N745B <br> 1N746 <br> 1N746A <br> 1N747 | $\begin{aligned} & \mathbf{s} \\ & \mathbf{S} \\ & \mathbf{S} \\ & \mathbf{s} \end{aligned}$ | $\begin{aligned} & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \end{aligned}$ |  |  | $\begin{aligned} & 250 \\ & 400 \\ & 400 \\ & 400 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 200 / 1 \\ & 3.3 / 20 \\ & 3.3 / 20 \\ & 3.6 / 20 \end{aligned}$ | 20 10 5 10 |
| 1N747A <br> 1N748 <br> 1N748A <br> 1N749 | $\begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}$ | $\left.\begin{aligned} & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zo} \end{aligned} \right\rvert\,$ | 1N747A <br> iN748 <br> IN748A <br> IN749 |  | $\begin{array}{r} 400 \\ 400 \\ 400 \\ 400 \end{array}$ |  |  |  |  |  | $\begin{aligned} & 3.6 / 20 \\ & 3.9 / 20 \\ & 3.9 / 20 \\ & 4.3 / 20 \end{aligned}$ | 5 10 5 10 |
| 1N749A <br> IN750 <br> 1N750A <br> iN751 | $\begin{aligned} & 5 \\ & s \\ & s \\ & 5 \end{aligned}$ | $\left(\begin{array}{l} \mathrm{ZD} \\ \mathrm{ZD} \\ \mathrm{ZD} \\ \mathrm{ZD} \end{array}\right.$ | 1N749A <br> iN750 <br> 1N750A <br> IN751 |  | $\begin{aligned} & 400 \\ & 400 \\ & 400 \\ & 400 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 4.3 / 20 \\ & 4.7 / 20 \\ & 4.7 / 20 \\ & 5.1 / 20 \end{aligned}$ | 5 10 5 10 |
| IN751A <br> iN752 <br> 1N752A <br> 1N753 | $\begin{aligned} & s \\ & s \\ & s \\ & s \\ & s \end{aligned}$ | ZD ZD ZD ZD | 1N751A <br> 1N752 <br> 1N752A <br> 1N753 |  | $\begin{aligned} & 400 \\ & 400 \\ & 400 \\ & 400 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 5.1 / 20 \\ & 5.6 / 20 \\ & 5.6 / 20 \\ & 6.2 / 20 \end{aligned}$ | 5 10 5 10 |
| 1N753A <br> 1N754 <br> 1N754A <br> 1N755 | $\begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}$ | $\begin{aligned} & \mathrm{zo} \\ & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \end{aligned}$ | 1N753A <br> 1N754 <br> 1N754A <br> 1N755 |  | $\begin{aligned} & 400 \\ & 400 \\ & 400 \\ & 400 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 6.2 / 20 \\ & 6.8 / 20 \\ & 6.8 / 20 \\ & 7.5 / 20 \end{aligned}$ | $\begin{array}{r} 5 \\ 10 \\ 5 \\ 10 \end{array}$ |


| TYPE NuMEER |  |  | TI | $\begin{aligned} & \text { FOR } \\ & \text { NEW } \\ & \text { DESICN } \end{aligned}$ | RATINOS |  |  | CHARACTERISTICS |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  |  | $\mathbf{V}_{\mathbf{R}}$ <br> (V) | (A) | $\begin{array}{ll} \mathbf{I}_{\mathbf{R}} & \bullet \mathbf{V}_{\mathbf{R}} \\ \mu \mathbf{A} & / \mathbf{V}) \end{array}$ | $\begin{array}{ll} V_{F} & \mathbf{l}_{\mathbf{F}} \\ (\mathrm{V}) & /(\mathrm{mA}) \end{array}$ | $\begin{aligned} & i n t \\ & (n *) \end{aligned}$ | $\mathbf{v}_{\mathbf{z}}$ - $\mathbf{l z}_{\mathbf{z}}$ <br> (V) $/$ (mA) | $\begin{gathered} \text { tot } \\ \% \end{gathered}$ |
| 1N755A <br> iN756 <br> 1N756A <br> 1N757 | s | $\begin{array}{\|c\|c} \mathrm{ZO} \\ \mathrm{ZD} & 1 \\ \mathrm{ZD} & 1 \\ \mathrm{ZD} & 1 \end{array}$ | $\begin{aligned} & \text { IN75SA } \\ & \text { 1N756 } \\ & \text { 1N75 A } \\ & \text { 1N757 } \end{aligned}$ |  | $\begin{array}{r} 400 \\ 400 \\ 400 \\ 400 \end{array}$ |  |  |  |  |  | $\begin{aligned} & 7.5 / 20 \\ & 8.2 / 20 \\ & 8.2 / 20 \\ & 9.1 / 20 \end{aligned}$ | 5 10 5 10 |
| $\begin{aligned} & \text { 1N757A } \\ & \text { iN758 } \\ & \text { 1N758A } \\ & \text { 1N759 } \end{aligned}$ | $\begin{aligned} & 5 \\ & 5 \\ & 5 \\ & 5 \end{aligned}$ | $\left.\begin{aligned} & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \end{aligned} \right\rvert\,$ | 1N757A <br> 1N758 <br> IN758A <br> iN759 |  | $\begin{array}{r} 400 \\ 400 \\ 400 \\ 400 \end{array}$ |  |  |  |  |  | $\begin{aligned} & 9.1 / 20 \\ & 10 / 20 \\ & 10 / 20 \\ & 12 / 20 \end{aligned}$ | $\begin{array}{r} 5 \\ 10 \\ 5 \\ 10 \end{array}$ |
| $\begin{aligned} & \text { 1N759A } \\ & \text { 1N761 } \\ & \text { 1N761-1 } \\ & \text { 1N761-2 } \end{aligned}$ | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\begin{aligned} & 20 \\ & 20 \\ & z 0 \\ & z 0 \\ & z 0 \end{aligned}$ | 1N759A <br> 1N761 <br> 1N761 <br> iN761 |  | $\begin{aligned} & 400 \\ & 250 \\ & 250 \\ & 250 \end{aligned}$ |  |  |  |  |  | $\begin{array}{r} 12 / 20 \\ 4.85 / 10 \\ 4.5 / 10 \\ 5 / 10 \end{array}$ | $\begin{array}{r} 5 \\ 10 \\ 5 \\ 5 \end{array}$ |
| $\begin{aligned} & \text { IN761A } \\ & \text { IN762 } \\ & \text { IN762-1 } \\ & \text { IN762-2 } \end{aligned}$ | $\left\lvert\, \begin{aligned} & \mathbf{s} \\ & \mathbf{S} \\ & \mathbf{S} \\ & \mathbf{s} \end{aligned}\right.$ | $\begin{aligned} & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \end{aligned}$ | $\left\{\begin{array}{l} \text { 1N761 } \\ \text { 1N762 } \\ \text { 1N762 } \\ \text { 1N762 } \end{array}\right.$ |  | $\begin{aligned} & 250 \\ & 250 \\ & 250 \\ & 250 \end{aligned}$ |  |  |  |  |  | $\begin{array}{r} 4.9 / 10 \\ 5.8 / 10 \\ 5.5 / 10 \\ 6 / 10 \end{array}$ | 5 10 5 5 |
| $\begin{aligned} & \text { 1N762A } \\ & \text { 1N763 } \\ & \text { 1N763-1 } \\ & \text { iN763-2 } \end{aligned}$ | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\left\|\begin{array}{l} \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \end{array}\right\|$ | $\begin{aligned} & \text { IN762 } \\ & \text { IN763 } \\ & \text { IN763 } \\ & \text { IN763 } \end{aligned}$ |  | $\begin{aligned} & 250 \\ & 250 \\ & 250 \\ & 250 \end{aligned}$ |  |  |  |  |  | $\begin{array}{r} 5.8 / 10 \\ 7.1 / 10 \\ 6.5 / 10 \\ 7 / 10 \end{array}$ | 5 10 5 5 |
| 1N763-3 <br> 1N763A <br> 1N764 <br> 1N764-1 | $\begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}$ | $\left.\begin{aligned} & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \end{aligned} \right\rvert\,$ | $\left\{\begin{array}{l} \text { IN763 } \\ \text { IN763 } \\ \text { 1N764 } \\ \text { IN764 } \end{array}\right.$ |  | $\begin{aligned} & 250 \\ & 250 \\ & 250 \\ & 250 \end{aligned}$ |  |  |  |  |  | $\begin{array}{r} 7.5 / 10 \\ 7.1 / 10 \\ 8.75 / 10 \\ 8 / 10 \end{array}$ | 5 5 10 5 |
| 1N764-2 <br> 1N764-3 <br> IN704-4 <br> IN764A | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\begin{aligned} & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \end{aligned}$ | $\left\{\begin{array}{l} \text { 1N764 } \\ \text { lN764 } \\ \text { 1N764 } \\ \text { 1N764 } \end{array}\right.$ |  | $\begin{aligned} & 250 \\ & 250 \\ & 250 \\ & 250 \end{aligned}$ |  |  |  |  |  | $\begin{array}{r} 8.5 / 10 \\ 9 / 10 \\ 9.5 / 10 \\ 8.8 / 10 \end{array}$ | 5 5 5 5 |
| 1N765 <br> 1N765-1 <br> 1N765-2 <br> iN763A | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\begin{aligned} & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \end{aligned}$ | $\left\{\begin{array}{l} \text { IN765 } \\ \text { IN765 } \\ \text { IN765 } \\ \text { IN765 } \end{array}\right.$ |  | $\begin{aligned} & 250 \\ & 250 \\ & 250 \\ & 250 \end{aligned}$ |  |  |  |  |  | $\begin{array}{r} 10.5 / 5 \\ 10 / 5 \\ 11 / 5 \\ 10 / 5 \end{array}$ | 10 5 5 5 |
| 1N766 <br> 1N766-1 <br> in766-2 <br> 1N766-3 | $\left\lvert\, \begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}\right.$ | $\left\lvert\, \begin{aligned} & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \end{aligned}\right.$ | $\begin{aligned} & \text { 1N766 } \\ & \text { IN766 } \\ & \text { 1N766 } \\ & \text { IN766 } \end{aligned}$ |  | $\begin{aligned} & 250 \\ & 250 \\ & 250 \\ & 250 \end{aligned}$ |  |  |  |  |  | $\begin{array}{r} 12.7 / 5 \\ 12 / 5 \\ 13 / 5 \\ 14 / 5 \end{array}$ | 10 5 5 5 |
| IN766A <br> 1N767 <br> 1N767-1 <br> IN767-2 | $\begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}$ | $\begin{aligned} & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \end{aligned}$ | $\begin{aligned} & \text { 1N766 } \\ & \text { 1N767 } \\ & \text { 1N767 } \\ & \text { 1N767 } \end{aligned}$ |  | $\begin{aligned} & 250 \\ & 250 \\ & 250 \\ & 250 \end{aligned}$ |  |  |  |  |  | $\begin{array}{r} 12.8 / 5 \\ 15.7 / 5 \\ 15 / 5 \\ 16 / 5 \end{array}$ | 5 10 5 5 |


| TYPF NUMBER |  | $\begin{aligned} & \frac{z}{2} \\ & \frac{2}{2} \\ & \frac{3}{4} \\ & 3 \end{aligned}$ | II REPLACIMENT | $\begin{aligned} & \text { FOR } \\ & \text { NEW } \\ & \text { DESION } \end{aligned}$ |  | tines <br> $V_{R}$ <br> (V) | I <br> (A) | $\begin{array}{ll} \mathbf{I}_{\mathbf{R}} & \Phi \mathbf{V}_{\mathbf{R}} \\ \mu_{\mathrm{A}} & /(\mathbf{V}) \end{array}$ | VF - IF <br> (V) $/$ (mA) | ERISTIC <br> $t_{r}$ <br> (ms) | $\mathbf{V}_{\mathbf{z}}$ - $\mathbf{I z}$ <br> (V) / (mA) |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| $\begin{aligned} & \text { IN767-3 } \\ & \text { 1N767A } \\ & \text { 1N768 } \\ & \text { iN768-1 } \end{aligned}$ | $\begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}$ | $\begin{aligned} & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \end{aligned}$ | $\begin{array}{\|l} \text { 1N767 } \\ \text { IN767 } \\ \text { IN768 } \\ \text { 1N768 } \end{array}$ |  | $\begin{aligned} & 250 \\ & 250 \\ & 250 \\ & 250 \end{aligned}$ |  |  |  |  |  | $\begin{array}{r} 17 / 5 \\ 15.8 / 5 \\ 19 / 5 \\ 18 / 5 \end{array}$ | 5 5 10 5 |
| 1N768-2 <br> 1N768-3 <br> iN768A <br> 1N769 | $\begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}$ | $\begin{aligned} & \mathrm{ZD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \end{aligned}$ | 1N768 <br> in768 <br> iN768 <br> 1N769 |  | $\begin{aligned} & 250 \\ & 250 \\ & 250 \\ & 250 \end{aligned}$ |  |  |  |  |  | $\begin{array}{r} 19 / 5 \\ 20 / 5 \\ 19 / 5 \\ 23.5 / 5 \end{array}$ | 5 5 5 10 |
| $\begin{aligned} & \text { 1N769-1 } \\ & \text { 1N769-2 } \\ & \text { iN769-3 } \\ & \text { 1N769-4 } \end{aligned}$ | $\begin{aligned} & 5 \\ & 5 \\ & 5 \\ & 5 \end{aligned}$ | $\left.\begin{aligned} & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \end{aligned} \right\rvert\,$ | IN769 <br> iN769 <br> 1N769 <br> IN769 |  | $\begin{aligned} & 250 \\ & 250 \\ & 250 \\ & 250 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 22 / 5 \\ & 24 / 5 \\ & 26 / 5 \\ & 28 / 5 \end{aligned}$ | $\begin{aligned} & 5 \\ & 5 \\ & 5 \\ & 5 \end{aligned}$ |
| 1N769A <br> 1N770 <br> 1N771 <br> IN771A | $\begin{aligned} & S \\ & G \\ & G \\ & G \end{aligned}$ | $\begin{array}{\|l\|} \mathrm{ZD} \\ \mathrm{SD} \\ \mathrm{SD} \\ \mathrm{SD} \end{array}$ | 1N769 |  | 250 | 20 92 92 |  | $\begin{aligned} & 40 / 10 \\ & 25 / 50 \\ & 25 / 50 \end{aligned}$ | $\begin{aligned} & .5 / 15 \\ & 1 / 100 \\ & 1 / 200 \end{aligned}$ | 350 | 23.5/5 | 5 |
| IN771B <br> 1N772 <br> 1N772A <br> iN773 | $\begin{aligned} & \mathbf{G} \\ & \mathbf{G} \\ & \mathbf{G} \\ & \mathbf{G} \end{aligned}$ | SD SD SD SD |  | 1N645 <br> 1N4448 <br> TID32 <br> 1N4448 |  | 92 80 80 75 |  | $\begin{aligned} & 25 / 50 \\ & 50 / 50 \\ & 50 / 50 \\ & 10 / 10 \end{aligned}$ | $\begin{aligned} & 1 / 400 \\ & 1 / 100 \\ & 1 / 200 \\ & 1 / 100 \end{aligned}$ |  |  |  |
| 1N773A <br> 1N774 <br> 1N774A <br> 1N775 | $\begin{aligned} & \mathbf{G} \\ & \mathbf{G} \\ & \mathbf{G} \\ & \mathbf{G} \end{aligned}$ | $\left\lvert\, \begin{aligned} & \text { SD } \\ & \text { SD } \\ & \text { SD } \\ & \text { SO } \end{aligned}\right.$ |  | $\begin{aligned} & \text { TID32 } \\ & \text { IN4448 } \\ & \text { TID32 } \\ & \text { IN4448 } \end{aligned}$ |  | 75 70 70 70 |  | $\begin{aligned} & 10 / 10 \\ & 15 / 10 \\ & 15 / 10 \\ & 20 / 10 \end{aligned}$ | $\begin{aligned} & 1 / 200 \\ & 1 / 100 \\ & 1 / 200 \\ & 1 / 100 \end{aligned}$ |  |  |  |
| $\begin{array}{\|l\|} \text { 1N776 } \\ \text { iN777 } \\ \text { iN778 } \\ \text { iN779 } \end{array}$ | $\begin{aligned} & \mathbf{G} \\ & \mathbf{G} \\ & \mathbf{S} \\ & \mathbf{S} \end{aligned}$ | $\begin{aligned} & \text { SD } \\ & S D \\ & S D \\ & S D \\ & S D \end{aligned}$ |  | 1N4448 <br> 1N4448 <br> 1N4148 <br> 1N4938 |  | $\begin{array}{r} 20 \\ 75 \\ 100 \\ 175 \end{array}$ |  | $\begin{gathered} 200 / 10 \\ 125 / 50 \\ .5 / 40 \\ .5 / 175 \end{gathered}$ | $\begin{aligned} & 1 / 50 \\ & 1 / 100 \\ & 1 / 10 \\ & 1 / 10 \end{aligned}$ | $\begin{aligned} & 500 \\ & 300 \\ & 300 \end{aligned}$ |  |  |
| 1N781 <br> 1N781A <br> 1N788 <br> 1N789 | $\begin{aligned} & G \\ & \mathbf{G} \\ & \mathbf{G} \\ & \mathbf{S} \end{aligned}$ | $\left\lvert\, \begin{aligned} & \text { SD } \\ & \text { SD } \\ & \text { SD } \\ & \text { SD } \end{aligned}\right.$ |  | iN4305 <br> 1N4305 <br> 1N4448 <br> 1N4148 |  | 40 40 60 27 |  | $\begin{array}{r} 5 / 10 \\ 5 / 10 \\ 200 / 10 \\ 1 / 20 \end{array}$ | $\begin{gathered} .45 / 10 \\ .45 / 10 \\ 1 / 100 \\ 1 / 10 \end{gathered}$ | $\begin{aligned} & 200 \\ & 500 \end{aligned}$ |  |  |
| $\begin{aligned} & \text { 1N789M } \\ & \text { 1N790 } \\ & \text { 1N790M } \\ & \text { 1N791 } \end{aligned}$ | $\left\lvert\, \begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}\right.$ | $\left\lvert\, \begin{aligned} & S D \\ & S D \\ & S D \\ & S D \\ & S D \end{aligned}\right.$ |  | 1N4148 <br> IN4148 <br> IN4148 <br> iN4448 |  | $\begin{aligned} & 30 \\ & 30 \\ & 30 \\ & 27 \end{aligned}$ |  | $\begin{aligned} & 1 / 20 \\ & 5 / 20 \\ & 5 / 20 \\ & 5 / 20 \end{aligned}$ | $\begin{aligned} & 1 / 10 \\ & 1 / 10 \\ & 1 / 10 \\ & 1 / 50 \end{aligned}$ | $\begin{aligned} & 500 \\ & 250 \\ & 250 \\ & 500 \end{aligned}$ |  |  |
| IN791M IN792 1N792M 1N793 | $\begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}$ | $\left\|\begin{array}{l} S D \\ S D \\ S D \\ S D \\ S D \end{array}\right\|$ |  | IN4448 <br> IN4448 <br> iN4448 <br> 1N4148 |  | $\begin{aligned} & 30 \\ & 27 \\ & 30 \\ & 60 \end{aligned}$ |  | $\begin{aligned} & 5 / 20 \\ & 5 / 20 \\ & 5 / 20 \\ & 1 / 50 \end{aligned}$ | $\begin{aligned} & 1 / 50 \\ & 1 / 100 \\ & 1 / 100 \\ & 1 / 10 \end{aligned}$ | $\begin{aligned} & 500 \\ & 500 \\ & 500 \\ & 500 \end{aligned}$ |  |  |

## DIODE INTERCHANGEABILITY

| TYPI MUMET䍝 |  | $\begin{array}{\|c\|} \hline \frac{3}{3} \\ \frac{3}{3} \\ 3 \\ 3 \\ 3 \end{array}$ | n | $\begin{aligned} & \text { FON } \\ & \text { NIW } \\ & \text { DESVON } \end{aligned}$ | Ratines |  |  | characteristics |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  |  | $\begin{aligned} & V_{R} \\ & (V) \end{aligned}$ | I <br> (A) | $\begin{array}{ll} \mathbf{L}_{\mathrm{R}} & \mathbf{V}_{\mathrm{R}} \\ \mu \mathrm{~A} & /(\mathbf{V}) \end{array}$ | $V_{f}$ - lf <br> (V) 1 (mA) | $\begin{gathered} \mathrm{f} \\ \mathrm{~m} \\ \mathrm{~m}) \end{gathered}$ | $\mathbf{V}_{\mathbf{Z}}$ - $\mathbf{z}$ <br> (V) $/$ (mA) | $\begin{aligned} & \text { rox } \\ & \% \end{aligned}$ |
| $\begin{aligned} & \text { iN793M } \\ & \text { iN794 } \\ & \text { iN795 } \\ & \text { iN796 } \end{aligned}$ | $\begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}$ | $\left\lvert\, \begin{gathered} S D \\ s o \\ S D \\ S D \end{gathered}\right.$ |  | 1N4148 <br> in4i48 <br> 1N4488 <br> 1N448 |  | 60 60 60 60 |  | $\begin{aligned} & 1 / 50 \\ & 3 / 50 \\ & 5 / 50 \\ & 5 / 50 \end{aligned}$ | $\begin{aligned} & 1 / 10 \\ & 1 / 10 \\ & 1 / 50 \\ & 1 / 100 \end{aligned}$ | $\begin{aligned} & 500 \\ & 250 \\ & 500 \\ & 500 \end{aligned}$ |  |  |
| $\begin{aligned} & \text { IN798 } \\ & \text { IN797 } \\ & \text { IN799 } \\ & \text { IN800 } \end{aligned}$ | $\left\lvert\, \begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}\right.$ | $\begin{array}{\|l\|} \text { SD } \\ \text { SD } \\ \text { SD } \\ \text { SD } \end{array}$ |  | $\left\{\begin{array}{l} 1 N 4938 \\ 1 N 4938 \\ 1 N 4938 \\ 1 N 4938 \end{array}\right.$ |  | 120 120 120 120 |  | $\begin{aligned} & 5 / 100 \\ & 1 / 100 \\ & 5 / 100 \\ & 5 / 100 \end{aligned}$ | $\begin{aligned} & 1 / 10 \\ & 1 / 10 \\ & 1 / 50 \\ & 1 / 100 \end{aligned}$ | $\begin{aligned} & 250 \\ & 500 \\ & 500 \\ & 500 \end{aligned}$ |  |  |
| $\begin{aligned} & \text { IN801 } \\ & \text { IN802 } \\ & \text { INBO3 } \\ & \text { iN8O4 } \end{aligned}$ | $\begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}$ | $\begin{aligned} & \text { SD } \\ & \text { SD } \\ & S D \\ & S D \end{aligned}$ |  | 1N4938 <br> 1N4938 <br> 1N4938 <br> 1N4938 |  | 150 150 200 200 |  | $\begin{array}{r} 1 / 125 \\ 5 / 125 \\ 5 / 175 \\ 10 / 175 \end{array}$ | $\begin{aligned} & 1 / 10 \\ & 1 / 50 \\ & 1 / 10 \\ & 1 / 50 \end{aligned}$ | $\begin{aligned} & 500 \\ & 500 \\ & 500 \\ & 500 \end{aligned}$ |  |  |
| $\begin{aligned} & \text { IN805 } \\ & \text { IN806 } \\ & \text { IN807 } \\ & \text { IN808 } \end{aligned}$ | $\begin{aligned} & G \\ & S \\ & s \\ & s \end{aligned}$ | $\left\|\begin{array}{l} \text { SD } \\ \text { SD } \\ S D \\ \text { SD } \end{array}\right\|$ |  | IN4148 <br> 1N4148 <br> IN4938 <br> 1N4448 |  | 40 100 200 100 |  | $\begin{gathered} 100 / 10 \\ .5 / 40 \\ .5 / 125 \\ 1 / 35 \end{gathered}$ | $\begin{aligned} & 1 / 3 \\ & 1 / 4 \\ & 1 / 4 \\ & 1 / 100 \end{aligned}$ | 300 300 300 |  |  |
| $\begin{aligned} & \text { IN809 } \\ & \text { IN810 } \\ & \text { IN811 } \\ & \text { IN811M } \end{aligned}$ | $\begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}$ | $\left.\begin{aligned} & \text { SD } \\ & \text { SD } \\ & \text { SD } \\ & \text { sD } \end{aligned} \right\rvert\,$ |  | 1N4938 1N4148 1N4148 1N4148 |  | 200 50 20 30 |  | $\begin{gathered} 1 / 200 \\ 1 / 40 \\ 1 / 10 \\ 10 / 20 \end{gathered}$ | $\begin{aligned} & 1 / 100 \\ & 1 / 10 \\ & 1 / 1 \\ & 1 / 1 \end{aligned}$ | $\begin{array}{r} 300 \\ 50 \\ 250 \\ 250 \end{array}$ |  |  |
| IN812 <br> 1N812M <br> 1N813 <br> 1N813M | $\begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}$ | $\left.\begin{aligned} & \text { SO } \\ & \text { SD } \\ & \text { SO } \\ & \text { SD } \end{aligned} \right\rvert\,$ |  | 1N4149 <br> iN4149 <br> 1N4148 <br> IN4148 |  | 30 40 15 20 |  | $\begin{gathered} .1 / 10 \\ 10 / 10 \\ .5 / 5 \\ 10 / 5 \end{gathered}$ | $\begin{aligned} & 1 / 2 \\ & 1 / 2 \\ & 1 / 5 \\ & 1 / 5 \end{aligned}$ | $\begin{aligned} & 250 \\ & 250 \\ & 250 \\ & 250 \end{aligned}$ |  |  |
| 1N814 <br> IN814M <br> IN815 <br> IN815M | $\begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}$ | $\left\|\begin{array}{l} S D \\ S D \\ S D \\ S D \\ S D \end{array}\right\|$ |  | 1N4148 <br> 1N4148 <br> 1 N4448 <br> 1N4448 |  | 40 50 15 20 |  | $\begin{gathered} .1 / 2 \\ 10 / 20 \\ .5 / 5 \\ .5 / 5 \end{gathered}$ | $\begin{gathered} 1 / 2 \\ 1 / 2 \\ 1.5 / 100 \\ 1 / 100 \end{gathered}$ | $\begin{aligned} & 250 \\ & 250 \\ & 250 \\ & 250 \end{aligned}$ |  |  |
| iN817 <br> 1N818 <br> 1N819 <br> 1N821 | $\begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}$ | $\left.\begin{aligned} & S D \\ & S D \\ & S D \\ & \text { SD } \\ & R D \end{aligned} \right\rvert\,$ |  | 1N4938 <br> 1N4148 <br> iN645 | 250 | 200 70 80 |  | $\begin{gathered} 20 / 175 \\ .25 / 60 \\ 25 N / 70 \end{gathered}$ | 1.5/6 <br> $1.5 / 30$ <br> $1 / 200$ | $\begin{array}{r} 1 U \\ 500 \end{array}$ | 6.2/7.5 | 5 |
| $\begin{aligned} & \text { 1N821A } \\ & \text { iN822 } \\ & \text { iN822A } \\ & \text { iN823 } \end{aligned}$ | $\begin{aligned} & s \\ & s \\ & s \\ & s \\ & s \end{aligned}$ | $\left.\begin{array}{\|l\|} R D \\ R D \\ R D \\ R D \\ R D \end{array} \right\rvert\,$ |  |  | 250 250 250 250 |  |  |  |  |  | $\begin{aligned} & 6.2 / 7.5 \\ & 6.2 / 7.5 \\ & 6.2 / 7.5 \\ & 6.2 / 7.5 \end{aligned}$ | 5 5 5 5 |
| $\begin{aligned} & \text { IN823A } \\ & \text { IN824 } \\ & \text { IN82AA } \\ & \text { in825 } \end{aligned}$ | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\begin{aligned} & R D \\ & R D \\ & R D \\ & R D \\ & R D \end{aligned}$ |  |  | 250 250 250 250 |  |  |  |  |  | $\begin{aligned} & 6.2 / 7.5 \\ & 6.2 / 7.5 \\ & 6.2 / 7.5 \\ & 6.2 / 7.5 \end{aligned}$ | 5 5 5 5 |


| TYPE NUMEER |  |  | 7 REPLACEMENT | $\begin{gathered} \text { FOR } \\ \text { NEW } \\ \text { DESIGN } \end{gathered}$ | $\begin{gathered} \mathrm{PD} \\ (\mathrm{~mW}) \end{gathered}$ | titings <br> $\mathbf{V}_{\mathbf{R}}$ <br> (V) | I <br> (A) | $\begin{array}{ll} \mathbf{I}_{\mathrm{R}} & \mathbf{V}_{\mathrm{R}} \\ \mu_{\mathrm{A}} & /(\mathrm{V}) \end{array}$ | $\mathbf{V F}_{F}$ IF <br> (V) $/$ (mA) | ${ }^{\prime} /{ }_{r}$ <br> (na) | $\mathbf{V}_{\mathbf{z}} \quad \mathbf{l}_{\mathbf{z}}$ <br> (V) $/$ (mA) | rol \% |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| $\begin{aligned} & \text { 1N825A } \\ & \text { 1N826 } \\ & \text { 1N826A } \\ & \text { 1N827 } \end{aligned}$ | $\begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}$ | $\begin{array}{\|l\|} \mathrm{RD} \\ \mathrm{RD} \\ \mathrm{RD} \\ \mathrm{RD} \end{array}$ |  |  | $\begin{aligned} & 250 \\ & 250 \\ & 250 \\ & 250 \end{aligned}$ |  |  |  |  |  | $\begin{array}{r} 6.2 / 7.5 \\ 6.55 / 7.5 \\ 6.55 / 7.5 \\ 6.2 / 7.5 \end{array}$ | 5 5 5 5 |
| $\begin{aligned} & \text { 1N827A } \\ & \text { iN828 } \\ & \text { 1N828A } \\ & \text { 1N829 } \end{aligned}$ | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\left\lvert\, \begin{aligned} & R D \\ & R D \\ & R D \\ & R D \end{aligned}\right.$ |  |  | $\begin{aligned} & 250 \\ & 250 \\ & 250 \\ & 250 \end{aligned}$ |  |  |  |  |  | $\begin{array}{r} 6.2 / 7.5 \\ 6.55 / 7.5 \\ 6.55 / 7.5 \\ 6.2 / 7.5 \end{array}$ | 5 5 5 5 |
| $\begin{aligned} & \text { 1N829A } \\ & \text { IN835 } \\ & \text { 1N837 } \\ & \text { IN837A } \end{aligned}$ | $\left\lvert\, \begin{aligned} & s \\ & G \\ & s \\ & s \end{aligned}\right.$ | $\begin{aligned} & \text { RD } \\ & \text { SD } \\ & \text { SD } \\ & \text { SD } \end{aligned}$ |  | $\begin{aligned} & \text { 1N4305 } \\ & \text { TID32 } \\ & \text { TID32 } \end{aligned}$ | 250 | 30 100 100 |  | 20/30 <br> .1/80 | $\begin{aligned} & .5 / 5 \\ & 1 / 150 \\ & 1 / 150 \end{aligned}$ | $\begin{aligned} & 500 \\ & 500 \\ & 300 \end{aligned}$ | 6.2/7.5 | 5 |
| IN83B <br> 1N839 <br> iN840 <br> IN840M | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\begin{aligned} & \text { SD } \\ & \text { SD } \\ & \text { SD } \\ & \text { SD } \end{aligned}$ |  | $\begin{aligned} & \text { 1N4938 } \\ & \text { 1N4938 } \\ & \text { TID32 } \\ & \text { 1N4938 } \end{aligned}$ |  | 150 200 40 50 |  | $\begin{aligned} & .1 / 40 \\ & .1 / 40 \end{aligned}$ | $\begin{aligned} & 1 / 150 \\ & 1 / 150 \\ & 1 / 150 \\ & 1 / 150 \end{aligned}$ | $\begin{aligned} & 500 \\ & 500 \\ & 300 \\ & 300 \end{aligned}$ | - |  |
| $\begin{aligned} & \text { IN841 } \\ & \text { IN842 } \\ & \text { IN843 } \\ & \text { IN8844 } \end{aligned}$ | $\begin{aligned} & \mathbf{s} \\ & s \\ & s \\ & s \\ & s \end{aligned}$ | $\begin{aligned} & \text { SD } \\ & \text { SD } \\ & \text { SD } \\ & \text { SD } \end{aligned}$ |  | 1N4938 <br> 1N4938 <br> 1N4938 <br> 1N4938 |  | $\begin{aligned} & 120 \\ & 160 \\ & 200 \\ & 100 \end{aligned}$ |  | $\begin{aligned} & .1 / 120 \\ & .1 / 160 \\ & .1 / 200 \\ & .1 / 80 \end{aligned}$ | $\begin{aligned} & 1 / 150 \\ & 1 / 150 \\ & 1 / 150 \\ & 1 / 200 \end{aligned}$ | $\begin{aligned} & 300 \\ & 300 \\ & 300 \\ & 500 \end{aligned}$ |  |  |
| $\begin{aligned} & \text { 1N845 } \\ & \text { 1N846 } \\ & \text { IN847 } \\ & \text { 1N848 } \end{aligned}$ | $\begin{aligned} & s \\ & S \\ & s \\ & s \end{aligned}$ | $\begin{aligned} & \mathrm{SD} \\ & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \end{aligned}$ |  | 1N4938 <br> 1 N4001 <br> 1N4002 <br> IN4003 |  | $\begin{array}{r} 200 \\ 50 \\ 100 \\ 200 \end{array}$ | $\begin{aligned} & .2 \\ & .2 \\ & .2 \end{aligned}$ | $\begin{aligned} & .1 / 160 \\ & 20 / 50 \\ & 20 / 100 \\ & 20 / 200 \end{aligned}$ | $\begin{aligned} & 1 / 200 \\ & .6 / 200 \\ & .6 / 200 \\ & .6 / 200 \end{aligned}$ | 500 |  |  |
| $\begin{array}{\|l} \text { 1N849 } \\ \text { IN850 } \\ \text { 1N851 } \\ \text { IN852 } \end{array}$ | $\begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}$ | $\left.\begin{aligned} & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \end{aligned} \right\rvert\,$ |  | 1N4004 1N4004 1N4005 1N4005 |  | $\begin{aligned} & 300 \\ & 400 \\ & 500 \\ & 600 \end{aligned}$ | $\begin{aligned} & .2 \\ & .2 \\ & .2 \\ & .2 \end{aligned}$ | $\begin{aligned} & 20 / 300 \\ & 20 / 400 \\ & 20 / 500 \\ & 20 / 600 \end{aligned}$ | $\begin{aligned} & .6 / 200 \\ & .6 / 200 \\ & .6 / 200 \\ & .6 / 200 \end{aligned}$ |  |  |  |
| IN853 <br> IN854 <br> IN855 <br> IN856 | $\begin{aligned} & \mathrm{s} \\ & \mathrm{~s} \\ & \mathrm{~s} \\ & \mathrm{~s} \end{aligned}$ | $\begin{aligned} & R E \\ & R E \\ & R E \\ & R E \\ & R E \end{aligned}$ |  | 1N4006 1 N4006 1N4007 1 N4007 |  | $\begin{array}{r} 700 \\ 800 \\ 900 \\ 1 K \end{array}$ | $\begin{aligned} & .2 \\ & .2 \\ & .2 \\ & .2 \end{aligned}$ | $\begin{aligned} & 20 / 700 \\ & 20 / 800 \\ & 20 / 900 \\ & 20 / 1 \mathrm{~K} \end{aligned}$ | $\begin{aligned} & .6 / 200 \\ & .6 / 200 \\ & .6 / 200 \\ & .6 / 200 \end{aligned}$ |  |  |  |
| 1N857 <br> 1N858 <br> iN859 <br> 1N860 | $\begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}$ | $\begin{aligned} & \mathbf{R E} \\ & \mathbf{R E} \\ & \mathbf{R E} \\ & \mathrm{RE} \end{aligned}$ |  | 1N4001 <br> 1N4002 <br> 1N4003 <br> in4004 |  | $\begin{array}{r} 50 \\ 100 \\ 200 \\ 300 \end{array}$ | $\begin{aligned} & .15 \\ & .15 \\ & .15 \\ & .15 \end{aligned}$ | $\begin{aligned} & 20 / 50 \\ & 20 / 100 \\ & 20 / 200 \\ & 20 / 300 \end{aligned}$ | $\begin{aligned} & .6 / 150 \\ & .6 / 150 \\ & .6 / 150 \\ & .6 / 150 \end{aligned}$ |  |  |  |
| 1N861 <br> 1 N862 <br> IN863 <br> 1N864 | $\begin{aligned} & 5 \\ & 5 \\ & s \\ & 5 \end{aligned}$ | $\begin{array}{\|c\|} \mathrm{RE} \\ \mathrm{RE} \\ \mathrm{RE} \\ \mathrm{RE} \end{array}$ |  | 1 N4004 iN4005 IN4005 1N4006 |  | $\begin{aligned} & 400 \\ & 500 \\ & 600 \\ & 700 \end{aligned}$ | $\begin{aligned} & .15 \\ & .15 \\ & .15 \\ & .15 \end{aligned}$ | $\begin{aligned} & 20 / 400 \\ & 20 / 500 \\ & 20 / 600 \\ & 20 / 700 \end{aligned}$ | $\begin{aligned} & .6 / 150 \\ & .6 / 150 \\ & .6 / 150 \\ & .6 / 150 \end{aligned}$ |  |  |  |

## DIODE INTERCHANGEABILITY

| TYPE NUMBER | 高$\frac{\text { m }}{3}$3 |  | TinEPLACEMENT | $\begin{aligned} & \text { FOR } \\ & \text { NEW } \\ & \text { DESIGN } \end{aligned}$ | RAtings |  |  | CHARACTERISTICS |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  | $\begin{gathered} P D \\ (\mathrm{~mW}) \end{gathered}$ | $\begin{aligned} & \mathbf{V}_{\mathbf{R}} \\ & (\mathbf{V}) \end{aligned}$ | 1 <br> (A) | $\begin{array}{ll} r_{R} & V_{R} \\ \mu \mathbf{A} & /(\mathbf{V}) \end{array}$ | $\mathbf{V F}_{F}$ - $\mathbf{I F}_{\mathbf{F}}$ <br> (V) $/(\mathrm{mA})$ | $\begin{gathered} t r r \\ (n s) \end{gathered}$ | $\mathbf{v}_{\mathbf{Z}}$. $\mathbf{z}$ <br> (V) $/$ (mA) | $\left\lvert\, \begin{gathered} 102 \\ \% \end{gathered}\right.$ |
| 1N865 1N866 1N867 1N868 | $\left\lvert\, \begin{aligned} & \mathbf{S} \\ & \mathbf{S} \\ & \mathbf{S} \\ & \mathbf{s} \end{aligned}\right.$ | $\begin{aligned} & R E \\ & R E \\ & R E \\ & R E \end{aligned}$ |  | 1N4006 <br> 1N4007 <br> 1N4007 <br> 1N4001 |  | 800 900 $1 K$ 50 | $\begin{array}{r} .15 \\ .15 \\ .15 \\ .1 \end{array}$ | $\begin{aligned} & 20 / 800 \\ & 20 / 900 \\ & 20 / 1 K \\ & 20 / 50 \end{aligned}$ | $\begin{aligned} & .6 / 150 \\ & .6 / 150 \\ & .6 / 150 \\ & .6 / 100 \end{aligned}$ |  |  |  |
| $\begin{aligned} & \text { 1N869 } \\ & \text { IN870 } \\ & \text { 1N871 } \\ & \text { IN872 } \end{aligned}$ | $\left\lvert\, \begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}\right.$ | $\begin{aligned} & R E \\ & R E \\ & R E \\ & R E \end{aligned}$ |  | 1N4002 <br> 1N4003 IN4004 IN4004 |  | 100 200 300 400 | .1 .1 .1 .1 | $\begin{aligned} & 20 / 100 \\ & 20 / 200 \\ & 20 / 300 \\ & 20 / 400 \end{aligned}$ | $\begin{aligned} & .6 / 100 \\ & .6 / 100 \\ & .6 / 100 \\ & .6 / 100 \end{aligned}$ |  |  |  |
| $\begin{aligned} & \text { 1N873 } \\ & \text { IN874 } \\ & \text { 1N875 } \\ & \text { IN876 } \end{aligned}$ | $\left[\begin{array}{l} s \\ s \\ s \\ s \end{array}\right.$ | $\left.\begin{array}{\|} \mathbf{R E} \\ \mathrm{RE} \\ \mathrm{RE} \\ \mathrm{RE} \end{array} \right\rvert\,$ |  | IN4005 1N4005 IN4006 1N4006 |  | $\begin{aligned} & 500 \\ & 600 \\ & 700 \\ & 800 \end{aligned}$ | $\begin{aligned} & .1 \\ & .1 \\ & .1 \\ & .1 \end{aligned}$ | $\begin{aligned} & 20 / 500 \\ & 20 / 600 \\ & 20 / 700 \\ & 20 / 800 \end{aligned}$ | $\begin{aligned} & .6 / 100 \\ & .6 / 100 \\ & .6 / 100 \\ & .6 / 100 \end{aligned}$ |  |  |  |
| $\begin{array}{\|l\|l} \text { 1N877 } \\ \text { 1N878 } \\ \text { 1N879 } \\ \text { 1N880 } \end{array}$ | $\begin{aligned} & 5 \\ & s \\ & s \\ & s \end{aligned}$ | $\left.\begin{array}{\|c\|} \mathrm{RE} \\ \mathrm{RE} \\ \mathrm{RE} \\ \mathrm{RE} \\ \mathbf{R E} \end{array} \right\rvert\,$ |  | $\left\{\begin{array}{l} \text { IN4007 } \\ \text { iN4007 } \\ \text { IN4001 } \\ \text { in } 4002 \end{array}\right.$ |  | $\begin{array}{r} 900 \\ 1 K \\ 50 \\ 100 \end{array}$ | $\begin{array}{r} .1 \\ .1 \\ .05 \\ .05 \end{array}$ | $\begin{aligned} & 20 / 900 \\ & 20 / 1 K \\ & 20 / 50 \\ & 20 / 100 \end{aligned}$ | $\begin{aligned} & .6 / 100 \\ & .6 / 100 \\ & .6 / 50 \\ & .6 / 50 \end{aligned}$ |  |  |  |
| 1N881 1N882 1 N883 in884 | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\begin{aligned} & \mathbf{R E} \\ & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \end{aligned}$ |  | $\begin{aligned} & \text { iN4003 } \\ & \text { iN4004 } \\ & \text { iN4004 } \\ & \text { iN4005 } \end{aligned}$ |  | $\begin{aligned} & 200 \\ & 300 \\ & 400 \\ & 500 \end{aligned}$ | $\begin{aligned} & .05 \\ & .05 \\ & .05 \\ & .05 \end{aligned}$ | $\begin{aligned} & 20 / 200 \\ & 20 / 300 \\ & 20 / 400 \\ & 20 / 500 \end{aligned}$ | $\begin{aligned} & .6 / 50 \\ & .6 / 50 \\ & .6 / 50 \\ & .6 / 50 \end{aligned}$ | - |  |  |
| 1N885 <br> 1 N886 <br> iN887 <br> 1N888 | $\left\lvert\, \begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}\right.$ | $\left.\begin{array}{\|l\|} \mathbf{R E} \\ \mathrm{RE} \\ \mathrm{RE} \\ \mathrm{RE} \end{array} \right\rvert\,$ |  | 1N4005 IN4006 1N4006 1N4007 |  | $\begin{aligned} & 600 \\ & 700 \\ & 800 \\ & 900 \end{aligned}$ | $\begin{aligned} & .05 \\ & .05 \\ & .05 \\ & .05 \end{aligned}$ | $\begin{aligned} & 20 / 600 \\ & 20 / 700 \\ & 20 / 800 \\ & 20 / 900 \end{aligned}$ | $\begin{aligned} & .6 / 50 \\ & .6 / 50 \\ & .6 / 50 \\ & .6 / 50 \end{aligned}$ |  |  |  |
| 1N889 <br> 1N890 <br> 1N891 <br> 1N892 | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\left\|\begin{array}{l} R E \\ S D \\ S D \\ S D \\ S D \end{array}\right\|$ |  | 1N4007 <br> 1N4447 <br> 1N4448 <br> iN4448 |  | $\begin{array}{r} 1 K \\ 60 \\ 60 \\ 100 \end{array}$ | . 05 | $\begin{array}{r} 20 / 1 \mathrm{~K} \\ 25 \mathrm{~N} / 60 \\ .1 / 50 \\ .1 / 40 \end{array}$ | $\begin{aligned} & .6 / 50 \\ & 1 / 20 \\ & 1 / 50 \\ & 1 / 50 \end{aligned}$ | 300 300 |  |  |
| 1N893 <br> 1N897 <br> 1N898 <br> 1N899 | $\begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}$ | $\left.\begin{gathered} \mathrm{SO} \\ \mathrm{SD} \\ \mathrm{SD} \\ \mathrm{SD} \end{gathered} \right\rvert\,$ |  | 1N4938 <br> 1N4148 <br> iN4448 <br> 1N4938 |  | $\begin{array}{r} 240 \\ 50 \\ 50 \\ 100 \end{array}$ |  | $\begin{aligned} & .1 / 200 \\ & .1 / 40 \\ & .5 / 40 \\ & .1 / 80 \end{aligned}$ | $\begin{aligned} & 1 / 50 \\ & 1 / 5 \\ & 1 / 100 \\ & 1 / 5 \end{aligned}$ | 300 |  |  |
| 1N900 <br> 1N901 <br> 1 N902 <br> IN903 | $\left\lvert\, \begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}\right.$ | $\left\|\begin{array}{l} S D \\ S D \\ S D \\ S D \end{array}\right\|$ |  | 1N4938 <br> IN4938 <br> IN4938 <br> IN4148 |  | $\begin{array}{r} 100 \\ 100 \\ 200 \\ 20 \end{array}$ |  | $\begin{aligned} & .1 / 80 \\ & .5 / 80 \\ & 1 / 100 \\ & .1 / 20 \end{aligned}$ | $\begin{aligned} & 1 / 50 \\ & 1 / 100 \\ & 1 / 10 \\ & 1 / 10 \end{aligned}$ | 4 |  |  |
| 1N903A IN903AM 1N903M 1N904 | $\begin{aligned} & \mathbf{S} \\ & \mathbf{S} \\ & \mathbf{S} \\ & \mathbf{S} \end{aligned}$ | $\left\|\begin{array}{l} \text { SD } \\ \text { SD } \\ \text { SD } \\ \text { SD } \end{array}\right\|$ |  | 1N4154 IN4154 1N4154 1N4154 |  | 50 50 50 30 |  | $\begin{aligned} & .1 / 40 \\ & .1 / 40 \\ & .1 / 40 \\ & .1 / 30 \end{aligned}$ | $\begin{aligned} & 1 / 20 \\ & 1 / 20 \\ & 1 / 10 \\ & 1 / 10 \end{aligned}$ | 4 4 4 4 |  |  |

## DIODE INTERCHANGEABILITY

| TYPE NUMBER |  |  | $\pi$ remacement |  | $\begin{gathered} P_{D} \\ (\mathrm{~mW}) \end{gathered}$ | ATINES <br> $\mathbf{V}_{\mathbf{R}}$ <br> (V) | I <br> (A) | $\begin{array}{ll} \mathrm{I}_{\mathrm{R}} & \mathrm{~V}_{\mathrm{R}} \\ \mu_{\mathrm{A}} & /(\mathrm{V}) \end{array}$ | $\mathbf{V F}_{\mathbf{F}} \cdot \mathbf{I F}_{\mathbf{F}}$ <br> (V) $/$ (ma) | Ristic <br> $t_{r}$ <br> (ns) | $\mathbf{V}_{\mathbf{Z}} \text { - } \mathbf{z}$ <br> (V) $/$ (ma) | $\left\lvert\, \begin{aligned} & 10 \mathrm{a} \\ & \% \end{aligned}\right.$ |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| $\begin{aligned} & \text { IN904A } \\ & \text { IN904AM } \\ & \text { 1N904M } \\ & \text { IN905 } \end{aligned}$ | $\begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}$ | SD |  | IN4154 <br> 1N4154 <br> INA154 <br> 1N4151 |  | 40 40 40 40 |  | $\begin{aligned} & .1 / 30 \\ & .1 / 30 \\ & .1 / 30 \\ & .1 / 40 \end{aligned}$ | $\begin{aligned} & 1 / 20 \\ & 1 / 20 \\ & 1 / 10 \\ & 1 / 10 \end{aligned}$ | 4 4 4 4 |  |  |
| 1NP05A 1N905AM 1N905M 1N906 | $\begin{aligned} & \mathbf{s} \\ & s \\ & s \\ & s \end{aligned}$ | $\begin{aligned} & \text { SD } \\ & \text { SD } \\ & \text { SD } \\ & \text { SD } \end{aligned}$ |  | IN4154 1N4154 1N4154 iN4149 |  | 30 30 30 20 |  | $\begin{aligned} & .1 / 20 \\ & .1 / 20 \\ & .1 / 20 \\ & .1 / 20 \end{aligned}$ | $\begin{aligned} & 1 / 20 \\ & 1 / 20 \\ & 1 / 10 \\ & 1 / 10 \end{aligned}$ | 4 4 4 4 |  |  |
| $\begin{aligned} & \text { 1 N906A } \\ & \text { 1 N906AM } \\ & \text { IN906M } \\ & \text { 1N907 } \end{aligned}$ | $\begin{aligned} & 5 \\ & 5 \\ & 5 \\ & 5 \end{aligned}$ | $\begin{aligned} & \text { SD } \\ & \text { SD } \\ & \text { SD } \\ & S D \end{aligned}$ |  | $\begin{aligned} & \text { 1N4447 } \\ & \text { 1N4447 } \\ & \text { IN4447 } \\ & \text { INA149 } \end{aligned}$ |  | 30 30 30 40 |  | $\begin{aligned} & .1 / 20 \\ & .1 / 20 \\ & .1 / 20 \\ & .1 / 30 \end{aligned}$ | $\begin{aligned} & 1 / 20 \\ & 1 / 20 \\ & 1 / 10 \\ & 1 / 10 \end{aligned}$ | 4 4 4 4 |  |  |
| 1N907A IN907AM IN907M 1N908 | $\begin{aligned} & s \\ & s \\ & s \\ & s \\ & s \end{aligned}$ | SD SD SD SD |  | IN4448 <br> IN4447 <br> INA149 <br> 1N4149 |  | 40 40 40 50 |  | $\begin{aligned} & .1 / 30 \\ & .1 / 30 \\ & .1 / 30 \\ & .1 / 40 \end{aligned}$ | $\begin{aligned} & 1 / 20 \\ & 1 / 20 \\ & 1 / 10 \\ & 1 / 10 \end{aligned}$ | 4 4 4 4 |  |  |
| IN908A 1N908AM 1N908M 1 N909 | $\begin{aligned} & \text { S } \\ & \mathbf{S} \\ & \mathbf{S} \\ & \mathbf{G} \end{aligned}$ | $\begin{aligned} & \text { SD } \\ & \text { SD } \\ & \text { SD } \\ & \text { SD } \end{aligned}$ |  | 1N4447 <br> 1N4447 <br> 1N4149 <br> 1N4449 |  | 50 50 50 50 |  | $\begin{aligned} & .1 / 40 \\ & .1 / 40 \\ & .1 / 40 \\ & 10 / 50 \end{aligned}$ | $\begin{aligned} & 1 / 20 \\ & 1 / 20 \\ & 1 / 10 \\ & 1 / 100 \end{aligned}$ | $\begin{aligned} & 4 \\ & 4 \\ & 4 \end{aligned}$ |  |  |
| $\begin{aligned} & \text { 1N910 } \\ & \text { 1N911 } \\ & \text { 1N912 } \\ & \text { 1N912A } \end{aligned}$ | $\begin{aligned} & \mathbf{G} \\ & \mathbf{G} \\ & \mathbf{S} \\ & \mathbf{S} \end{aligned}$ | $\left\|\begin{array}{l} \mathrm{sD} \\ \mathrm{sD} \\ \mathrm{zD} \\ \mathrm{ZD} \end{array}\right\|$ |  | 1N4449 1N4449 | $\begin{aligned} & 500 \\ & 500 \end{aligned}$ | 30 |  | $\begin{aligned} & 10 / 30 \\ & 10 / 20 \end{aligned}$ | $\begin{aligned} & 1 / 100 \\ & 1 / 100 \end{aligned}$ |  | $\begin{aligned} & .62 / 1 \\ & .62 / 1 \end{aligned}$ | 10 |
| 1N913 <br> 1N913A <br> 1N914 <br> 1N914A | $\begin{aligned} & 5 \\ & 5 \\ & 5 \\ & 5 \end{aligned}$ | $\left\|\begin{array}{c\|} \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{SD} \\ \mathrm{SD} \end{array}\right\|$ | $\begin{aligned} & \text { IN914 } \\ & \text { IN914A } \end{aligned}$ |  | $\begin{aligned} & 600 \\ & 600 \end{aligned}$ | $\begin{aligned} & 100 \\ & 100 \end{aligned}$ |  | $\begin{aligned} & 5 / 75 \\ & 5 / 75 \end{aligned}$ | $\begin{aligned} & 1 / 10 \\ & 1 / 20 \end{aligned}$ | 4 | $\begin{aligned} & .62 / 1 \\ & .62 / 1 \end{aligned}$ | 5 10 |
| 1N914B <br> IN914M <br> IN915 <br> 1N916 | $\begin{aligned} & 5 \\ & 5 \\ & 5 \\ & 5 \end{aligned}$ |  | 1N9148 <br> 1N914 <br> IN915 <br> iN916 |  |  | $\begin{array}{r} 100 \\ 75 \\ 65 \\ 100 \end{array}$ |  | $\begin{array}{r} 5 / 75 \\ 25 N / 20 \\ 5 / 50 \\ 5 / 75 \end{array}$ | $\begin{aligned} & 1 / 100 \\ & 1 / 10 \\ & 1 / 50 \\ & 1 / 10 \end{aligned}$ | 4 <br> 4 <br> 10 <br> 4 |  |  |
| 1N916A <br> 1N916B <br> 1N917 <br> 1N919 | $\begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}$ | $\begin{array}{\|l\|l\|l\|} \hline \text { SD } & 1 \\ \text { SD } & 1 \\ \text { SD } & 1 \\ \text { SD } & \end{array}$ |  | 1N4938 |  | $\begin{array}{r} 100 \\ 100 \\ 40 \\ 150 \end{array}$ |  | $\begin{gathered} 5 / 75 \\ 5 / 75 \\ .05 / 10 \\ .5 / 150 \end{gathered}$ | $\begin{aligned} & 1 / 20 \\ & 1 / 30 \\ & 1 / 10 \\ & 1 / 100 \end{aligned}$ | 4 4 3 300 |  |  |
| 1N920 <br> 1N921 <br> 1N922 <br> 1N923 | $\begin{aligned} & 5 \\ & 5 \\ & s \\ & 5 \end{aligned}$ | $\begin{aligned} & \text { SD } \\ & \text { SD } \\ & \text { SD } \\ & \text { SD } \end{aligned}$ |  | 1N4608 <br> 1N4608 <br> 1N4608 <br> 1N4608 |  | $\begin{array}{r} 36 \\ 80 \\ 100 \\ 130 \end{array}$ |  | $\begin{aligned} & .25 / 30 \\ & .25 / 60 \\ & .25 / 90 \\ & .25 / 120 \end{aligned}$ | $\begin{aligned} & 1 / 500 \\ & 1 / 500 \\ & 1 / 500 \\ & 1 / 500 \end{aligned}$ | $\begin{aligned} & 300 \\ & 300 \\ & 300 \\ & 300 \end{aligned}$ |  |  |

## DIODE INTERCHANGEABILITY

| TYFE Rumeter |  |  | ninncement | $\begin{aligned} & \text { FOR } \\ & \text { NEW } \\ & \text { DESteN } \end{aligned}$ | datmes |  |  | CHARACTEEISTICS |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  | PD <br> (mW) | $\begin{aligned} & \mathbf{V}_{\mathbf{R}} \\ & \mathbf{( V )} \end{aligned}$ | I <br> (A) | $\begin{array}{ll} \mathrm{n} & \bullet \mathbf{V}_{\mathrm{R}} \\ \mu \mathrm{~A} & /(\mathrm{V}) \end{array}$ | $\begin{array}{ccc} \mathbf{V F}_{F} & \mathbf{4} \\ \text { (V) } & 1(\mathrm{~mA}) \end{array}$ | $\begin{aligned} & \mathrm{i}_{\mathrm{IT}} \\ & \text { (men } \end{aligned}$ | $\mathbf{V Z}_{\mathbf{z}}$ - $\mathbf{z}$ <br> (V) / (mA) | $\begin{gathered} \mathrm{TOL} \\ \% \end{gathered}$ |
| 1N924 <br> IN925 <br> 1N926 <br> 1N927 | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\begin{aligned} & \text { SD } \\ & \text { SD } \\ & \text { SD } \\ & \text { SD } \end{aligned}$ |  | $\begin{aligned} & \text { IN483 } \\ & \text { 1N4148 } \\ & \text { 1NA148 } \\ & \text { IN4148 } \end{aligned}$ |  | 60 40 40 65 |  | $\begin{array}{r} 25 N / 60 \\ 1 / 10 \\ .1 / 10 \\ .1 / 10 \end{array}$ | $\begin{aligned} & 1 / 30 \\ & 1 / 5 \\ & 1 / 5 \\ & 1 / 10 \end{aligned}$ | $\begin{array}{r} 2 U \\ 150 \\ 150 \\ 150 \end{array}$ |  |  |
| $\begin{array}{\|l\|l} \text { IN928 } \\ \text { 1 N929 } \\ \text { 1N930 } \\ \text { IN931 } \end{array}$ | $\left\lvert\, \begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{S} \\ & \mathbf{s} \end{aligned}\right.$ | $\begin{aligned} & \text { SD } \\ & \text { SD } \\ & \text { SD } \\ & \text { SD } \end{aligned}$ |  | IN4938 1N446 1N4446 iN4938 |  | $\begin{array}{r} 120 \\ 25 \\ 75 \\ 125 \end{array}$ |  | $\begin{aligned} & .1 / 100 \\ & 100 / 25 \\ & 100 / 75 \\ & 100 / 125 \end{aligned}$ | $\begin{aligned} & 1 / 10 \\ & 1 / 20 \\ & 1 / 20 \\ & 1 / 20 \end{aligned}$ | 150 |  |  |
| $\begin{aligned} & \text { 1N932 } \\ & \text { IN933 } \\ & \text { 1N934 } \\ & \text { IN935 } \end{aligned}$ | $\begin{aligned} & s \\ & \mathbf{G} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}$ | $\begin{aligned} & S D \\ & S D \\ & S D \\ & S D \\ & R D \end{aligned}$ |  | $\begin{aligned} & \text { iN4938 } \\ & \text { 1N4148 } \\ & \text { 1N4938 } \end{aligned}$ | 500 | 250 100 70 |  | $\begin{gathered} 100 / 250 \\ 10 / 10 \\ 25 N / 60 \end{gathered}$ | $\begin{aligned} & 1 / 20 \\ & 1 / 4 \\ & 1 / 30 \end{aligned}$ | 400 14 | 9/7.5 | 5 |
| $\begin{aligned} & \text { IN935A } \\ & \text { iN935B } \\ & \text { iN936 } \\ & \text { iN936A } \end{aligned}$ | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\left.\begin{aligned} & R D \\ & R D \\ & R D \\ & R D \end{aligned} \right\rvert\,$ |  |  | $\begin{aligned} & 500 \\ & 500 \\ & 500 \\ & 500 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 9 / 7.5 \\ & 9 / 7.5 \\ & 9 / 7.5 \\ & 9 / 7.5 \end{aligned}$ | 5 5 5 5 |
| $\begin{aligned} & \text { 1N9368 } \\ & \text { iN937 } \\ & \text { 1N937A } \\ & \text { 1N9378 } \end{aligned}$ | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\left.\begin{aligned} & R D \\ & R D \\ & R D \\ & R D \end{aligned} \right\rvert\,$ |  |  | 500 500 500 500 |  |  |  |  |  | $\begin{aligned} & 9 / 7.5 \\ & 9 / 7.5 \\ & 9 / 7.5 \\ & 9 / 7.5 \end{aligned}$ | 5 5 5 5 |
| 1N938 <br> 1N938A <br> 1N9388 <br> 1N939 | $\begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}$ | $\left.\begin{array}{\|l\|} R D \\ R D \\ R D \\ R D \end{array} \right\rvert\,$ |  |  | $\begin{aligned} & 500 \\ & 500 \\ & 500 \\ & 500 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 9 / 7.5 \\ & 9 / 7.5 \\ & 9 / 7.5 \\ & 9 / 7.5 \end{aligned}$ | 5 5 5 5 |
| IN93PA <br> IN9398 <br> IN940 <br> IN940A | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\left\|\begin{array}{l} R D \\ R D \\ R D \\ R D \end{array}\right\|$ |  |  | $\begin{aligned} & 500 \\ & 500 \\ & 500 \\ & 500 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 9 / 7.5 \\ & 9 / 7.5 \\ & 9 / 7.5 \\ & 9 / 7.5 \end{aligned}$ | 5 5 5 5 |
| $\begin{aligned} & \text { 1N9403 } \\ & \text { 1N941 } \\ & \text { 1N941A } \\ & \text { 1N9418 } \end{aligned}$ | $\left\lvert\, \begin{aligned} & 5 \\ & 5 \\ & 5 \\ & 5 \end{aligned}\right.$ | $\left.\begin{aligned} & R D \\ & R D \\ & R D \\ & R D \end{aligned} \right\rvert\,$ |  |  | $\begin{aligned} & 500 \\ & 500 \\ & 500 \\ & 500 \end{aligned}$ |  |  |  |  |  | $\begin{array}{r} 9 / 7.5 \\ 11.7 / 7.5 \\ 11.7 / 7.5 \\ 11.7 / 7.5 \end{array}$ | 5 5 5 5 |
| $\begin{aligned} & \text { IN942 } \\ & \text { iN942A } \\ & \text { iN942B } \\ & \text { iN943 } \end{aligned}$ | S | $\begin{aligned} & R D \\ & R D \\ & R D \\ & R D \end{aligned}$ |  |  | $\begin{aligned} & 500 \\ & 500 \\ & 500 \\ & 500 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 11.7 / 7.5 \\ & 11.7 / 7.5 \\ & 11.7 / 7.5 \\ & 11.7 / 7.5 \end{aligned}$ | 5 5 5 5 |
| $\begin{aligned} & \text { IN943A } \\ & \text { IN9438 } \\ & \text { 1N944 } \\ & \text { 1N944A } \end{aligned}$ | S | $\left.\begin{aligned} & R D \\ & R D \\ & R D \\ & R D \end{aligned} \right\rvert\,$ |  |  | 500 500 500 500 |  |  |  |  |  | $\begin{aligned} & 11.7 / 7.5 \\ & 11.7 / 7.5 \\ & 11.7 / 7.5 \\ & 11.7 / 7.5 \end{aligned}$ | 5 5 5 5 |

## DIODE INTERCHANGEABILITY

| TYPE NUMBER |  |  |  | $\underset{\text { REPLACEMENT }}{\pi}$ | $\begin{gathered} \text { FOR } \\ \text { NEW } \\ \text { DESIGN } \end{gathered}$ | $\begin{gathered} P_{D} \\ (\mathrm{~mW}) \end{gathered}$ | $\begin{aligned} & \mathbf{V}_{\mathbf{R}} \mathrm{NGS} \\ & (\mathrm{~V}) \end{aligned}$ | I <br> (A) | $\begin{array}{ll} I_{R} & V_{R} \\ \mu_{\mathbf{A}} & /(\mathbf{V}) \end{array}$ | $\begin{array}{cc} V_{F} & \mathbf{V F}_{f} \\ (\mathrm{~V}) & I(\mathrm{~mA}) \end{array}$ | RISTICS <br> ${ }^{\prime} \mathrm{rr}$ <br> (ns) | $\begin{array}{ccc} v_{z} & \bullet & l_{z} \\ \text { (v) } & /(\mathrm{mA}) \end{array}$ | $\left\lvert\, \begin{gathered} \text { rou } \\ \% \end{gathered}\right.$ |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| $\begin{aligned} & \text { 1N944B } \\ & \text { 1N945 } \\ & \text { 1N945A } \\ & \text { 1N945B } \end{aligned}$ | s |  | $R D$ <br> $R D$ <br> $R D$ <br> $R D$ <br> RD |  |  | $\begin{aligned} & 500 \\ & 500 \\ & 500 \\ & 500 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 11.7 / 7.5 \\ & 11.7 / 7.5 \\ & 11.7 / 7.5 \\ & 11.7 / 7.5 \end{aligned}$ | 5 5 5 5 |
| $\begin{aligned} & \text { iN946 } \\ & \text { iN946A } \\ & \text { iN946B } \\ & \text { iN947 } \end{aligned}$ | s S s S |  | RD |  | 1N647 | $\begin{aligned} & 500 \\ & 500 \\ & 500 \end{aligned}$ | 600 |  | 2/480 | 1/400 |  | $\begin{aligned} & 11.7 / 7.5 \\ & 11.7 / 7.5 \\ & 11.7 / 7.5 \end{aligned}$ | 5 5 5 |
| $\begin{array}{\|l\|} \text { 1N948 } \\ \text { 1N949 } \\ \text { IN957 } \\ \text { 1N957A } \end{array}$ | S |  | O | $\begin{array}{\|l\|l\|l\|l\|l\|l\|} \hline \text { IN957 } \\ \text { iN957A } \end{array}$ | IN4448 1N4305 | $\begin{aligned} & 400 \\ & 400 \end{aligned}$ | $\begin{aligned} & 36 \\ & 50 \end{aligned}$ |  | $\begin{aligned} & .25 / 30 \\ & 10 / 10 \end{aligned}$ | $\begin{aligned} & 1.5 / 100 \\ & .39 / 10 \end{aligned}$ |  | $\begin{aligned} & 6.8 / 18 \\ & 6.8 / 18 \end{aligned}$ | 20 10 |
| $\begin{aligned} & \text { 1N957B } \\ & \text { 1N958 } \\ & \text { 1N958A } \\ & \text { 1N958B } \end{aligned}$ | s s s s |  |  |  |  | $\begin{aligned} & 400 \\ & 400 \\ & 400 \\ & 400 \end{aligned}$ |  |  |  |  |  | 6.8/18 7.5/16 7.5/16 7.5/16 | 5 20 10 5 |
| IN959 <br> IN959A <br> 1N959B <br> 1N960 | $\left[\begin{array}{l} \mathbf{s} \\ \mathbf{s} \\ \mathbf{s} \\ \mathbf{s} \end{array}\right.$ |  |  | IN959 <br> 1N959A <br> in959B <br> 1N960 |  | $\begin{aligned} & 400 \\ & 400 \\ & 400 \\ & 400 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 8.2 / 15 \\ & 8.2 / 15 \\ & 8.2 / 15 \\ & 9.1 / 14 \end{aligned}$ | 20 10 5 20 |
|  | $\begin{aligned} & s \\ & s \\ & s \\ & s \\ & s \end{aligned}$ | ZD | 1 |  |  | $\begin{aligned} & 400 \\ & 400 \\ & 400 \\ & 400 \end{aligned}$ |  |  |  |  |  | $9.1 / 14$ <br> 9.1/14 <br> 10/12 <br> 10/12 | 10 5 20 10 |
| 1N9618 <br> 1N962 <br> 1N962A <br> 1N962B | $\begin{aligned} & \mathbf{s} \\ & s \\ & s \\ & s \end{aligned}$ | z0 |  | IN961B 1N962 1N962A iN962B |  | $\begin{aligned} & 400 \\ & 400 \\ & 400 \\ & 400 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 10 / 12 \\ & 11 / 11 \\ & 11 / 11 \\ & 11 / 11 \end{aligned}$ | 5 20 10 5 |
| 1N963 1N963A 1N963B IN964 | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\left\{\begin{array}{l} \mathrm{zn} \\ \mathrm{zv} \\ \mathrm{zd} \\ \mathrm{zD} \\ \mathrm{zD} \end{array}\right.$ |  | 1N963 <br> IN963A <br> 1N963B <br> iN964 |  | $\begin{aligned} & 400 \\ & 400 \\ & 400 \\ & 400 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 12 / 10 \\ & 12 / 10 \\ & 12 / 10 \\ & 13 / 9.5 \end{aligned}$ | 20 10 5 20 |
| IN964A 1N964B 1N965 iN965A | [s | ZD |  | in964A <br> iN964B <br> iN965 <br> IN965A |  | $\begin{aligned} & 400 \\ & 400 \\ & 400 \\ & 400 \end{aligned}$ |  |  |  |  |  | 13/9.5 13/9.5 15/8.5 15/8.5 | 10 5 20 10 |
| 1N965B 1N966 1N966A 1N966B | $\begin{aligned} & \mathrm{s} \\ & \mathrm{~s} \\ & \mathrm{~s} \\ & \mathrm{~s} \end{aligned}$ | $\left\{\begin{array}{l} \mathrm{ZD} \\ \mathrm{ZD} \\ \mathrm{ZD} \\ \mathrm{ZD} \end{array}\right.$ |  | N965B 1N966 IN966A N966B |  | $\begin{aligned} & 400 \\ & 400 \\ & 400 \\ & 400 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 15 / 8.5 \\ & 16 / 7.8 \\ & 16 / 7.8 \\ & 16 / 7.8 \end{aligned}$ | $\begin{array}{r} 5 \\ 20 \\ 10 \\ 5 \end{array}$ |


| $\begin{gathered} \text { TYre } \\ \text { number } \end{gathered}$ |  |  | $\underset{\text { remacement }}{t}$ | $\begin{aligned} & \text { FOR } \\ & \text { NEW } \\ & \text { DESICN } \end{aligned}$ | Ratancs |  |  | CHARACTERISTICS |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  | $\begin{gathered} P_{D} \\ (m W) \end{gathered}$ | $\mathbf{V}_{\mathrm{R}}$ <br> (V) | (A) | $\begin{array}{lll} \mathbf{L}_{\mathbf{R}} & \bullet \mathbf{V}_{\mathbf{R}} \\ \mu_{\mathbf{A}} & /\left(\mathbf{V}^{2}\right. \end{array}$ | $\begin{array}{cc} \mathbf{V}_{\mathbf{F}} & \mathbf{l}_{\mathbf{F}} \\ \text { (v) } & /(\mathrm{mA}) \end{array}$ | $\begin{aligned} & \text { ir } \\ & \text { (ns) } \end{aligned}$ | $\mathbf{v}_{\mathbf{z}} \cdot \mathbf{z}_{\mathbf{z}}$ <br> (V) $/$ (mA) | $\begin{aligned} & \text { ror } \\ & x \end{aligned}$ |
| 1N967 1N967A 1N9678 IN968 | $\begin{array}{\|l} \mathbf{s} \\ \mathbf{s} \\ \mathbf{s} \\ \mathbf{s} \end{array}$ | $\left\lvert\, \begin{array}{c\|c} \mathrm{ZD} & 11 \\ \mathrm{ZD} & 11 \\ \mathrm{ZD} & 11 \\ \mathrm{ZD} & 11 \end{array}\right.$ | 1N967 <br> 1N967A <br> 1N967B <br> 1N968 |  | $\begin{aligned} & 400 \\ & 400 \\ & 400 \\ & 400 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 18 / 7.0 \\ & 18 / 7.0 \\ & 18 / 7.0 \\ & 20 / 6.2 \end{aligned}$ | 20 10 5 20 |
| 1N968A 1N9688 1N969 1N969A |  | ZD 1 <br> ZD  <br> ZD 1 <br> ZD 1 | 1N968A 1N9688 1N969 1N969A |  | $\begin{aligned} & 400 \\ & 400 \\ & 400 \\ & 400 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 20 / 6.6 \\ & 20 / 6.2 \\ & 22 / 5.6 \\ & 22 / 5.6 \end{aligned}$ | 10 5 20 10 |
|  | $\begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}$ | $\left\|\begin{array}{l} \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \end{array}\right\|$ | 1N9698 1N970 1N9704 1N970 |  | $\begin{aligned} & 400 \\ & 400 \\ & 400 \\ & 400 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 22 / 5.6 \\ & 24 / 5.2 \\ & 24 / 5.2 \\ & 24 / 5.2 \end{aligned}$ | $\begin{array}{r} 5 \\ 20 \\ 10 \\ 5 \end{array}$ |
| $\begin{aligned} & \text { 1N971 } \\ & \text { 1N971A } \\ & \text { 1N9718 } \\ & \text { 1N972 } \end{aligned}$ | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\left\|\begin{array}{l} \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \end{array}\right\|$ |  |  | $\begin{aligned} & 400 \\ & 400 \\ & 400 \\ & 400 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 27 / 4.6 \\ & 27 / 4.6 \\ & 27 / 4.6 \\ & 30 / 4.6 \end{aligned}$ | 20 10 5 20 |
| 1N972A iN972B 1N973 1N973A | $\left\lvert\, \begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}\right.$ | $\left\|\begin{array}{l} \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \end{array}\right\|$ | $\begin{aligned} & \text { 1N972A } \\ & \text { lN972B } \\ & \text { lN973 } \\ & \text { IN973A } \end{aligned}$ |  | $\begin{aligned} & 400 \\ & 400 \\ & 400 \\ & 400 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 30 / 4.2 \\ & 30 / 4.2 \\ & 33 / 3.8 \\ & 33 / 3.8 \end{aligned}$ | 10 5 20 10 |
|  | s | $\left\|\begin{array}{l} \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \end{array}\right\|$ | 1N973E |  | $\begin{aligned} & 400 \\ & 400 \\ & 400 \\ & 400 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 33 / 3.8 \\ & 36 / 3.4 \\ & 36 / 3.4 \\ & 36 / 3.4 \end{aligned}$ | 5 20 10 5 |
| 1N975 <br> 1N975A 1N975 1N976 | S | $\left\|\begin{array}{l} \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \end{array}\right\|$ |  |  | $\begin{aligned} & 400 \\ & 400 \\ & 400 \\ & 400 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 39 / 3.2 \\ & 39 / 3.2 \\ & 39 / 3.2 \\ & 43 / 3.0 \end{aligned}$ | 20 10 5 20 |
|  | S | $\begin{aligned} & \mathrm{ZD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \end{aligned}$ |  |  | 400 400 400 400 |  |  |  |  |  | $\begin{aligned} & 43 / 3.0 \\ & 43 / 3.0 \\ & 47 / 2.7 \\ & 47 / 2.7 \end{aligned}$ | 10 5 20 10 |
|  | S | $\left\|\begin{array}{l} \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \end{array}\right\|$ |  |  | 400 400 400 400 |  |  |  |  |  | $\begin{aligned} & 47 / 2.7 \\ & 51 / 2.5 \\ & 51 / 2.5 \\ & 51 / 2.5 \end{aligned}$ | 5 20 10 5 |
| $\begin{aligned} & \text { 1N979 } \\ & \text { in979A } \\ & \text { iN9798 } \\ & \text { in990 } \end{aligned}$ | $\left[\begin{array}{l} s \\ s \\ s \\ s \end{array}\right.$ | $\left\lvert\, \begin{aligned} & \mathrm{ZD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \end{aligned}\right.$ |  |  | 400 400 400 400 |  |  |  |  |  | $\begin{aligned} & 56 / 2.2 \\ & 56 / 2.2 \\ & 56 / 2.2 \\ & 62 / 2 \end{aligned}$ | 20 10 5 20 |


| TYPE MUMBER |  |  | $\begin{array}{\|c\|} \text { TI } \\ \text { REPLACEMENT } \end{array}$ | $\begin{gathered} \text { FOR } \\ \text { NEW } \\ \text { DESION } \end{gathered}$ | Po (mW) | atinges <br> $\mathbf{V}_{\mathbf{R}}$ <br> (V) | I <br> (A) | $\begin{array}{ll} \mathbf{R}_{\mathbf{R}} & \mathbf{V}_{\mathbf{R}} \\ \mu_{\mathrm{A}} & /(\mathbf{V}) \end{array}$ | $\mathbf{V F}_{\mathbf{F}}$ - $\mathbf{I F}_{\mathbf{F}}$ <br> (V) $/$ (mA) | aristics <br> ${ }^{1} \boldsymbol{r}$ <br> (ns) | $\begin{array}{ccc} \mathbf{v}_{\mathbf{z}} & \mathbf{l z} \\ (\mathbf{v}) & 1 & (\mathrm{~mA}) \end{array}$ | rou * |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| in980A 1 $\mathrm{N980B}$ 1N981 1N981A | [ | 20 |  |  | $\begin{aligned} & 400 \\ & 400 \\ & 400 \\ & 400 \end{aligned}$ |  |  |  |  |  | 62/2 <br> 62/2 <br> $68 / 1.8$ <br> 68/1.8 | 10 5 20 10 |
| 1N981B 1 N982 iN982A 1N982B |  | $\left\|\begin{array}{l} \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \end{array}\right\|$ |  |  | $\begin{aligned} & 400 \\ & 400 \\ & 400 \\ & 400 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 68 / 1.8 \\ & 75 / 1.7 \\ & 7511.7 \\ & 75 / 1.7 \end{aligned}$ | 5 20 10 5 |
| $\left[\begin{array}{l} \text { IN983 } \\ \text { iN983A } \\ \text { IN983B } \\ \text { IN984 } \\ \hline \end{array}\right.$ | $\begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}$ | $\begin{aligned} & \mathrm{ZD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \end{aligned}$ |  |  | $\begin{aligned} & 400 \\ & 100 \\ & 100 \\ & 100 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 82 / 1.5 \\ & 82 / 1.5 \\ & 82 / 1.5 \\ & 91 / 1.4 \end{aligned}$ | 20 10 5 20 |
| $\begin{aligned} & \text { 1N984A } \\ & \text { 1N984B } \\ & \text { 1N985 } \\ & \text { 1N985A } \end{aligned}$ | $\begin{aligned} & \mathrm{s} \\ & \mathrm{~s} \\ & \mathrm{~s} \\ & \mathrm{~s} \end{aligned}$ | $\left\|\begin{array}{l} \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \end{array}\right\|$ |  |  | $\begin{aligned} & 400 \\ & 400 \\ & 400 \\ & 400 \end{aligned}$ |  |  |  |  |  | $91 / 1.4$ $91 / 1.4$ 100/1.3 100/1.3 | 10 5 20 10 |
| $\begin{array}{\|l\|} \hline \text { 1N9858 } \\ \text { iN986 } \\ \text { 1N986A } \\ \text { iN986B } \\ \hline \end{array}$ | $\begin{array}{\|l} \hline s \\ s \\ s \\ s \end{array}$ | $\begin{aligned} & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \end{aligned}$ |  |  | $\begin{aligned} & 400 \\ & 400 \\ & 400 \\ & 400 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 100 / 1.3 \\ & 110 / 1.1 \\ & 110 / 1.1 \\ & 110 / 1.1 \end{aligned}$ | 5 20 10 5 |
| $\begin{aligned} & \text { 1N987 } \\ & \text { 1N987A } \\ & \text { 1N987B } \\ & \text { iN988 } \end{aligned}$ | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\left\|\begin{array}{l} \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \end{array}\right\|$ |  |  | $\begin{aligned} & 400 \\ & 400 \\ & 400 \\ & 400 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 120 / 1 \\ & 120 / 1 \\ & 120 / 1 \\ & 130 / .95 \end{aligned}$ | 20 10 5 20 |
| IN988A <br> 1N988B <br> 1N989 <br> 1N989A | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\left\|\begin{array}{l} \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \end{array}\right\|$ |  |  | $\begin{aligned} & 100 \\ & 400 \\ & 400 \\ & 400 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 130 / .95 \\ & 130 / .95 \\ & 150 / .85 \\ & 150 / .85 \end{aligned}$ | 10 5 20 10 |
| 1N989B 1N990 ing90A 1N990B | $\begin{aligned} & \mathrm{s} \\ & \mathrm{~s} \\ & \mathrm{~s} \\ & \mathrm{~s} \end{aligned}$ | $\left\|\begin{array}{l} \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \end{array}\right\|$ |  |  | $\begin{aligned} & 400 \\ & 400 \\ & 400 \\ & 400 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 150 / .85 \\ & 160 / .8 \\ & 160 / 8 \\ & 160 / .8 \end{aligned}$ | 5 20 10 5 |
| 1N991 in991A 1N9918 1N992 | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\left\|\begin{array}{l} \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \end{array}\right\|$ |  |  | $\begin{aligned} & 400 \\ & 400 \\ & 400 \\ & 400 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 180 / .68 \\ & 180 / .68 \\ & 180 / .68 \\ & 200 / .65 \end{aligned}$ | 20 10 5 20 |
| in992A <br> 1 1992 g <br> 1N993 <br> 1N994 | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & c \end{aligned}\right.$ | $\left\|\begin{array}{l} \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{sD} \\ \mathrm{sD} \end{array}\right\|$ |  | $\begin{aligned} & \text { IN447 } \\ & \text { IN4151 } \end{aligned}$ | $\begin{aligned} & 400 \\ & 400 \end{aligned}$ | $\begin{array}{r} 8 \\ 6.5 \end{array}$ |  | $\begin{array}{r} 1 / 6 \\ 30 / 6 \end{array}$ | $\begin{array}{r} 1.2 / 10 \\ 1 / 10 \end{array}$ | 4 | $\begin{aligned} & 200 / .65 \\ & 200 / .65 \end{aligned}$ | 10 5 |


|  | 7 | $6$ |  |  |  |  |  |  | CHARACTE | RISTICS |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| TYPE MUMEE | $\frac{8}{6}$ |  | TI | $\begin{aligned} & \text { FOR } \\ & \text { NEW } \\ & \text { DESicN } \end{aligned}$ | $P_{D}$ <br> (mW) | $\begin{aligned} & \mathbf{V}_{\mathbf{R}} \\ & (\mathbf{V}) \end{aligned}$ | I <br> (A) | $\left.\begin{array}{lll} u_{R} & V_{R} \\ \mu & /(V) \end{array} \right\rvert\,$ | VF - F <br> (v) $/$ (mA) | $\begin{gathered} i_{r} \\ (n s) \end{gathered}$ | $\begin{array}{ll} V_{Z} & \geq \mathbf{Z} \\ \left(V_{1}\right) & / \mathrm{mA}) \end{array}$ | $\begin{gathered} \text { TOL } \\ \% \end{gathered}$ |
| 1N995 <br> 1N996 <br> 1N997 <br> 1N998 | $\left\lvert\, \begin{aligned} & G \\ & G \\ & S \\ & S \end{aligned}\right.$ | $\begin{aligned} & \text { SD } \\ & \text { SD } \\ & \text { SD } \\ & \text { SD } \end{aligned}$ |  | 1N4305 1N4607 1N4148 1N484 |  | 15 20 35 150 |  | $\begin{gathered} 10 / 6 \\ 15 / 15 \\ 30 N / 12 \\ 1 N / 125 \end{gathered}$ | $\begin{aligned} & .5 / 10 \\ & .8 / 40 \\ & 1 / 10 \\ & 1 / 200 \end{aligned}$ | $\begin{array}{r} 6 \\ 300 \\ 150 \end{array}$ |  |  |
| IN999 <br> 1N1005 <br> 1N1007 <br> IN1008 | $\left\lvert\, \begin{aligned} & \mathbf{S} \\ & \mathbf{G} \\ & \mathbf{G} \\ & \mathbf{G} \end{aligned}\right.$ | $\left.\begin{aligned} & \mathrm{SD} \\ & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \end{aligned} \right\rvert\,$ |  | 1N444 |  | 100 380 380 380 | .25 .35 .4 | 1N/75 | $\begin{aligned} & 1 / 50 \\ & .15 / \\ & .3 / \\ & .3 / \end{aligned}$ | 4 |  |  |
| IN1013 <br> IN1016 <br> iN1021 <br> iN1022 | $\left\lvert\, \begin{aligned} & \mathbf{G} \\ & \mathbf{G} \\ & \mathbf{G} \end{aligned}\right.$ | $\left.\begin{aligned} & \mathbf{R E} \\ & \mathbf{R E} \\ & \mathrm{RE} \\ & \mathrm{RE} \end{aligned} \right\rvert\,$ |  |  |  | 380 380 380 380 | $\begin{array}{r} .25 \\ .4 \\ .25 \\ .3 \end{array}$ |  | $\begin{aligned} & .15 / \\ & .15 / \\ & .15 / \\ & .15 / \end{aligned}$ |  |  |  |
| $\begin{aligned} & \text { 1N1023 } \\ & \text { iN1024 } \\ & \text { iN1028 } \\ & \text { iN1029 } \end{aligned}$ | $\begin{aligned} & \mathbf{G} \\ & \mathbf{G} \\ & \mathbf{s} \\ & \mathbf{S} \end{aligned}$ | $\left.\begin{array}{\|l\|} \mathbf{R E} \\ \mathbf{R E} \\ \mathbf{R E} \\ \mathbf{R E} \end{array} \right\rvert\,$ |  | $\begin{aligned} & \text { 1N4001 } \\ & \text { IN } 4002 \end{aligned}$ |  | $\begin{array}{r} 380 \\ 380 \\ 50 \\ 100 \end{array}$ | $\begin{array}{r} .35 \\ .4 \\ .5 \\ .5 \end{array}$ | $\begin{aligned} & 200 / 50 \\ & 200 / 100 \end{aligned}$ | $\begin{aligned} & .15 / \\ & .15 / \\ & 1.5 / 500 \\ & 1.5 / 500 \end{aligned}$ |  |  |  |
| $\begin{aligned} & \text { 1N1030 } \\ & \text { 1N1031 } \\ & \text { 1N1032 } \\ & \text { IN1033 } \end{aligned}$ | $\begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}$ | $\left.\begin{aligned} & R E \\ & R E \\ & R E \\ & R E \\ & R E \end{aligned} \right\rvert\,$ |  | $\begin{aligned} & \text { IN4003 } \\ & \text { IN } 4003 \\ & \text { IN4004 } \\ & \text { IN } 4004 \end{aligned}$ |  | $\begin{aligned} & 150 \\ & 200 \\ & 300 \\ & 400 \end{aligned}$ | $\begin{aligned} & .5 \\ & .5 \\ & .5 \\ & .5 \end{aligned}$ | $\begin{aligned} & 200 / 150 \\ & 200 / 200 \\ & 200 / 300 \\ & 200 / 400 \end{aligned}$ | $\begin{aligned} & 1.5 / 500 \\ & 1.5 / 500 \\ & 1.5 / 500 \\ & 1.5 / 500 \end{aligned}$ |  |  |  |
| IN1034 <br> 1N1035 <br> IN1036 <br> IN1037 | $\begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}$ | $\begin{aligned} & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathbf{R E} \end{aligned}$ |  |  |  | $\begin{array}{r} 50 \\ 100 \\ 150 \\ 200 \end{array}$ | $\begin{aligned} & 1 \\ & 1 \\ & 1 \\ & 1 \end{aligned}$ | $\begin{aligned} & 200 / 50 \\ & 200 / 100 \\ & 200 / 150 \\ & 200 / 200 \end{aligned}$ | $\begin{aligned} & 1.5 / 1 \\ & 1.5 / 1 \\ & 1.5 / 1 \\ & 1.5 / 1 \end{aligned}$ |  |  |  |
| 1N1038 <br> 1N1039 <br> 1N1040 <br> 1NIO41 | $\left\lvert\, \begin{aligned} & 5 \\ & 5 \\ & s \\ & 5 \end{aligned}\right.$ | $\begin{aligned} & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \end{aligned}$ |  |  |  | $\begin{array}{r} 300 \\ 400 \\ 50 \\ 100 \end{array}$ | 1 <br> 1 <br> 1 <br> 1 | $\begin{aligned} & 200 / 300 \\ & 200 / 400 \\ & 200 / 50 \\ & 200 / 100 \end{aligned}$ | $\begin{aligned} & 1.5 / 1 \\ & 1.5 / 1 \\ & 1.5 / 1 \\ & 1.5 / 1 \end{aligned}$ |  |  |  |
| 1N1042 iN1043 1N1044 IN1045 | $\begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}$ | $\begin{aligned} & \mathbf{R E} \\ & \mathbf{R E} \\ & R E \\ & R E \\ & R E \end{aligned}$ |  |  |  | $\begin{aligned} & 150 \\ & 200 \\ & 300 \\ & 400 \end{aligned}$ | 1 1 1 1 | $\begin{aligned} & 200 / 150 \\ & 200 / 200 \\ & 200 / 300 \\ & 200 / 400 \end{aligned}$ | $\begin{aligned} & 1.5 / 1 \\ & 1.5 / 1 \\ & 1.5 / 1 \\ & 1.5 / 1 \end{aligned}$ |  |  |  |
| IN1046 1N1047 1N1048 IN1049 | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\begin{aligned} & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \end{aligned}$ |  |  |  | $\begin{array}{r} 50 \\ 100 \\ 150 \\ 200 \end{array}$ | 1 1 1 1 | $\begin{aligned} & 200 / 50 \\ & 200 / 100 \\ & 200 / 150 \\ & 200 / 200 \end{aligned}$ | $\begin{aligned} & 1.5 / 1 \\ & 1.5 / 1 \\ & 1.5 / 1 \\ & 1.5 / 1 \end{aligned}$ |  |  |  |
| IN1050 1N1051 IN1052 1N1053 | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\begin{aligned} & R E \\ & R E \\ & R E \\ & R E \end{aligned}$ |  |  |  | $\begin{array}{r} 300 \\ 400 \\ 50 \\ 100 \end{array}$ | $\begin{array}{r} 1 \\ 1 \\ 1.5 \\ 1.5 \end{array}$ | $\begin{aligned} & 200 / 300 \\ & 200 / 400 \\ & 1 \mathrm{M} / 50 \\ & 1 \mathrm{M} / 100 \end{aligned}$ | $\begin{aligned} & 1.5 / 1 \\ & 1.5 / 1 \\ & 1.5 / 1.5 \\ & 1.5 / 1.5 \end{aligned}$ |  |  |  |

## DIODE INTERCHANGEABILITY



| TYPENUMBER |  |  | $\begin{gathered} \mathrm{I} \\ \text { REPLACEMENT } \end{gathered}$ | $\begin{gathered} \text { FOR } \\ \text { NRW } \\ \text { DESIGN } \end{gathered}$ | RATINGS |  |  | CHARACTERISTICS |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  | $\begin{gathered} P_{D} \\ (m w) \end{gathered}$ | $\begin{aligned} & \mathbf{v}_{\mathbf{R}} \\ & (\mathbf{v}) \end{aligned}$ | (A) | $\begin{array}{ll} I_{R} & V_{R} \\ \mu_{A} & /(V) \end{array}$ | $\mathbf{V}_{\mathrm{F}}$ - IF <br> (v) 1 (ma) | $\begin{gathered} \mathbf{t}^{\mathbf{n}} \\ \text { (ns) } \end{gathered}$ | $\begin{array}{lcc} v_{z} & \mathbf{z} \\ \text { (V) } & / \mathrm{mA}) \end{array}$ | $\begin{aligned} & \text { rot } \\ & \% \end{aligned}$ |
| 1N1088A 1N1089 <br> 1N1089A <br> 1N1090 | $\left\lvert\, \begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}\right.$ | $\begin{array}{\|l\|} \hline \mathrm{RE} \\ \mathrm{RE} \\ \mathrm{RE} \\ \mathrm{RE} \end{array}$ |  |  |  | $\begin{aligned} & 400 \\ & 100 \\ & 100 \\ & 200 \end{aligned}$ | 2 5 5 5 | $\begin{array}{r} 25 N / 400 \\ 2 M / 100 \\ \\ 2 M / 200 \end{array}$ | $\begin{aligned} & 1.5 / 5 A \\ & 1.5 / 5 A \\ & 1.5 / 5 A \end{aligned}$ |  |  |  |
| 1N1090A 1N1091 1N1091A 1N1092 | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\left.\begin{aligned} & \mathbf{R E} \\ & \mathbf{R E} \\ & \mathbf{R E} \\ & \mathbf{R E} \end{aligned} \right\rvert\,$ |  |  |  | 200 300 300 400 | 5 5 5 5 |  | $\begin{aligned} & 1.5 / 5 \mathrm{~A} \\ & 1.5 / 5 \mathrm{~A} \\ & 1.5 / 5 \mathrm{~A} \\ & 1.5 / 5 \mathrm{~A} \end{aligned}$ |  |  |  |
| $\begin{aligned} & \text { 1N1092A } \\ & \text { 1N1093 } \\ & \text { 1N1095 } \\ & \text { IN1096 } \end{aligned}$ | $\left\lvert\, \begin{aligned} & \mathbf{s} \\ & \mathbf{G} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}\right.$ | $\left.\begin{aligned} & \mathrm{RE} \\ & \mathrm{SD} \\ & \mathrm{RE} \\ & \mathrm{RE} \end{aligned} \right\rvert\,$ |  |  |  | $\begin{array}{r\|} 400 \\ 15 \\ 500 \\ 600 \end{array}$ | $\begin{array}{r} 5 \\ .75 \\ .75 \end{array}$ |  | $\begin{gathered} 1.5 / 5 \mathrm{~A} \\ .4 / 5 \\ .5 / 250 \\ .5 / 250 \end{gathered}$ | 500 |  |  |
| 1N1100 1N1 101 INIIO2 1N1103 | $\left[\begin{array}{l} s \\ s \\ s \\ s \end{array}\right.$ | $\left.\begin{aligned} & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \end{aligned} \right\rvert\,$ |  |  |  | 100 200 300 400 | $\begin{aligned} & .77 \\ & .77 \\ & .77 \\ & .77 \end{aligned}$ |  | $\begin{aligned} & 1.5 / 12 \mathrm{~A} \\ & 1.5 / 12 \mathrm{~A} \\ & 1.5 / 12 \mathrm{~A} \\ & 1.5 / 12 \mathrm{~A} \end{aligned}$ |  |  |  |
| $\left\lvert\, \begin{aligned} & \text { IN1 104 } \\ & \text { INI } 105 \\ & \text { IN1 } 108 \\ & \text { INI } 109 \end{aligned}\right.$ | $\begin{aligned} & s \\ & s \\ & s \\ & s \\ & s \end{aligned}$ | $\begin{array}{\|c\|} \hline \mathbf{R E} \\ \mathrm{RE} \\ \mathrm{RE} \\ \mathrm{RE} \end{array}$ |  |  |  | $\begin{array}{r} 500 \\ 600 \\ 800 \\ 1.2 K \end{array}$ | $\begin{aligned} & .77 \\ & .75 \\ & .45 \\ & .43 \end{aligned}$ | $\begin{aligned} & 2 M / 800 \\ & 2 M / 1.2 K \end{aligned}$ | $\begin{aligned} & 1.5 / 12 \mathrm{~A} \\ & 1.5 / 12 \mathrm{~A} \end{aligned}$ |  |  |  |
| $\left\lvert\, \begin{aligned} & \text { IN } 11110 \\ & \text { IN } 11111 \\ & 1 N 1112 \\ & 1 N 1113 \end{aligned}\right.$ | $\left[\begin{array}{l} \mathrm{s} \\ \mathrm{~s} \\ \mathrm{~s} \\ \mathrm{~s} \end{array}\right.$ | $\left\|\begin{array}{l} R E \\ R E \\ R E \\ R E \\ R E \end{array}\right\|$ |  |  |  | $\begin{gathered} 1.6 K \\ 20 K \\ 24 K \\ 28 K \end{gathered}$ | $\begin{array}{r} .4 \\ .48 \\ .35 \\ .33 \end{array}$ | 2M/1.6K <br> 2M/20K <br> 2M/24K <br> 2M/28K |  |  |  |  |
| $\begin{aligned} & \text { IN1115 } \\ & \text { 1N1116 } \\ & \text { IN1117 } \\ & \text { IN1118 } \end{aligned}$ | $\left\lvert\, \begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}\right.$ | $\left.\begin{aligned} & \mathbf{R E} \\ & \mathbf{R E} \\ & \mathbf{R E} \\ & \mathbf{R E} \end{aligned} \right\rvert\,$ |  |  |  | $\begin{aligned} & 100 \\ & 200 \\ & 300 \\ & 400 \end{aligned}$ | $\begin{aligned} & 1.5 \\ & 1.5 \\ & 1.5 \\ & 1.5 \end{aligned}$ |  | .65/ <br> .65/ <br> .65/ <br> .65/ |  |  |  |
| $\begin{aligned} & \text { IN1 } 119 \\ & \text { IN1 } 120 \\ & \text { 1N1124 } \\ & \text { IN1124A } \end{aligned}$ | $\begin{aligned} & s \\ & s \\ & s \\ & s \\ & s \end{aligned}$ | $\begin{aligned} & \mathbf{R E} \\ & \mathbf{R E} \\ & \mathbf{R E} \\ & \mathbf{R E} \\ & \mathbf{R E} \end{aligned}$ |  |  |  | $\begin{aligned} & 500 \\ & 600 \\ & 200 \\ & 250 \end{aligned}$ | 1.5 1.5 3 3.3 | 10/250 | .65/ <br> .65/ <br> 1.1/1A <br> 1/1A |  |  |  |
| $\begin{aligned} & \text { 1N1125 } \\ & \text { 1N1125A } \\ & \text { 1N1126 } \\ & 1 \text { N1126A } \end{aligned}$ | $\begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}$ | $\begin{aligned} & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \end{aligned}$ |  |  |  | $\begin{aligned} & 300 \\ & 300 \\ & 400 \\ & 400 \end{aligned}$ | 3 3.3 1 3.3 | $\begin{aligned} & 10 / 300 \\ & 10 / 400 \end{aligned}$ | $\begin{aligned} & 1.1 / 1 A \\ & 1.1 / 1 A \\ & 1.1 / 1 A \\ & 1.1 / 1 A \end{aligned}$ |  |  |  |
|  | $\left\lvert\, \begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}\right.$ | $\begin{aligned} & \mathbf{R E} \\ & \mathbf{R E} \\ & \mathbf{R E} \\ & \mathbf{R E} \\ & \mathbf{R E} \end{aligned}$ |  |  |  | $\begin{aligned} & 500 \\ & 500 \\ & 600 \\ & 600 \end{aligned}$ | 1 3.3 1 3.3 | $\begin{aligned} & 10 / 500 \\ & 10 / 600 \end{aligned}$ | 1.1/1A <br> 1.1/1A <br> 1.1/1A <br> $1.1 / 1 \mathrm{~A}$ |  |  |  |

## DIODE INTERCHANGEABILITY

| TYPE NUMPER |  |  | TI | $\begin{aligned} & \text { FOR } \\ & \text { NEW } \\ & \text { DESICN } \end{aligned}$ | PD (mW) | atines <br> $\mathbf{V}_{\mathbf{R}}$ <br> (V) | 1 <br> (A) | $\begin{array}{ll} \mathbf{I}_{\mathbf{R}} & \mathbf{V}_{\mathbf{R}} \\ \mu_{\mathrm{A}} & /(\mathbf{V}) \end{array}$ | $\begin{array}{cc}  & \text { CHARACT } \\ \mathbf{V}_{F} & \mathbf{q} \\ \text { (V) } & / \text { (mA) } \end{array}$ | IISTIC <br> $I_{17}$ <br> (ns) | $\mathbf{v}_{\mathbf{z}} \cdot \mathbf{l}_{\mathbf{z}}$ <br> (V) $/$ (ma) | 101 <br> * |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| $\begin{aligned} & \text { 1N1130 } \\ & \text { 1N1131 } \\ & 1 N 1133 \\ & 1 N 1134 \end{aligned}$ | $\begin{aligned} & 5 \\ & 5 \\ & 5 \\ & 5 \end{aligned}$ | $\left.\begin{aligned} & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \end{aligned} \right\rvert\,$ |  |  |  | 1.5 K 1.5 K 1.5 K 1.5 K | .3 .3 .075 .1 | $\begin{aligned} & 50 / \\ & 50 / \end{aligned}$ | $\begin{aligned} & 15 / \\ & 15 / \\ & 15 / 85 \\ & 7.5 / 115 \end{aligned}$ |  |  |  |
| 1N1135 <br> IN1136 <br> 1N1137 <br> IN1 138 | $\left\{\begin{array}{l} s \\ s \\ s \\ s \end{array}\right.$ | $\left.\begin{aligned} & R E \\ & R E \\ & R E \\ & R E \end{aligned} \right\rvert\,$ |  |  |  | 1.8 K 1.8 K 2.4 K 2.4 K | .065 .065 .057 .06 |  | $\begin{array}{r} 18 / 75 \\ 9 / 95 \\ 24 / 57 \\ 12 / 70 \end{array}$ |  |  |  |
| IN1139 <br> 1N1 140 <br> IN1 141 <br> 1N1 142 | $\left\lvert\, \begin{aligned} & \mathbf{s} \\ & \mathbf{S} \\ & \mathbf{S} \\ & \mathbf{s} \end{aligned}\right.$ | $\begin{aligned} & R E \\ & R E \\ & R E \\ & R E \\ & R E \end{aligned}$ |  |  |  | $\begin{aligned} & 3.6 \mathrm{~K} \\ & 3.6 \mathrm{~K} \\ & 4.8 \mathrm{~K} \\ & 4.8 \mathrm{~K} \end{aligned}$ | $\begin{array}{r} .055 \\ .055 \\ .05 \\ .05 \end{array}$ |  | $\begin{aligned} & 27 / 75 \\ & 18 / 75 \\ & 36 / 70 \\ & 24 / 57 \end{aligned}$ |  |  |  |
| 1N1143 <br> 1NIIA3A <br> 1NI144 <br> 1N1145 | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\begin{aligned} & \text { RE } \\ & \text { RE } \\ & \text { RE } \\ & \text { RE } \end{aligned}$ |  |  |  | $6 K$ $6 K$ 7.2 K 7.2 K | .05 .055 .05 .06 |  | $\begin{aligned} & 45 / 57 \\ & 30 / 75 \\ & 54 / 57 \\ & 36 / 70 \end{aligned}$ |  |  |  |
| 1N1146 <br> 1N1147 <br> 1N1148 <br> IN1 149 | $\begin{aligned} & 5 \\ & s \\ & s \\ & s \end{aligned}$ | $\begin{aligned} & R E \\ & R E \\ & R E \\ & R E \end{aligned}$ |  |  |  | $8 K$ $12 K$ $14 K$ $16 K$ | $\begin{array}{r} .045 \\ .045 \\ .05 \\ .045 \end{array}$ |  | $\begin{aligned} & 60 / 50 \\ & 60 / 50 \\ & 52 / 57 \\ & 60 / 50 \end{aligned}$ |  |  |  |
| 1N1 150 <br> INII50A <br> 1N1169 <br> IN1169A | $\begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}$ | $\begin{aligned} & R E \\ & R E \\ & R E \\ & R E \\ & R E \end{aligned}$ |  |  |  | $\begin{aligned} & 1.6 \mathrm{~K} \\ & 1.6 \mathrm{~K} \\ & 400 \\ & 400 \end{aligned}$ | $\begin{array}{r} .75 \\ .75 \\ .79 \\ .5 \end{array}$ | $\begin{gathered} 200 / 1.6 \mathrm{~K} \\ 2 \mathrm{M} / 1.6 \mathrm{~K} \\ \\ 100 / 400 \end{gathered}$ | $\begin{array}{r} .9 / 500 \\ 1.2 / 800 \end{array}$ |  |  |  |
| 1N1170 <br> INII83 <br> 1N1183A <br> 1N1184 | $\begin{aligned} & \mathbf{G} \\ & \mathbf{S} \\ & \mathbf{S} \\ & \mathbf{S} \end{aligned}$ | $\begin{aligned} & \mathrm{SD} \\ & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \end{aligned}$ |  | 1N4148 |  | 50 50 50 100 | 35 40 35 | 5/50 | $\begin{aligned} & 1 / 4 \\ & 1.7 / 35 \mathrm{~A} \\ & 1.1 / \\ & 1.7 / 35 \mathrm{~A} \end{aligned}$ |  |  |  |
| 1N1184A <br> 1Ni185 <br> 1N1185A <br> 1N1186 | $\begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}$ | $\begin{aligned} & R E \\ & R E \\ & R E \\ & R E \\ & R E \end{aligned}$ |  |  |  | $\begin{aligned} & 100 \\ & 150 \\ & 150 \\ & 200 \end{aligned}$ | $\begin{aligned} & 40 \\ & 35 \\ & 40 \\ & 35 \end{aligned}$ |  | $\begin{aligned} & 1.1 / \\ & 1.7 / 35 \mathrm{~A} \\ & 1.1 / \\ & 1.7 / 35 \mathrm{~A} \end{aligned}$ |  |  |  |
| IN1186A <br> 1N1187 <br> 1N1187A <br> 1N1188 | $\begin{aligned} & \mathbf{s} \\ & s \\ & s \\ & s \end{aligned}$ | $\begin{aligned} & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \end{aligned}$ |  |  |  | $\begin{aligned} & 200 \\ & 300 \\ & 300 \\ & 400 \end{aligned}$ | $\begin{aligned} & 40 \\ & 35 \\ & 40 \\ & \mathbf{3 5} \end{aligned}$ | 15/300 | $\begin{aligned} & 1.1 / \\ & 1.7 / 35 \mathrm{~A} \\ & 1.7 / 35 \mathrm{~A} \end{aligned}$ |  |  |  |
| 1NT188A <br> IN1189 <br> IN1189A <br> 1N1190 | $\begin{aligned} & \mathbf{s} \\ & s \\ & s \\ & s \end{aligned}$ | $\begin{aligned} & R E \\ & R E \\ & R E \\ & R E \\ & R E \end{aligned}$ |  |  |  | $\begin{aligned} & 400 \\ & 500 \\ & 500 \\ & 600 \end{aligned}$ | $\begin{aligned} & 40 \\ & 35 \\ & 40 \\ & 35 \end{aligned}$ | $\begin{aligned} & 15 / 400 \\ & 15 / 500 \end{aligned}$ | $\begin{aligned} & 1.7 / 35 A \\ & 1.7 / 35 A \end{aligned}$ |  |  |  |

## DIODE INTERCHANGEABILITY

| MYME | $\begin{aligned} & \frac{1}{2} \\ & \frac{6}{2} \\ & \frac{5}{3} \end{aligned}$ |  | $\frac{\text { In }}{\text { RERACEMT }}$ | $\begin{gathered} \text { FOR } \\ \text { New } \\ \text { DESion } \end{gathered}$ | Ratinges |  |  | CHARACTERISTICS |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  | $\begin{gathered} P_{D} \\ (\mathrm{~mW}) \end{gathered}$ | $V_{R}$ (V) | (A) | $\begin{array}{ll} \mathbf{R}_{\mathbf{R}} & \bullet V_{\mathbf{R}} \\ \mu \boldsymbol{A} & /(\mathrm{V}) \end{array}$ | $\begin{array}{cc} v_{F} & i_{F} \\ (\mathrm{~V}) & 1(\mathrm{ma}) \end{array}$ | $t_{17}$ <br> (m) | $\begin{array}{ccc} \mathbf{v}_{\mathbf{z}} & \mathbf{z} \\ (\mathrm{v}) & /(\mathrm{mA}) \end{array}$ | $\left.\right\|_{x} ^{\text {TOL }}$ |
|  | S | $\begin{aligned} & R E \\ & R E \\ & R E \\ & R E \\ & R E \end{aligned}$ |  |  |  | $\begin{array}{r} 600 \\ 50 \\ 50 \\ 100 \end{array}$ | $\begin{aligned} & 40 \\ & 18 \\ & 22 \\ & 25 \end{aligned}$ | 15/600 <br> 10/100 | $\begin{aligned} & 1.4 / 30 \mathrm{~A} \\ & 1.2 / 60 \mathrm{~A} \\ & 1.4 / 30 \mathrm{~A} \end{aligned}$ |  |  |  |
|  | $\left\lvert\, \begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}\right.$ | $\left.\begin{aligned} & R E \\ & R E \\ & R E \\ & R E \end{aligned} \right\rvert\,$ |  |  |  | $\begin{aligned} & 100 \\ & 150 \\ & 150 \\ & 100 \end{aligned}$ | $\begin{aligned} & 22 \\ & 25 \\ & 22 \\ & 25 \end{aligned}$ | $\begin{aligned} & 10 / 150 \\ & 10 / 200 \end{aligned}$ | $\begin{aligned} & 1.2 / 60 \mathrm{~A} \\ & 1.4 / 30 \mathrm{~A} \\ & 1.2 / 60 \mathrm{~A} \\ & 1.4 / 30 \mathrm{~A} \end{aligned}$ |  |  |  |
|  | $\begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}$ | $\left.\begin{aligned} & \mathbf{R E} \\ & \mathbf{R E} \\ & \mathbf{R E} \\ & \mathbf{R E} \end{aligned} \right\rvert\,$ |  |  |  | $\begin{aligned} & 200 \\ & 300 \\ & 300 \\ & 400 \end{aligned}$ | $\begin{aligned} & \mathbf{2 2} \\ & \mathbf{2 5} \\ & \mathbf{2 0} \\ & \mathbf{2 5} \end{aligned}$ | $\begin{aligned} & 10 / 300 \\ & 10 / 400 \end{aligned}$ | $\begin{gathered} 1.2 / 60 \mathrm{~A} \\ 1.4 / 30 \mathrm{~A} \\ .6 / 20 \mathrm{~A} \\ 1.4 / 30 \mathrm{~A} \end{gathered}$ |  |  |  |
| $\begin{aligned} & \text { IN1196A } \\ & \text { iN1197 } \\ & \text { IN197A } \\ & \text { iN1198 } \\ & \hline \end{aligned}$ | $\left\lvert\, \begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}\right.$ | $\left.\begin{array}{\|l\|} \mathbf{R E} \\ \mathrm{RE} \\ \mathrm{RE} \\ \mathrm{RE} \\ \mathbf{R E} \end{array} \right\rvert\,$ |  |  |  | $\begin{aligned} & 400 \\ & 500 \\ & 500 \\ & 600 \end{aligned}$ | $\begin{aligned} & 20 \\ & 25 \\ & 20 \\ & 25 \end{aligned}$ | $\begin{aligned} & 10 / 500 \\ & 10 / 600 \end{aligned}$ | $\begin{gathered} .6 / 20 \mathrm{~A} \\ 1.4 / 30 \mathrm{~A} \\ .6 / 20 \mathrm{~A} \\ 1.4 / 30 \mathrm{~A} \end{gathered}$ |  |  |  |
| $\begin{aligned} & \text { IN1198A } \\ & \text { iN1199 } \\ & \text { iN1199A } \\ & \text { iN11998 } \end{aligned}$ | $\begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}$ | $\begin{array}{\|c\|} \hline \mathrm{RE} \\ \mathrm{RE} \\ \mathrm{RE} \\ \mathrm{RE} \\ \hline \end{array}$ |  |  |  | $\begin{array}{r} 600 \\ 50 \\ 50 \\ 50 \end{array}$ | $\begin{aligned} & 20 \\ & 12 \\ & 12 \\ & 12 \end{aligned}$ | 10/50 | $\begin{aligned} & .6 / 20 A \\ & 1.4 / 20 A \\ & 1.3 / 12 A \\ & 1.1 / 12 A \end{aligned}$ |  |  |  |
| $\begin{aligned} & \text { 1N1200 } \\ & \text { 1N1200A } \\ & 1 \text { N1200 } \\ & 1 \text { N1 } 201 \end{aligned}$ | $\begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}$ | $\left\|\begin{array}{l} R E \\ R E \\ R E \\ R E \\ R E \end{array}\right\|$ |  |  |  | $\begin{aligned} & 100 \\ & 100 \\ & 100 \\ & 150 \end{aligned}$ | $\begin{aligned} & 12 \\ & 12 \\ & 12 \\ & 12 \end{aligned}$ | $\begin{aligned} & 10 / 100 \\ & 10 / 150 \end{aligned}$ | $\begin{aligned} & 1.4 / 20 A \\ & 1.3 / 12 A \\ & 1.1 / 12 A \\ & 1.4 / 20 A \end{aligned}$ |  |  |  |
| $\begin{aligned} & \text { IN1201A } \\ & \text { IN12018 } \\ & \text { IN1202 } \\ & \text { IN1202A } \end{aligned}$ | S | $\left.\begin{array}{\|l\|} \mathbf{R E} \\ \mathbf{R E} \\ \mathbf{R E} \\ \mathbf{R E} \end{array} \right\rvert\,$ |  |  |  | $\begin{aligned} & 150 \\ & 150 \\ & 200 \\ & 200 \end{aligned}$ | $\begin{aligned} & 12 \\ & 12 \\ & 12 \\ & 12 \end{aligned}$ | 10/200 | 1.3/12A <br> 1.1/12A <br> 1.4/20A <br> 1.3/12A |  |  |  |
| $\begin{aligned} & \text { IN1202B } \\ & \text { IN1203 } \\ & \text { IN1203A } \\ & \text { IN1203B } \end{aligned}$ | [ | $\left.\begin{aligned} & R E \\ & R E \\ & R E \\ & R E \\ & R E \\ & R E \end{aligned} \right\rvert\,$ |  |  |  | $\begin{aligned} & 200 \\ & 300 \\ & 300 \\ & 300 \end{aligned}$ | 12 12 12 12 | 10/300 | 1.1/12A <br> 1.4/20A <br> 1.3/12A <br> 1.1/12A |  |  |  |
| iN1204 iN1204A IN1204B IN120S | ( $\begin{aligned} & \text { s } \\ & \text { s } \\ & \text { s } \\ & \text { s }\end{aligned}$ | $\begin{array}{\|l\|l} \mathbf{R E} \\ \mathbf{R E} \\ \mathbf{R E} \\ \mathbf{R E} \\ \hline \end{array}$ |  |  |  | $\begin{aligned} & 400 \\ & 400 \\ & 400 \\ & 500 \end{aligned}$ | 12 12 12 12 | $\begin{aligned} & 10 / 400 \\ & 10 / 500 \end{aligned}$ | $\begin{aligned} & 1.4 / 20 \mathrm{~A} \\ & 1.3 / 12 \mathrm{~A} \\ & 1.1 / 12 \mathrm{~A} \\ & 1.4 / 20 \mathrm{~A} \end{aligned}$ |  |  |  |
|  | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\begin{aligned} & R E \\ & R E \\ & R E \\ & R E \\ & R E \end{aligned}$ |  |  |  | $\begin{aligned} & 500 \\ & 500 \\ & 600 \\ & 600 \end{aligned}$ | 12 12 12 12 | 10/600 | 1.3/12A <br> 1.1/12A <br> 1.4/20A <br> 1.3/12A |  |  |  |

## DIODE INTERCHANGEABILITY

| TYPE NUMBER | 畐畐4 |  | II REPLACEMENT |  | ratings |  |  | CHARACTERISTICS |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  | $\begin{gathered} \mathrm{PD}_{\mathrm{D}} \\ (\mathrm{~mW}) \end{gathered}$ | $\mathbf{V}_{\mathbf{R}}$ <br> (V) | I <br> (A) |  |  |  |  |  |
| $\begin{aligned} & \text { IN1206B } \\ & \text { IN1217 } \\ & \text { IN1217A } \\ & \text { IN1217B } \end{aligned}$ | $\begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}$ | $\begin{aligned} & R E \\ & R E \\ & R E \\ & R E \end{aligned}$ |  |  |  | 600 50 50 50 | 12 1.6 1.6 1.6 | $\begin{array}{r} 500 / 50 \\ 50 / 50 \\ 300 / 50 \end{array}$ | $\begin{aligned} & 1.1 / 12 \mathrm{~A} \\ & 1.5 / \\ & 1.5 / \\ & 1.7 / \end{aligned}$ |  |  |  |
| $\begin{array}{\|l} \text { IN1218 } \\ 1 \mathrm{~N} 1218 \mathrm{~A} \\ 1 \mathrm{~N} 1218 \mathrm{~B} \\ 1 \mathrm{~N} 1219 \end{array}$ | $\begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}$ | $\begin{aligned} & R E \\ & R E \\ & R E \\ & R E \end{aligned}$ |  |  |  | $\begin{aligned} & 100 \\ & 100 \\ & 100 \\ & 150 \end{aligned}$ | $\begin{aligned} & 1.6 \\ & 1.6 \\ & 1.6 \\ & 1.6 \end{aligned}$ | $\begin{array}{r} 500 / 100 \\ 50 / 100 \\ 300 / 100 \\ 500 / 150 \end{array}$ | $\begin{aligned} & 1.5 / \\ & 1.5 / \\ & 1.7 / \\ & 1.5 / \end{aligned}$ |  |  |  |
| 1N1219A 1N1219B 1N1220 1N1220A | $\begin{aligned} & 5 \\ & 5 \\ & 5 \\ & 5 \end{aligned}$ | $\begin{aligned} & R E \\ & R E \\ & R E \\ & R E \end{aligned}$ |  |  |  | $\begin{aligned} & 150 \\ & 150 \\ & 200 \\ & 200 \end{aligned}$ | $\begin{aligned} & 1.6 \\ & 1.6 \\ & 1.6 \\ & 1.6 \end{aligned}$ | $\begin{array}{r} 50 / 150 \\ 300 / 150 \\ 500 / 200 \\ 50 / 200 \end{array}$ | $\begin{aligned} & 1.5 / \\ & 1.7 / \\ & 1.5 / \\ & 1.5 / \end{aligned}$ |  |  |  |
| $\begin{aligned} & \text { IN1220B } \\ & \text { IN1221 } \\ & \text { 1N122IA } \\ & \text { IN1221B } \end{aligned}$ | $\begin{aligned} & 5 \\ & 5 \\ & 5 \\ & 5 \end{aligned}$ | $\begin{aligned} & R E \\ & R E \\ & R E \\ & R E \\ & R E \end{aligned}$ |  |  |  | $\begin{aligned} & 200 \\ & 300 \\ & 300 \\ & 300 \end{aligned}$ | $\begin{aligned} & 1.6 \\ & 1.6 \\ & 1.6 \\ & 1.6 \end{aligned}$ | $\begin{array}{r} 300 / 200 \\ 500 / 300 \\ 50 / 300 \\ 300 / 300 \end{array}$ | $\begin{aligned} & 1.7 / \\ & 1.5 / \\ & 1.5 / \\ & 1.7 / \end{aligned}$ |  |  |  |
| $\begin{aligned} & \text { 1N1222 } \\ & \text { 1N1222A } \\ & \text { IN1222B } \\ & \text { IN1223 } \end{aligned}$ | $\begin{aligned} & 5 \\ & s \\ & s \\ & 5 \end{aligned}$ | $\begin{aligned} & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \end{aligned}$ |  |  |  | $\begin{array}{r} 400 \\ 400 \\ 400 \\ 500 \end{array}$ | $\begin{aligned} & 1.6 \\ & 1.6 \\ & 1.6 \\ & 1.6 \end{aligned}$ | $\begin{array}{r} 500 / 400 \\ 50 / 400 \\ 300 / 400 \\ 500 / 500 \end{array}$ | $\begin{aligned} & 1.5 / \\ & 1.5 / \\ & 1.7 / \\ & 1.5 / \end{aligned}$ |  |  |  |
| IN1223A <br> IN1223B <br> INI 224 <br> 1N1224A | $\begin{aligned} & s \\ & s \\ & s \\ & s \\ & s \end{aligned}$ | $\begin{aligned} & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \end{aligned}$ |  |  |  | $\begin{aligned} & 500 \\ & 500 \\ & 600 \\ & 600 \end{aligned}$ | $\begin{aligned} & 1.6 \\ & 1.6 \\ & 1.6 \\ & 1.6 \end{aligned}$ | $\begin{array}{r} 50 / 500 \\ 300 / 500 \\ 500 / 600 \\ 50 / 600 \end{array}$ | $\begin{aligned} & 1.5 / \\ & 1.7 / \\ & 1.5 / \\ & 1.5 / \end{aligned}$ |  |  |  |
| $\begin{aligned} & \text { IN1224B } \\ & \text { IN1225 } \\ & \text { 1N1225A } \\ & \text { 1N1225B } \end{aligned}$ | $\begin{aligned} & \mathbf{S} \\ & \mathbf{S} \\ & \mathbf{S} \\ & \mathbf{S} \end{aligned}$ | $\begin{aligned} & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \end{aligned}$ |  |  |  | $\begin{aligned} & 600 \\ & 700 \\ & 700 \\ & 700 \end{aligned}$ | $\begin{aligned} & 1.6 \\ & 1.6 \\ & 1.6 \\ & 1.6 \end{aligned}$ | $\begin{array}{r} 300 / 600 \\ 500 / 700 \\ 50 / 700 \\ 300 / 700 \end{array}$ | $\begin{aligned} & 1.7 / \\ & 1.5 / \\ & 1.5 / 1 \mathrm{~A} \\ & 1.6 / \end{aligned}$ |  |  |  |
| 1N1226 <br> 1N1226A <br> 1N1226B <br> 1N1227 | $\begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}$ | $\begin{aligned} & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \end{aligned}$ |  |  |  | $\begin{array}{r} 800 \\ 800 \\ 800 \\ 50 \end{array}$ | $\begin{aligned} & 1.6 \\ & 1.6 \\ & 1.6 \\ & 1.6 \end{aligned}$ | $\begin{gathered} 500 / 800 \\ 50 / 800 \\ 300 / 800 \\ 500 / 50 \end{gathered}$ | $\begin{aligned} & 1.5 / \\ & 1.5 / 1 \mathrm{~A} \\ & 1.5 / \\ & 1.5 / \end{aligned}$ |  |  |  |
| $\begin{aligned} & \text { IN1227A } \\ & \text { IN12278 } \\ & \text { IN1228 } \\ & \text { IN1228A } \end{aligned}$ | $\begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}$ | $\begin{aligned} & R E \\ & R E \\ & R E \\ & R E \end{aligned}$ |  |  |  | $\begin{array}{r} 50 \\ 50 \\ 100 \\ 100 \end{array}$ | $\begin{aligned} & 1.6 \\ & 1.6 \\ & 1.6 \\ & 1.6 \end{aligned}$ | $\begin{array}{r} 50 / 50 \\ 10 / 50 \\ 500 / 100 \\ 50 / 100 \end{array}$ | $\begin{aligned} & 1.5 / \\ & 1.2 / 1 \mathrm{~A} \\ & 1.5 / \\ & 1.5 / \end{aligned}$ |  |  |  |
| 1N1228B <br> 1N1229 <br> 1N1229A <br> IN1229B | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\begin{aligned} & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \end{aligned}$ |  |  |  | $\begin{aligned} & 100 \\ & 150 \\ & 150 \\ & 150 \end{aligned}$ | $\begin{aligned} & 1.6 \\ & 1.6 \\ & 1.6 \\ & 1.6 \end{aligned}$ | $\begin{array}{r} 10 / 100 \\ 500 / 150 \\ 50 / 150 \\ 10 / 150 \end{array}$ | $\begin{aligned} & 1.2 / 1 \mathrm{~A} \\ & 1.5 / \\ & 1.5 / \\ & 1.2 / 1 \mathrm{~A} \end{aligned}$ |  |  |  |

## DIODE INTERCHANGEABILITY

| Trpe number |  | $\left\|\begin{array}{c} \frac{3}{0} \\ \frac{1}{6} \\ 0 \\ 0_{0}^{2} \\ 3 \end{array}\right\|$ | $\begin{gathered} \pi \\ \text { RERLACEMENT } \end{gathered}$ | $\begin{aligned} & \text { FOR } \\ & \text { NEW } \\ & \text { DESIGN } \end{aligned}$ | $\begin{gathered} \mathrm{PD}_{\mathrm{D}} \\ (\mathrm{~mW}) \end{gathered}$ | $\begin{aligned} & \text { nines } \\ & \mathbf{v}_{\mathbf{R}} \\ & \text { (V) } \end{aligned}$ | (A) | $\begin{array}{ll} L_{R} & \bullet V_{R} \\ \mu A & /(V) \end{array}$ | $$ | RISTIC <br> $i_{r}$ <br> ( ns ) | $\begin{array}{ccc} v_{z} & 0 & \mathbf{z} \\ (\mathrm{v}) & 1 & (\mathrm{~mA}) \end{array}$ | ${ }_{x}^{101}$ |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\begin{array}{\|c\|} \hline \mathbf{R E} \\ \mathrm{RE} \\ \mathrm{RE} \\ \mathbf{R E} \\ \hline \mathbf{R E} \end{array}$ |  |  |  | $\begin{aligned} & 200 \\ & 200 \\ & 200 \\ & 300 \end{aligned}$ | $\begin{aligned} & 1.6 \\ & 1.6 \\ & 1.6 \\ & 1.6 \end{aligned}$ | $\begin{array}{r} 500 / 200 \\ 50 / 200 \\ 10 / 200 \\ 500 / 300 \end{array}$ | $\begin{aligned} & 1.5 / \\ & 1.5 / \\ & 1.2 / 1 \mathrm{~A} \\ & 1.5 / \end{aligned}$ |  |  |  |
| $\left\lvert\, \begin{aligned} & \text { IN1231A } \\ & \text { 1N1231B } \\ & \text { 1N1232 } \\ & \text { IN1232A } \end{aligned}\right.$ | $\begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}$ | $\begin{aligned} & \mathbf{R E} \\ & \mathbf{R E} \\ & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathbf{R E} \end{aligned}$ |  |  |  | $\begin{aligned} & 300 \\ & 300 \\ & 400 \\ & 400 \end{aligned}$ | $\begin{aligned} & 1.6 \\ & 1.6 \\ & 1.6 \\ & 1.6 \end{aligned}$ | $\begin{array}{r} 50 / 300 \\ 10 / 300 \\ 500 / 400 \\ 50 / 400 \end{array}$ | $\begin{aligned} & 1.5 / \\ & 1.2 / 1 \mathrm{~A} \\ & 1.5 / \\ & 1.5 / \end{aligned}$ |  |  |  |
| 1N1232B iN1233 1N1233A iN1233 | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\left.\begin{aligned} & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \end{aligned} \right\rvert\,$ |  |  |  | $\begin{aligned} & 400 \\ & 500 \\ & 500 \\ & 500 \end{aligned}$ | $\begin{aligned} & 1.6 \\ & 1.6 \\ & 1.6 \\ & 1.6 \end{aligned}$ | $\begin{array}{r} 10 / 400 \\ 500 / 500 \\ 50 / 500 \\ 10 / 500 \end{array}$ | $\begin{aligned} & 1.2 / 1 \mathrm{~A} \\ & 1.5 / \\ & 1.5 / \\ & 1.2 / 1 \mathrm{~A} \end{aligned}$ |  |  |  |
|  | $\left\lvert\, \begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}\right.$ | RE <br> RE <br> RE <br> RE <br> RE |  |  |  | $\begin{aligned} & 600 \\ & 600 \\ & 600 \\ & 700 \end{aligned}$ | $\begin{aligned} & 1.6 \\ & 1.6 \\ & 1.6 \\ & 1.6 \end{aligned}$ | $\begin{array}{r} 500 / 600 \\ 50 / 600 \\ 10 / 600 \\ 500 / 700 \end{array}$ | $\begin{aligned} & 1.5 / \\ & 1.5 / \\ & 1.2 / 1 \mathrm{~A} \\ & 1.5 / \end{aligned}$ |  |  |  |
| $\begin{aligned} & \text { 1N1235A } \\ & \text { IN1235B } \\ & \text { IN1236 } \\ & \text { IN1236A } \end{aligned}$ | $\begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}$ | $\left.\begin{aligned} & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \end{aligned} \right\rvert\,$ |  |  |  | $\begin{aligned} & 700 \\ & 700 \\ & 800 \\ & 800 \end{aligned}$ | $\begin{aligned} & 1.6 \\ & 1.6 \\ & 1.6 \\ & 1.6 \end{aligned}$ | $\begin{array}{r} 50 / 700 \\ 10 / 700 \\ 500 / 800 \\ 50 / 800 \end{array}$ | $\begin{aligned} & 1.2 / 1 \mathrm{~A} \\ & 1.2 / 1 \mathrm{~A} \\ & 1.5 / \\ & 1.2 / 1 \mathrm{~A} \end{aligned}$ |  |  |  |
| IN12368 IN1237 IN1238 IN1239 | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\left\|\begin{array}{l} \mathrm{RE} \\ \mathrm{RE} \\ \mathrm{RE} \\ \mathrm{RE} \end{array}\right\|$ |  |  |  | $\begin{aligned} & 800 \\ & 1.6 \mathrm{~K} \\ & 1.6 \mathrm{~K} \\ & 2.8 \mathrm{~K} \end{aligned}$ | $\begin{gathered} 1.6 \\ .75 \\ .75 \\ .5 \end{gathered}$ | $\begin{array}{r} 10 / 800 \\ 11.6 \mathrm{~K} \\ 11.6 \mathrm{~K} \\ 12.8 \mathrm{~K} \end{array}$ | $\begin{array}{r} 1.2 / 1 \mathrm{~A} \\ 6 / 750 \\ 6 / 750 \\ 12 / 500 \end{array}$ |  |  |  |
| $\begin{aligned} & \hline 1 N 1240 \\ & 1 N 1241 \\ & 1 N 1242 \\ & 1 N 1243 \end{aligned}$ | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\left.\begin{aligned} & \mathbf{R E} \\ & \mathbf{R E} \\ & \mathbf{R E} \\ & \mathrm{RE} \end{aligned} \right\rvert\,$ |  | IN4001 1N4002 1N4003 1N4004 |  | $\begin{array}{r} 50 \\ 100 \\ 200 \\ 300 \end{array}$ | $\begin{array}{r} .25 \\ .25 \\ .25 \\ .2 \end{array}$ | 500/50 500/100 500/200 500/300 | $\begin{aligned} & 1 / 250 \\ & 1 / 250 \\ & 1 / 250 \\ & 1 / 200 \end{aligned}$ | . |  |  |
| 1N124A iN124A iN1245 iN1246 | $\left[\begin{array}{l} \mathbf{s} \\ \mathbf{s} \\ \mathbf{s} \\ \mathbf{s} \end{array}\right.$ | $\begin{array}{\|l\|} \hline \mathbf{R E} \\ \mathbf{R E} \\ \mathbf{R E} \\ \mathrm{RE} \end{array}$ |  | 1N4004 1N4004 IN4005 iN4005 |  | $\begin{aligned} & 400 \\ & 400 \\ & 500 \\ & 600 \end{aligned}$ | $\begin{array}{r} .15 \\ .2 \\ .13 \\ .115 \end{array}$ | $\begin{aligned} & 500 / 400 \\ & 500 / 400 \\ & 400 / 500 \\ & 300 / 800 \end{aligned}$ | $\begin{aligned} & 1 / 150 \\ & 1 / 200 \\ & 1 / 130 \\ & 1 / 115 \end{aligned}$ |  |  |  |
| IN1247 <br> 1N1248 <br> 1N1249 <br> IN1250 | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\begin{aligned} & \mathbf{R E} \\ & \mathbf{R E} \\ & \mathbf{R E} \\ & \mathbf{R E} \\ & \mathbf{R E} \end{aligned}$ |  | 1 N4006 <br> 1N4007 <br> IN4007 |  | $\begin{array}{r} 700 \\ 800 \\ 900 \\ 1 K \end{array}$ | $\begin{array}{r} .1 \\ .08 \\ .065 \\ .05 \end{array}$ | $\begin{aligned} & 200 / 700 \\ & 100 / 800 \\ & 100 / 900 \\ & 100 / 1 \mathrm{~K} \end{aligned}$ | $\begin{aligned} & 1 / 100 \\ & 1 / 80 \\ & 1 / 65 \\ & 1 / 50 \end{aligned}$ |  |  |  |
| 1N1251 INi252 IN1253 iN1254 | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\left\|\begin{array}{l} \mathbf{R E} \\ \mathbf{R E} \\ \mathbf{R E} \\ \mathbf{R E} \end{array}\right\|$ |  | $\left\lvert\, \begin{aligned} & \text { IN4001 } \\ & \text { INL002 } \\ & \text { iN4003 } \\ & \text { INA004 } \end{aligned}\right.$ |  | $\begin{array}{r} 50 \\ 100 \\ 200 \\ 300 \end{array}$ | .5 .5 .5 .5 | 500/50 500/100 500/200 500/300 | $\begin{aligned} & 1 / 500 \\ & 1 / 500 \\ & 1 / 500 \\ & 1 / 500 \end{aligned}$ |  |  |  |

## DIODE INTERCHANGEABILITY

| TYPE NUMBER |  |  | $\underset{\text { REPLACEMENT }}{\text { TI }}$ | $\begin{aligned} & \text { FOR } \\ & \text { NEW } \\ & \text { DESIIGN } \end{aligned}$ | PD (mW) | $\begin{gathered} \text { ATINGS } \\ \mathbf{V}_{\mathbf{R}} \\ \text { (V) } \end{gathered}$ | (A) | $\begin{array}{ll} I_{R} & V_{R} \\ \mu_{A} & (V) \end{array}$ | $\begin{array}{cc} v_{F} & l_{F} \\ (\mathrm{~V}) & 1(\mathrm{~mA}) \end{array}$ | ERISTICS <br> $t_{r}$ <br> (ns) | $\begin{array}{ccc} \mathbf{v}_{\mathbf{z}} & \mathrm{lz} \\ (\mathrm{v}) & /(\mathrm{mA}) \end{array}$ | $\left.\right\|_{x} ^{\text {rot }}$ |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| $\begin{array}{\|l} \hline \text { 1N1255 } \\ \text { 1N1255A } \\ \text { IN1256 } \\ \text { IN1257 } \end{array}$ | $\begin{aligned} & \mathrm{s} \\ & \mathrm{~s} \\ & \mathrm{~s} \\ & \mathrm{~s} \\ & \mathrm{~s} \end{aligned}$ | $\left.\begin{array}{\|l\|} \mathbf{R E} \\ \mathbf{R E} \\ \mathbf{R E} \\ \mathbf{R E} \end{array} \right\rvert\,$ |  | 1N4004 1N4004 1N4005 IN4005 |  | $\begin{aligned} & 400 \\ & 400 \\ & 500 \\ & 600 \end{aligned}$ | $\begin{array}{r} .5 \\ .5 \\ .32 \\ .3 \end{array}$ | $\begin{aligned} & 500 / 400 \\ & 500 / 400 \\ & 400 / 500 \\ & 300 / 600 \end{aligned}$ | $\begin{aligned} & 1 / 500 \\ & 1 / 500 \\ & 1 / 320 \\ & 1 / 300 \end{aligned}$ |  |  |  |
| $\left\{\begin{array}{l} \text { 1N1258 } \\ \text { 1N1259 } \\ \text { IN1260 } \\ \text { IN1261 } \end{array}\right.$ | $\begin{aligned} & \mathrm{s} \\ & \mathrm{~s} \\ & \mathrm{~s} \\ & \mathrm{~s} \end{aligned}$ | $\begin{aligned} & R E \\ & R E \\ & R E \\ & R E \\ & R E \end{aligned}$ |  | $\begin{array}{\|l} \text { in } 4006 \\ \text { in } 4006 \\ \text { in } 4007 \\ \text { in } 4007 \end{array}$ |  | $\begin{array}{r\|} 700 \\ 800 \\ 900 \\ 1 K \end{array}$ | $\begin{aligned} & .28 \\ & .27 \\ & .25 \\ & .24 \end{aligned}$ | $\begin{aligned} & 200 / 700 \\ & 100 / 800 \\ & 100 / 900 \\ & 100 / 1 \mathrm{~K} \end{aligned}$ | $\begin{aligned} & 1 / 280 \\ & 1 / 270 \\ & 1 / 250 \\ & 1 / 240 \end{aligned}$ |  |  |  |
| 1N1262 <br> 1N1313 <br> 1N1313A <br> 1N1314 | $\begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}$ | ( RE |  | $\begin{aligned} & \text { 1N959A } \\ & \text { 1N9598 } \\ & \text { 1N961A } \end{aligned}$ | $\begin{aligned} & 150 \\ & 150 \\ & 150 \end{aligned}$ | 4.5K | . 25 | 2M/4.5K | 12/250 |  | $\begin{aligned} & 8.75 / .2 \\ & 8.75 / .2 \\ & 10.5 / .2 \end{aligned}$ | 10 5 10 |
| 1N1314A <br> 1N1315 <br> IN1315A <br> 1N1316 | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\left\|\begin{array}{l} \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \end{array}\right\|$ |  | 1N961B <br> 1N963A <br> 1N963B <br> 1N965A | $\begin{aligned} & 150 \\ & 150 \\ & 150 \\ & 150 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 10.5 / .2 \\ & 12.8 / .2 \\ & 12.8 / .2 \\ & 15.7 / .2 \end{aligned}$ | 5 10 5 10 |
| 1NI316A <br> 1N1317 <br> 1N1317A <br> 1N1318 | $\begin{aligned} & 5 \\ & 5 \\ & 5 \\ & 5 \end{aligned}$ | $\left\|\begin{array}{l} \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \end{array}\right\|$ |  | 1N9658 <br> 1N967A <br> 1N967B <br> 1N969A | $\begin{aligned} & 150 \\ & 150 \\ & 150 \\ & 150 \end{aligned}$ |  |  |  |  |  | $\begin{array}{r} 15.7 / .2 \\ 19 / .2 \\ 19 / .2 \\ 23.5 / .2 \end{array}$ | 5 10 5 10 |
| 1N1318A IN1319 1N1319A iN1320 | $\begin{aligned} & 5 \\ & 5 \\ & 5 \\ & 5 \end{aligned}$ | $\left\|\begin{array}{l} \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \end{array}\right\|$ |  | 1No698 <br> 1N971A <br> 1N971B | $\begin{aligned} & 150 \\ & 150 \\ & 150 \\ & 150 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 23.5 / .2 \\ & 28.5 / .2 \\ & 28.5 / .2 \\ & 34.5 / .2 \end{aligned}$ | 5 10 5 10 |
| 1N1320A <br> 1N1321 <br> 1N1321A <br> 1N1322 | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\left\|\begin{array}{l} \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \end{array}\right\|$ |  |  | $\begin{aligned} & 150 \\ & 150 \\ & 150 \\ & 150 \end{aligned}$ |  |  |  |  |  | 34.5/. 2 <br> 41/.2 <br> $41 / 2$ $48.5 / .2$ <br> 48.5/. | 5 10 5 10 |
| 1N1322A <br> IN1323 <br> 1N1323A <br> IN1324 | $\left[\begin{array}{l} s \\ s \\ s \\ s \end{array}\right.$ | $\left.\begin{array}{\|l\|} \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \end{array} \right\rvert\,$ |  |  | $\begin{aligned} & 150 \\ & 150 \\ & 150 \\ & 150 \end{aligned}$ |  |  |  |  |  | 48.5/.2 58/.2 58/.2 71/. 2 | 5 10 5 10 |
| 1NI32AA <br> 1N1325 <br> 1N1325A <br> 1N1326 | $\left[\begin{array}{l} s \\ s \\ s \\ s \end{array}\right.$ | $\left.\begin{array}{\|l\|} \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \end{array} \right\rvert\,$ |  |  | $\begin{aligned} & 150 \\ & 150 \\ & 150 \\ & 150 \end{aligned}$ |  |  |  |  |  | $\begin{array}{r} 71 / .2 \\ 87 / .2 \\ 87 / .2 \\ 105 / .2 \end{array}$ | 5 10 5 10 |
| 1N1326A 1N1327 1NI327A 1N1329 | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\left\|\begin{array}{l} \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{ZD} \\ \mathrm{RE} \end{array}\right\|$ |  |  | $\begin{aligned} & 150 \\ & 150 \\ & 150 \end{aligned}$ | 1.5K | .1 | 201 | 1.3/100 |  | $\begin{aligned} & 105 / .2 \\ & 128 / .2 \\ & 128 / .2 \end{aligned}$ | 5 10 5 |

## DIODE INTERCHANGEABILITY

| TYME NUMEER |  | $\begin{aligned} & \frac{8}{6} \\ & \frac{3}{3} \\ & \frac{3}{3} \\ & 3 \end{aligned}$ | TI | $\begin{aligned} & \text { FOR } \\ & \text { NEW } \\ & \text { DESIMN } \end{aligned}$ | RATINES |  |  | CHARACTERISTICS |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  | $(m W)$ | $\mathbf{V}_{\mathbf{R}}$ <br> (V) | 1 <br> (A) | $\begin{array}{ll} \mathbf{L}_{\mathbf{R}} & \bullet \mathbf{V}_{\mathbf{R}} \\ \mu_{\mathbf{A}} & /(\mathbf{V}) \end{array}$ | $\begin{array}{ll} V_{F} & \mathbf{l}_{F} \\ \text { (V) } & /(\mathrm{mA}) \end{array}$ | $\begin{aligned} & t_{1 r} \\ & (n s) \end{aligned}$ | $\begin{array}{ll} V_{Z} & \mathbf{I Z}_{\mathbf{z}} \\ (\mathrm{V}) & /(\mathrm{ma}) \end{array}$ | $\begin{aligned} & \text { TOL } \\ & \% \end{aligned}$ |
| 1N1406 <br> 1N1407 <br> 1NI 408 <br> IN1409 | $\left\lvert\, \begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}\right.$ | RE <br> RE <br> RE <br> RE <br> RE |  |  |  | $\begin{array}{r} 600 \\ 800 \\ 1 K \\ 1.2 K \end{array}$ | $\begin{aligned} & .125 \\ & .125 \\ & .125 \\ & .125 \end{aligned}$ | 10/800 <br> 10/800 <br> 10/1K <br> .10/1.2K | $\begin{aligned} & 5 / \\ & 5 / \\ & 5 / \\ & 5 / \end{aligned}$ |  |  |  |
| 1N1410 <br> 1N1411 <br> 1N1412 <br> 1N1413 | $\left\lvert\, \begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}\right.$ | $\begin{aligned} & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \end{aligned}$ |  |  |  | $\begin{array}{r} 1.5 K \\ 1.8 K \\ 2 K \\ 2.4 K \end{array}$ | $\begin{aligned} & .125 \\ & .125 \\ & .125 \\ & .125 \end{aligned}$ | 10/1.5K <br> 10/1.8K <br> 10/2K <br> 10/2.4K | 6.21 <br> 7.5/ <br> 6.21 <br> 7.5/ |  |  |  |
| 1N1415 <br> 1N1425 <br> IN1426 <br> 1N1427 | $\left\lvert\, \begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & s \\ & s \end{aligned}\right.$ | $\begin{aligned} & \mathrm{SD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \end{aligned}$ |  | IN4004 1N4738A IN4742A IN4744A | $\begin{aligned} & \text { iw } \\ & \text { iw } \\ & \text { iw } \end{aligned}$ | 400 | 1 | 2/320 | 1.1/1A |  | 8.2/20 <br> 12/20 <br> 15/10 | 5 5 5 |
| 1N1428 IN1429 1N1430 1N1431 | $\begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}$ | $\begin{aligned} & \mathrm{ZD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \end{aligned}$ |  | 1N4746A 1N4748A IN4750A | 1W <br> IW <br> 1W <br> IW |  |  |  |  |  | $\begin{aligned} & 18 / 10 \\ & 22 / 10 \\ & 27 / 5 \\ & 68 / 2 \end{aligned}$ | 5 5 5 5 |
| $\begin{aligned} & \text { 1N1432 } \\ & \text { 1N1433 } \\ & \text { IN1440 } \\ & \text { IN1441 } \end{aligned}$ | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\begin{aligned} & \mathrm{ZD} \\ & \mathrm{ZD} \\ & \mathrm{RE} \\ & \mathrm{RE} \end{aligned}$ |  | $\begin{aligned} & \text { IN4003 } \\ & \text { IN4004 } \end{aligned}$ | $\begin{aligned} & \text { IW } \\ & \text { iw } \end{aligned}$ | $\begin{aligned} & 200 \\ & 300 \end{aligned}$ | $\begin{aligned} & .75 \\ & .75 \end{aligned}$ | $\begin{aligned} & 500 / \\ & 500 / \end{aligned}$ | $\begin{aligned} & 1.2 / 750 \\ & 1.2 / 750 \end{aligned}$ |  | $\begin{aligned} & 100 / 2 \\ & 150 / 1 \end{aligned}$ | $\begin{aligned} & 5 \\ & 5 \end{aligned}$ |
| $\begin{aligned} & \text { IN1442 } \\ & \text { IN1443 } \\ & \text { IN1443A } \\ & \text { IN14438 } \end{aligned}$ | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\begin{aligned} & R E \\ & R E \\ & R E \\ & R E \end{aligned}$ |  | IN4004 |  | $\begin{aligned} & 400 \\ & 1 K \\ & 1 K \\ & 1 K \end{aligned}$ | $\begin{aligned} & .75 \\ & 1.6 \\ & 1.1 \\ & 1.1 \end{aligned}$ | $\begin{aligned} & 500 / \\ & 1 \mathrm{M} / \\ & 500 / \\ & 300 / \end{aligned}$ | $\begin{aligned} & 1.2 / 750 \\ & 1 / \\ & 1.4 / \\ & 1.5 / \end{aligned}$ |  |  |  |
| IN1444 1N1444A 1N1443 INT445 | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\begin{aligned} & R E \\ & R E \\ & R E \\ & R E \\ & R E \end{aligned}$ |  |  |  | $\begin{array}{r} 1 K \\ 1 K \\ 1 K \\ 360 \end{array}$ | $\begin{array}{r} 1.6 \\ 1.6 \\ 1.6 \\ .2 \end{array}$ | 1M/ <br> $50 /$ <br> 101 <br> 4M/ | $\begin{array}{r} 1 / \\ 1.2 / \\ 1.2 / \\ 2 / \end{array}$ |  |  |  |
| 1N1446 1N1447 1N1448 1N1449 | $\left\lvert\, \begin{aligned} & 5 \\ & 5 \\ & 5 \\ & 5 \end{aligned}\right.$ | $\begin{aligned} & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \end{aligned}$ |  |  |  | $\begin{aligned} & 100 \\ & 200 \\ & 300 \\ & 400 \end{aligned}$ | $\begin{aligned} & 1.8 \\ & 1.8 \\ & 1.8 \\ & 1.8 \end{aligned}$ | $\begin{aligned} & 2 M / \\ & 2 M / \\ & 2 M / \\ & 2 M / \end{aligned}$ | $\begin{array}{r} 2 / \\ 2 / \\ 1.4 / \\ 2 / \end{array}$ |  |  |  |
| 1N1450 1N1451 1N1452 1N1453 | $\begin{aligned} & 5 \\ & 5 \\ & 5 \\ & 5 \end{aligned}$ | $\begin{aligned} & R E \\ & R E \\ & R E \\ & R E \\ & R E \end{aligned}$ |  |  |  | $\begin{aligned} & 100 \\ & 200 \\ & 300 \\ & 400 \end{aligned}$ | $\begin{aligned} & 1.8 \\ & 1.8 \\ & 1.8 \\ & 1.8 \end{aligned}$ | 5M/ <br> 5M/ <br> 5M/ <br> 5M/ | $\begin{aligned} & 1.4 / \\ & 1.4 / \\ & 1.4 / \\ & 1.4 / \end{aligned}$ |  |  |  |
| $\begin{aligned} & 1 N 1484 \\ & \text { 1N1485 } \\ & \text { 1N1486 } \\ & \text { 1N1487 } \end{aligned}$ | $\begin{aligned} & \mathbf{s} \\ & \mathbf{S} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}$ | $\begin{aligned} & Z D \\ & Z D \\ & R E \\ & R E \end{aligned}$ |  | $\begin{aligned} & \text { 1N4732A } \\ & \text { 1N4735A } \\ & \text { 1N4006 } \\ & \text { 1N4002 } \end{aligned}$ | $\begin{aligned} & \text { iw } \\ & \text { iw } \end{aligned}$ | $\begin{aligned} & 500 \\ & 100 \end{aligned}$ | $.5$ | $\begin{array}{r} 400 / 500 \\ 300 / 100 \end{array}$ | $\begin{aligned} & .55 / 250 \\ & .55 / 250 \end{aligned}$ |  | $\begin{aligned} & 4.7 / 50 \\ & 6.2 / 50 \end{aligned}$ | 5 |

## DIODE INTERCHANGEABILITY

| TYPE NUMBER |  | $\begin{aligned} & 7 \\ & 0 \\ & \frac{3}{2} \\ & \frac{3}{4} \\ & \frac{5}{5} \\ & 3 \end{aligned}$ | 7 REPLACEMENT |  | PD (mW) | tines <br> $\mathbf{V}_{\mathbf{R}}$ <br> (V) | 1 <br> (A) | $\begin{array}{ll} \mathbf{L}_{\mathrm{R}} & \mathbf{V}_{\mathrm{R}} \\ \mu \mathrm{~A} & \boldsymbol{f}(\mathrm{~V}) \end{array}$ | $\mathbf{V}_{F}$ - $\mathbf{F}_{\mathbf{F}}$ <br> (V) $/$ (mA) | ITr <br> (ma) | $\mathbf{V}_{\mathbf{z}}$ - $\mathbf{z}$ <br> (V) $/$ (mA) | $\mathrm{TOL}$ |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 1N1488 <br> 1N1489 <br> 1N1490 <br> IN1491 | $\begin{aligned} & 5 \\ & s \\ & s \\ & s \end{aligned}$ | $\begin{aligned} & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \end{aligned}$ |  | 1N4003 <br> in4004 <br> 1N4004 <br> 1 N4005 |  | $\begin{aligned} & 200 \\ & 300 \\ & 400 \\ & 500 \end{aligned}$ | $\begin{aligned} & .75 \\ & .75 \\ & .75 \\ & .75 \end{aligned}$ | $\begin{aligned} & 300 / 200 \\ & 300 / 300 \\ & 300 / 400 \\ & 300 / 500 \end{aligned}$ | $\begin{aligned} & .55 / 250 \\ & .55 / 250 \\ & .55 / 250 \\ & .55 / 250 \end{aligned}$ |  |  |  |
| 1N1492 <br> IN1507 <br> 1N1507A <br> 1N1508 | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\begin{aligned} & \mathrm{RE} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \end{aligned}$ |  | 1N4005 <br> 1N4730 <br> 1N4730A <br> 1N4732 | $\begin{array}{r} 750 \\ 750 \\ 750 \\ \hline \end{array}$ | 600 | . 75 | 300/600 | .55/250 |  | $\begin{aligned} & 3.9 / 35 \\ & 3.9 / 35 \\ & 4.7 / 30 \end{aligned}$ | 10 5 10 |
| 1NI508A <br> 1N1509 <br> INI509A <br> 1N1510 | $\begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}$ | $\begin{aligned} & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \end{aligned}$ |  | 1N4732A <br> 1N4734 <br> 1N4734A <br> 1N4736 | $\begin{aligned} & 750 \\ & 750 \\ & 750 \\ & 750 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 4.7 / 30 \\ & 5.6 / 25 \\ & 5.6 / 25 \\ & 6.8 / 22 \end{aligned}$ | 5 10 5 10 |
| 1NT510A 1N1511 1N1511A 1N1512 | $\begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}$ | $\begin{aligned} & \mathrm{zD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \end{aligned}$ |  | 1N4736A 1N4738 1N4738A 1N4740 | $\begin{aligned} & 750 \\ & 750 \\ & 750 \\ & 750 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 8.8 / 22 \\ & 8.2 / 18 \\ & 8.2 / 18 \\ & 10 / 15 \end{aligned}$ | $\begin{array}{r} 5 \\ 10 \\ 5 \\ 10 \end{array}$ |
| 1N1512A <br> IN1513 <br> IN1513A <br> IN1514 | $\begin{aligned} & \mathrm{s} \\ & \mathrm{~s} \\ & \mathrm{~s} \\ & \mathrm{~s} \end{aligned}$ | ZD ZD ZD ZD |  | INA740A <br> 1N4742 <br> 1N4742A <br> 1N4744 | $\begin{aligned} & 750 \\ & 750 \\ & 750 \\ & 750 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 10 / 15 \\ & 12 / 12 \\ & 12 / 12 \\ & 15 / 10 \end{aligned}$ | 5 10 5 10 |
| IN151AA IN1515 IN1515A 1N1516 | $\begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}$ | $\begin{aligned} & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \end{aligned}$ |  | 1N4744A <br> 1N4746 <br> 1N4746A <br> 1N4748 | $\begin{aligned} & 750 \\ & 750 \\ & 750 \\ & 750 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 15 / 10 \\ & 18 / 8 \\ & 18 / 8 \\ & 22 / 6 \end{aligned}$ | 5 10 5 10 |
| IN1516A <br> 1N1517 <br> 1N1517A <br> 1N1518 | $\begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}$ | $\begin{aligned} & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \end{aligned}$ |  | 1N4748A <br> 1N4750 <br> 1N4750A <br> 1N4730 | $\begin{aligned} & 750 \\ & 750 \\ & 750 \\ & 1 w \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 22 / 6 \\ & 27 / 5 \\ & 27 / 5 \\ & 3.9 / 50 \end{aligned}$ | 5 10 5 10 |
| 1N1518A 1N1519 1N1519A 1N1520 | $\begin{aligned} & \mathrm{s} \\ & \mathrm{~s} \\ & \mathrm{~s} \\ & \mathrm{~S} \end{aligned}$ | $\begin{aligned} & \mathrm{ZD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \end{aligned}$ |  | 1N4730A <br> 1N4732 <br> 1N4732A <br> iN4734 | IW <br> 1W <br> IW <br> 1w |  |  |  |  |  | $\begin{aligned} & 3.9 / 50 \\ & 4.7 / 40 \\ & 4.7 / 40 \\ & 5.6 / 35 \end{aligned}$ | 5 10 5 10 |
| $\begin{aligned} & \text { IN1520A } \\ & \text { IN1521 } \\ & \text { 1N1521A } \\ & \text { IN1522 } \end{aligned}$ | $\begin{aligned} & 5 \\ & s \\ & s \\ & s \end{aligned}$ | $\begin{aligned} & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \end{aligned}$ |  | 1N4734A <br> 1N4736 <br> 1N4736A <br> 1N4738 | IW <br> 1w <br> 1W <br> 1W |  |  |  |  |  | $\begin{aligned} & 5.6 / 35 \\ & 6.8 / 30 \\ & 6.8 / 30 \\ & 8.2 / 25 \end{aligned}$ | 5 10 5 10 |
| 1N1522A <br> 1NI523 <br> 1N1523A <br> 1N1524 | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\begin{aligned} & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \end{aligned}$ |  | 1N4738A <br> 1N4740 <br> IN4740A <br> 1N4742 | $\begin{aligned} & \text { iw } \\ & \text { iw } \\ & \text { iw } \\ & \text { iw } \end{aligned}$ |  |  |  | . |  | $\begin{aligned} & 8.2 / 25 \\ & 10 / 20 \\ & 10 / 20 \\ & 12 / 15 \end{aligned}$ | $\begin{array}{r} 5 \\ 10 \\ 5 \\ 10 \end{array}$ |


|  |  | $\overline{7}$ |  |  | RATINGS |  |  | CHARACTERISTICS |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| TYFE MUMEER | $\frac{\text { 鬲 }}{3}$ |  | REPLACEMENT | $\begin{aligned} & \text { FOR } \\ & \text { NEW } \\ & \text { DESYCN } \end{aligned}$ | $\begin{gathered} \mathrm{PD}_{\mathrm{D}} \\ (\mathrm{~mW}) \end{gathered}$ | $\mathbf{V}_{\mathbf{R}}$ <br> (V) | I <br> (A) | $\begin{array}{ll} \mathrm{I}_{\mathrm{R}} & \mathrm{~V}_{\mathrm{R}} \\ \mu \mathrm{M} & \mathrm{~V}) \end{array}$ | $\begin{array}{cc} \mathbf{V}_{\mathrm{F}} & \mathbf{v F}_{\mathrm{F}} \\ \text { (v) } & 1 \text { (mA) } \end{array}$ | In <br> (ns) | $\begin{array}{lc} v_{z} & \mathbf{z}_{2} \\ \text { (V) } & / \mathrm{mA}) \end{array}$ | $\begin{gathered} \text { TOL } \\ \times \end{gathered}$ |
| 1N1524A <br> 1N1525 <br> 1N1525A <br> IN1526 | $\begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{S} \\ & \mathbf{S} \end{aligned}$ | $\left\|\begin{array}{l} Z D \\ Z D \\ Z D \\ Z D \end{array}\right\|$ |  | 1N4742A <br> 1N4744 <br> 1N4744A <br> 1N4746 | $\begin{aligned} & \text { iw } \\ & \text { iw } \\ & \text { iw } \\ & \text { iw } \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 12 / 15 \\ & 15 / 13 \\ & 15 / 13 \\ & 18 / 10 \end{aligned}$ | 5 10 5 10 |
| $\begin{aligned} & \text { IN1526A } \\ & \text { IN1527 } \\ & \text { IN1527A } \\ & \text { IN1528 } \end{aligned}$ | $\begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}$ | $\left\lvert\, \begin{aligned} & \mathrm{ZD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \end{aligned}\right.$ |  | 1N4746A <br> 1N4747 <br> 1N4747A <br> 1N4748 | $\begin{aligned} & 16 \\ & 16 \\ & 16 \\ & 1 W \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 18 / 10 \\ & 22 / 9 \\ & 22 / 9 \\ & 27 / 7 \end{aligned}$ | $\begin{array}{r} 5 \\ 10 \\ 5 \\ 10 \end{array}$ |
| 1N1528A <br> 1N1537 <br> 1N1538 <br> 1N1539 | $\begin{aligned} & 5 \\ & 5 \\ & 5 \\ & 5 \end{aligned}$ | $\begin{aligned} & \mathrm{ZD} \\ & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \end{aligned}$ |  | 1N4748A | 1W | $\begin{array}{r} 50 \\ 100 \\ 150 \end{array}$ | $\begin{aligned} & 1.6 \\ & 1.6 \\ & 1.6 \end{aligned}$ | $\begin{aligned} & 50 \% \\ & 50 \% \\ & 50 / \end{aligned}$ | $\begin{aligned} & 1.5 / \\ & 1.5 / \\ & 1.5 / \end{aligned}$ |  | $27 / 7$ | 5 |
| 1N1540 <br> 1N1541 <br> IN1542 <br> IN1543 | $\left\lvert\, \begin{aligned} & 5 \\ & 5 \\ & 5 \\ & 5 \end{aligned}\right.$ | $\begin{aligned} & R E \\ & R E \\ & R E \\ & R E \end{aligned}$ |  |  |  | $\begin{aligned} & 200 \\ & 300 \\ & 400 \\ & 500 \end{aligned}$ | $\begin{aligned} & 1.6 \\ & 1.6 \\ & 1.6 \\ & 1.6 \end{aligned}$ | $\begin{aligned} & 50 / \\ & 50 / \\ & 50 / \\ & 50 / \end{aligned}$ | $\begin{aligned} & 1.5 / \\ & 1.5 / \\ & 1.5 / \\ & 1.5 / \end{aligned}$ |  |  |  |
| 1N1544 <br> IN1551 <br> 1N1552 <br> IN1553 | S S S S | $\begin{array}{\|l\|} \mathbf{R E} \\ \mathrm{RE} \\ \mathrm{RE} \\ \mathrm{RE} \end{array}$ |  |  |  | $\begin{aligned} & 600 \\ & 100 \\ & 200 \\ & 300 \end{aligned}$ | $\begin{array}{r} 1.6 \\ 1 \\ 1 \\ 1 \end{array}$ | $\begin{aligned} & 50 / \\ & 1 \mathrm{M} / \\ & 1 \mathrm{M} / \\ & 1 \mathrm{M} / \end{aligned}$ | $\begin{aligned} & 1.5 / \\ & 1.4 / \\ & 1.4 / \\ & 1.4 / \end{aligned}$ |  |  |  |
| 1N1554 <br> IN1555 <br> 1N1556 <br> IN1557 | $\begin{aligned} & \mathbf{s} \\ & \mathbf{S} \\ & \mathbf{S} \\ & \mathbf{s} \end{aligned}$ | $\begin{array}{\|l\|} \mathrm{RE} \\ \mathrm{RE} \\ \mathrm{RE} \\ \mathrm{RE} \end{array}$ |  |  |  | $\begin{aligned} & 400 \\ & 500 \\ & 100 \\ & 200 \end{aligned}$ | $\begin{array}{r} 1 \\ 1 \\ .75 \\ .75 \end{array}$ | $\begin{aligned} & 1 \mathrm{M} / \\ & 1 \mathrm{M} / \\ & 1 \mathrm{M} / \\ & 1 \mathrm{M} \end{aligned}$ | $\begin{aligned} & 1.4 / \\ & 1.4 / \\ & 1.4 / \\ & 1.4 / \end{aligned}$ |  |  |  |
| 1N1558 <br> 1N1559 <br> INIS60 <br> 1N1561 | $\begin{aligned} & s \\ & s \\ & s \\ & G \end{aligned}$ | $\left\|\begin{array}{c} R E \\ R E \\ R E \\ S D \end{array}\right\|$ |  | 1N4305 |  | $\begin{array}{r} 300 \\ 400 \\ 500 \\ 25 \end{array}$ | $\begin{aligned} & .75 \\ & .75 \\ & .75 \end{aligned}$ | 1M/ <br> 1M/ <br> 1M/ <br> 25/20 | 1.4/ <br> 1.4/ <br> 1.4/ <br> .4/12 |  |  |  |
| 1N1562 <br> 1N1563 <br> 1N1563A <br> 1N1564 | G <br> $\mathbf{S}$ <br> $\mathbf{S}$ <br> $\mathbf{S}$ | SD <br> RE <br> RE <br> RE |  | $\begin{aligned} & \text { IN4305 } \\ & \text { TID382 } \\ & \text { TID382 } \\ & \text { TID383 } \end{aligned}$ |  | $\begin{array}{r} 25 \\ 100 \\ 100 \\ 200 \end{array}$ | $\begin{array}{r} 1 \\ 1.5 \\ 1 \end{array}$ | $\begin{aligned} & 25 / 20 \\ & 3 / 100 \\ & 3 / 100 \\ & 3 / 200 \end{aligned}$ | $\begin{gathered} .4 / 8 \\ 1.5 / 500 \\ 1.5 / 500 \\ 1.5 / 500 \end{gathered}$ |  |  |  |
| 1N1564A 1N1 565 1N1565A 1N1566 | S | $\begin{array}{\|l\|} \mathbf{R E} \\ \mathrm{RE} \\ \mathrm{RE} \\ \mathrm{RE} \end{array}$ |  | $\begin{aligned} & \text { TID383 } \\ & \text { TID384 } \\ & \text { TID384 } \\ & \text { TID384 } \end{aligned}$ |  | $\begin{aligned} & 200 \\ & 300 \\ & 300 \\ & 400 \end{aligned}$ | $\begin{array}{r} 1.5 \\ 1 \\ 1.5 \\ 1 \end{array}$ | $\begin{aligned} & 3 / 200 \\ & 3 / 300 \\ & 3 / 300 \\ & 3 / 400 \end{aligned}$ | $\begin{aligned} & 1.5 / 500 \\ & 1.5 / 500 \\ & 1.5 / 500 \\ & 1.5 / 500 \end{aligned}$ |  |  |  |
| 1N1566A IN1567 1N1567A IN1568 | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\left.\begin{array}{\|} \mathrm{RE} \\ \mathrm{RE} \\ \mathrm{RE} \\ \mathrm{RE} \end{array} \right\rvert\,$ |  | $\begin{aligned} & \text { TID384 } \\ & \text { THD385 } \\ & \text { TID385 } \\ & \text { TID385 } \end{aligned}$ |  | $\begin{aligned} & 400 \\ & 500 \\ & 500 \\ & 600 \end{aligned}$ | $\begin{array}{r} 1.5 \\ 1 \\ 1.5 \\ 1 \end{array}$ | $\begin{aligned} & 3 / 400 \\ & 5 / 500 \\ & 3 / 500 \\ & 5 / 600 \end{aligned}$ | $\begin{aligned} & 1.5 / 500 \\ & 1.2 / 500 \\ & 1.5 / 500 \\ & 1.2 / 500 \end{aligned}$ |  |  |  |


| TYPE NUMOER | $\begin{aligned} & \text { 数 } \\ & \text { 䍏 } \\ & k \end{aligned}$ | 各 | $\pi$ REPLACEMENT | $\begin{aligned} & \text { FOR } \\ & \text { NEW } \\ & \text { DESKCN } \end{aligned}$ | $P_{D}$ （mW） | tincs <br> $\mathbf{V}_{\mathbf{R}}$ <br> （V） | 1 <br> （A） | $\begin{array}{ll} \mathbf{l}_{\mathbf{R}} & \mathbf{V}_{\mathbf{R}} \\ \mu_{\mathbf{A}} & /(\mathbf{V}) \end{array}$ | $V_{F}$－lF <br> （V）$/$（mA） | $\begin{gathered} t_{1 T} \\ (n s) \end{gathered}$ | $\mathbf{V}_{\mathbf{Z}} \cdot \mathbf{l}_{\mathbf{z}}$ <br> （V）$/(\mathrm{mA})$ | $\begin{aligned} & \text { TOL } \\ & \% \end{aligned}$ |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| IN1568A 1N1577 IN1578 1N1579 | $\begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{S} \\ & \mathbf{s} \end{aligned}$ | $\begin{aligned} & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \end{aligned}$ |  | 710385 |  | $\begin{aligned} & 600 \\ & 300 \\ & 400 \\ & 500 \end{aligned}$ | $\begin{aligned} & 1.5 \\ & 3.5 \\ & 3.5 \\ & 3.5 \end{aligned}$ | $\begin{aligned} & 3 / 600 \\ & 5 / \\ & 5 / \\ & 5 / \end{aligned}$ | $\begin{aligned} & 1.5 / 500 \\ & 1.5 / \\ & 1.5 / \\ & 1.5 / \end{aligned}$ |  |  |  |
| IN1580 <br> 1N1581 <br> IN1582 <br> IN1583 | $\left\lvert\, \begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}\right.$ | $\begin{aligned} & R E \\ & R E \\ & R E \\ & R E \\ & R E \end{aligned}$ |  |  |  | $\begin{array}{r} 600 \\ 50 \\ 100 \\ 200 \end{array}$ | $\begin{array}{r} 3.5 \\ 3 \\ 3 \\ 3 \end{array}$ | $\begin{array}{r} 5 / \\ 5 M / \\ 5 M / \\ 5 M / \end{array}$ | $\begin{aligned} & 1.5 / \\ & 1.5 / \\ & 1.5 / \\ & 1.5 / \end{aligned}$ |  |  |  |
| 1N1584 <br> IN1585 <br> 1N1586 <br> 1N1587 | $\begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}$ | $\begin{aligned} & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \end{aligned}$ |  |  |  | $\begin{aligned} & 300 \\ & 400 \\ & 500 \\ & 600 \end{aligned}$ | 3 3 3 3 | 5M／ <br> 5M／ <br> 5M／ <br> 5M／ | $\begin{aligned} & 1.5 / \\ & 1.5 / \\ & 1.5 / \\ & 1.5 / \end{aligned}$ |  |  |  |
| 1N1612 <br> 1N1612A <br> 1N1612R <br> 1N1613 | $\begin{aligned} & \mathbf{S} \\ & \mathbf{S} \\ & \mathbf{S} \\ & \mathbf{S} \end{aligned}$ | $\begin{aligned} & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \end{aligned}$ |  |  |  | 50 50 50 100 | 5 5 7 5 |  | $\begin{aligned} & 1.5 / 10 \mathrm{~A} \\ & 1.1 / 6 \mathrm{~A} \\ & .7 / 1 \mathrm{~A} \\ & 1.5 / 10 \mathrm{~A} \end{aligned}$ |  |  |  |
| 1N1613A <br> IN1613R <br> 1N1614 <br> 1N1614A | $\begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}$ | $\begin{aligned} & R E \\ & R E \\ & R E \\ & R E \\ & R E \end{aligned}$ |  |  |  | 100 100 200 200 | 5 7 5 5 |  | $\begin{gathered} 1.1 / 6 A \\ .7 / 1 A \\ 1.5 / 10 A \\ 1.1 / 6 A \end{gathered}$ |  |  |  |
| 1N1614R <br> 1N1615 <br> 1N1615A <br> 1N1615R | $\begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}$ | $\begin{aligned} & R E \\ & R E \\ & R E \\ & R E \\ & R E \end{aligned}$ |  |  |  | 200 400 400 400 | 7 5 5 7 |  | $\begin{gathered} .7 / 1 \mathrm{~A} \\ 1.5 / 10 \mathrm{~A} \\ 1.1 / 6 \mathrm{~A} \\ .7 / 1 \mathrm{~A} \end{gathered}$ |  |  |  |
| 1N1616 <br> 1N1616A <br> 1N1616R <br> IN1617 | $\left\lvert\, \begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}\right.$ | $\begin{aligned} & R E \\ & R E \\ & R E \\ & R E \\ & R E \end{aligned}$ |  |  |  | $\begin{aligned} & 600 \\ & 600 \\ & 600 \\ & 100 \end{aligned}$ | 5 5 7 1.5 |  | $\begin{gathered} 1.5 / 10 \mathrm{~A} \\ 1.1 / 6 \mathrm{~A} \\ .7 / 1 \mathrm{~A} \\ 1.21 \end{gathered}$ |  |  |  |
| IN1618 <br> 1N1619 <br> IN1620 <br> 1N1644 | $\begin{aligned} & 5 \\ & 5 \\ & 5 \\ & 5 \end{aligned}$ | $\begin{aligned} & \mathbf{R E} \\ & \mathbf{R E} \\ & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathbf{R E} \end{aligned}$ |  | 1N4001 |  | $\begin{array}{r} 200 \\ 300 \\ 400 \\ 50 \end{array}$ | $\begin{aligned} & 1.5 \\ & 1.5 \\ & 1.5 \\ & .25 \end{aligned}$ | 400／50 | 1．2／ <br> $1.2 /$ <br> 1．2／ <br> ．5／250 |  |  |  |
| 1N1645 <br> 1N1646 <br> IN1647 <br> 1N1648 | $\begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}$ | $\begin{aligned} & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathbf{R E} \end{aligned}$ |  | 1N4002 <br> 1N4003 <br> 1N4003 <br> IN4004 |  | $\begin{aligned} & 100 \\ & 150 \\ & 200 \\ & 250 \end{aligned}$ | $\begin{aligned} & .25 \\ & .25 \\ & .25 \\ & .25 \end{aligned}$ | $\begin{aligned} & 400 / 100 \\ & 300 / 150 \\ & 300 / 200 \\ & 300 / 250 \end{aligned}$ | $\begin{aligned} & .5 / 250 \\ & .5 / 250 \\ & .5 / 250 \\ & .5 / 250 \end{aligned}$ |  |  |  |
| 1N1649 <br> 1N1650 <br> 1N1651 <br> 1N1652 | $\begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}$ | $\begin{aligned} & R E \\ & R E \\ & R E \\ & R E \end{aligned}$ |  | 1N4004 1N4004 1N4004 1N4005 |  | $\begin{aligned} & 300 \\ & 350 \\ & 400 \\ & 500 \end{aligned}$ | $\begin{aligned} & .25 \\ & .25 \\ & .25 \\ & .25 \end{aligned}$ | $\begin{aligned} & 300 / 300 \\ & 300 / 350 \\ & 300 / 400 \\ & 300 / 500 \end{aligned}$ | $\begin{aligned} & .5 / 250 \\ & .5 / 250 \\ & .5 / 250 \\ & .5 / 250 \end{aligned}$ |  |  |  |

## DIODE INTERCHANGEABILTTY

| TYF Mumber |  |  | $\begin{gathered} n \\ \text { REPLACEMENT } \end{gathered}$ | $\begin{aligned} & \text { FOR } \\ & \text { NBW } \\ & \text { DESNeN } \end{aligned}$ | RATINES |  |  | CHARACTERISTICS |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  | $\begin{gathered} P D \\ (\mathrm{~mW}) \end{gathered}$ | $\mathbf{V}_{\mathrm{R}}$ <br> (V) | I <br> (A) | $\begin{array}{ll} \mathbf{m}_{\mathbf{n}} & \mathbf{V}_{\mathrm{n}} \\ \mu \mathrm{~V} \end{array}$ | $\begin{array}{cc} V_{F} & \mathbf{F}_{\mathrm{F}} \\ (\mathrm{~V}) & /(\mathrm{mA}) \end{array}$ | $\begin{aligned} & i r r \\ & \text { (ns) } \end{aligned}$ | $\begin{array}{lc} \mathbf{V}_{\mathbf{Z}} & \bullet \mathbf{Z} \\ (\mathrm{V}) & f(\mathrm{~m} \mathrm{~m}) \end{array}$ | $\left\lvert\, \begin{gathered} \mathrm{rat} \\ \% \end{gathered}\right.$ |
| 1N1653 1N1692 1N1693 1N1694 | S | $\left.\begin{array}{\|l\|} R E \\ R E \\ R E \\ R E \end{array} \right\rvert\,$ |  | IN4005 IN4002 IN4003 IN4004 |  | 600 100 200 300 | $\begin{aligned} & .25 \\ & .25 \\ & .25 \\ & .25 \end{aligned}$ | $\begin{aligned} & 300 / 600 \\ & 500 / 100 \\ & 500 / 200 \\ & 500 / 300 \end{aligned}$ | $\begin{aligned} & .5 / 250 \\ & .6 / 250 \\ & .6 / 250 \\ & .6 / 250 \end{aligned}$ |  |  |  |
| 1N1695 <br> 1N1696 <br> IN1697 <br> IN1698 | $\begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}$ | $\begin{aligned} & R E \\ & R E \\ & R E \\ & R E \\ & R E \end{aligned}$ |  |  |  | $\begin{aligned} & 400 \\ & 500 \\ & 600 \\ & 6.8 K \end{aligned}$ | $\begin{array}{r} .25 \\ .6 \\ .6 \\ .062 \end{array}$ | $\begin{aligned} & 500 / 400 \\ & 500 / 500 \\ & 500 / 600 \end{aligned}$ | $\begin{aligned} & .6 / 250 \\ & .6 / 250 \\ & .6 / 250 \\ & 33 / 68 \end{aligned}$ |  |  |  |
| IN1699 <br> IN1700 <br> IN1701 <br> 1N1702 | $\left\lvert\, \begin{aligned} & 5 \\ & 5 \\ & s \\ & s \end{aligned}\right.$ | $\left.\begin{array}{\|l\|} \mathrm{RE} \\ \mathrm{RE} \\ \mathrm{RE} \\ \mathrm{RE} \end{array} \right\rvert\,$ |  | $\begin{aligned} & \text { IN4001 } \\ & \text { IN4002 } \end{aligned}$ |  | $\begin{array}{r} 10 K \\ 12 K \\ 50 \\ 100 \end{array}$ | $\begin{array}{r} .058 \\ .05 \\ .3 \\ .3 \end{array}$ | $\begin{aligned} & 200 / 50 \\ & 200 / 100 \end{aligned}$ | $\begin{aligned} & 37 / 58 \\ & 45 / 50 \\ & 1.3 / 300 \\ & 1.3 / 300 \end{aligned}$ |  |  |  |
| 1N1703 1N1704 1N1705 1N1706 | $\left\lvert\, \begin{aligned} & 5 \\ & 5 \\ & 5 \\ & s \end{aligned}\right.$ | RE <br> RE <br> RE <br> RE |  | 1N4003 1N4004 1N4004 1N4005 |  | $\begin{aligned} & 200 \\ & 300 \\ & 400 \\ & 500 \end{aligned}$ | $\begin{aligned} & .3 \\ & .3 \\ & .3 \\ & .3 \end{aligned}$ | $\begin{aligned} & 200 / 200 \\ & 200 / 300 \\ & 200 / 400 \\ & 200 / 500 \end{aligned}$ | $\begin{aligned} & 1.3 / 300 \\ & 1.3 / 300 \\ & 1.3 / 300 \\ & 1.3 / 300 \end{aligned}$ |  |  |  |
| 1N1707 <br> 1N1708 <br> iN1709 <br> 1N1710 | $\left\lvert\, \begin{aligned} & 5 \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\begin{aligned} & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \end{aligned}$ |  | 1N4001 in4002 1N4003 IN4004 |  | $\begin{array}{r} 50 \\ 100 \\ 200 \\ 300 \end{array}$ | .5 .5 .5 .5 | $\begin{aligned} & 200 / 50 \\ & 200 / 100 \\ & 200 / 200 \\ & 200 / 300 \end{aligned}$ | $\begin{aligned} & 1.1 / 500 \\ & 1.1 / 500 \\ & 1.1 / 500 \\ & 1.1 / 500 \end{aligned}$ |  |  |  |
| 1N1711 <br> 1N1712 <br> 1N1730 <br> IN1730A | $\left\lvert\, \begin{aligned} & 5 \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\left\|\begin{array}{l} R E \\ R E \\ R E \\ R E \end{array}\right\|$ |  | IN4004 <br> IN4005 <br> iN4007 <br> 1 N4007 |  | 400 500 $1 K$ $1 K$ | .5 .5 .2 .35 | $\begin{gathered} 200 / 400 \\ 200 / 500 \\ 10 / 1 K \\ I / 1 K \end{gathered}$ | $\begin{array}{r} 1.1 / 500 \\ 1.1 / 500 \\ 5 / 100 \\ 3 / 400 \end{array}$ |  |  |  |
| $\begin{aligned} & \text { 1N1731 } \\ & \text { 1N1731A } \\ & \text { 1N1732 } \\ & \text { 1N1732A } \end{aligned}$ | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\begin{aligned} & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \end{aligned}$ |  |  |  | $\begin{array}{r} 1.5 K \\ 1.5 K \\ 2 K \\ 2 K \end{array}$ | .2 .35 .2 .5 | $\begin{gathered} 10 / 1.5 \mathrm{~K} \\ 1 / 1.5 \mathrm{~K} \\ 10 / 2 \mathrm{~K} \\ 1 / 2 \mathrm{~K} \end{gathered}$ | $\begin{aligned} & 5 / 100 \\ & 3 / 400 \\ & 9 / 100 \\ & 3 / 400 \end{aligned}$ |  |  |  |
| 1N1733 <br> 1N1733A <br> 1N1734 <br> 1N1734A | $\begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}$ | $\begin{aligned} & \mathbf{R E} \\ & \mathbf{R E} \\ & \mathbf{R E} \\ & \mathbf{R E} \end{aligned}$ |  |  |  | 3K <br> 3K <br> 5K <br> 5K | $\begin{array}{r} .15 \\ .5 \\ .1 \\ .5 \end{array}$ | $\begin{array}{r} 10 / 3 K \\ 1 / 3 K \\ 10 / 5 K \\ 1 / 5 K \end{array}$ | $\begin{array}{r} 12 / 100 \\ 6 / 400 \\ 18 / 100 \\ 8 / 400 \end{array}$ |  |  |  |
| $\begin{aligned} & \text { 1N1735 } \\ & \text { 1N1736 } \\ & \text { IN1736A } \\ & \text { 1N1737 } \end{aligned}$ | S | $\begin{aligned} & R D \\ & R D \\ & R D \\ & R D \end{aligned}$ |  |  | $\begin{aligned} & 200 \\ & 400 \\ & 400 \\ & 600 \end{aligned}$ |  |  |  |  |  | $\begin{array}{r} 6.2 / 7.5 \\ 12.4 / 7.5 \\ 12.4 / 7.5 \\ 18.6 / 7.5 \end{array}$ | 5 5 5 5 |
| $\begin{aligned} & \text { IN1737A } \\ & \text { IN1738 } \\ & \text { IN1738A } \\ & \text { IN1739 } \end{aligned}$ | $\left\lvert\, \begin{aligned} & 5 \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\begin{aligned} & R D \\ & R D \\ & R D \\ & R D \end{aligned}$ |  |  | $\begin{aligned} & 600 \\ & 800 \\ & 800 \\ & 1 W \end{aligned}$ |  |  |  |  |  | $\begin{array}{r} 18.6 / 7.5 \\ 24.8 / 7.5 \\ 24.8 / 7.5 \\ 31 / 7.5 \end{array}$ | 5 5 5 5 |

## DIODE INTERCHANGEABILITY

| TYPE NJMBER |  | $\begin{aligned} & \text { z } \\ & \frac{0}{2} \\ & \frac{3}{0} \\ & 3 \\ & 3 \end{aligned}$ | II <br> REPLACEMENT |  | $\begin{gathered} \mathrm{PD} \\ (\mathrm{~mW}) \end{gathered}$ | TINGS <br> $V_{R}$ <br> (V) | I <br> (A) | $\begin{gathered} \mathbf{I}_{\mathbf{R}}: \mathbf{V}_{\mathbf{R}} \\ \boldsymbol{\mu} \mathbf{A} \end{gathered}$ | $\begin{array}{cc}  & \text { CHARACT } \\ \mathbf{V F F}_{\mathbf{F}} & \mathbf{l}_{\mathbf{F}} \\ (\mathrm{V}) & /(\mathrm{mA}) \end{array}$ | $\begin{gathered} \text { R1STIC } \\ \text { trv } \\ \text { (ns) } \end{gathered}$ | $\mathbf{V}_{\mathbf{Z}}: \mathbf{z}$ <br> (V) $/$ (mA) | rot |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 1N1739A <br> IN1740 <br> IN1740A <br> 1N1741 | $\begin{aligned} & s \\ & s \\ & s \\ & s \\ & s \end{aligned}$ | $\begin{aligned} & R D \\ & R D \\ & R D \\ & R D \\ & R D \end{aligned}$ |  |  | $\begin{aligned} & 1 \mathrm{~W} \\ & 1.2 \mathrm{~W} \\ & 1.2 \mathrm{~W} \\ & 1.4 \mathrm{~W} \end{aligned}$ |  |  |  |  |  | $\begin{array}{r} 31 / 7.5 \\ 37.2 / 7.5 \\ 37.2 / 7.5 \\ 43.4 / 7.5 \end{array}$ | 5 5 5 5 |
| INI741A <br> 1N1742 <br> 1N1742A <br> 1N1745 | $\left[\begin{array}{l} s \\ s \\ s \\ s \end{array}\right.$ | $\begin{aligned} & R D \\ & R D \\ & R D \\ & R E \end{aligned}$ |  |  | $\begin{aligned} & 1.4 W \\ & 1.8 W \\ & 1.6 W \end{aligned}$ | 1.5K | . 38 | 25/1.5K | 15/600 |  | $\begin{aligned} & 43.4 / 7.5 \\ & 49.6 / 7.5 \\ & 49.6 / 7.5 \end{aligned}$ | $\begin{aligned} & 5 \\ & 5 \\ & 5 \end{aligned}$ |
| 1N1746 <br> 1N1747 <br> 1N1748 <br> 1N1749 | $\begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}$ | $\begin{aligned} & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \end{aligned}$ |  |  |  | $\begin{aligned} & 1.5 K \\ & 1.8 K \\ & 1.8 K \\ & 2.4 K \end{aligned}$ | $\begin{aligned} & .44 \\ & .36 \\ & .42 \\ & .32 \end{aligned}$ | $\begin{aligned} & 25 / 1.5 K \\ & 25 / 1.8 K \\ & 25 / 1.8 K \\ & 25 / 2.4 K \end{aligned}$ | $\begin{array}{r} 7.5 / 700 \\ 18 / 600 \\ 9 / 700 \\ 24 / 600 \end{array}$ |  |  |  |
| 1N1750 1N1751 1N1752 1N1753 | $\begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}$ | $\begin{aligned} & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \end{aligned}$ |  |  |  | $\begin{aligned} & 2.4 \mathrm{~K} \\ & 3.6 \mathrm{~K} \\ & 3.6 \mathrm{~K} \\ & 4.8 \mathrm{~K} \end{aligned}$ | $\begin{aligned} & .38 \\ & .37 \\ & .36 \\ & .38 \end{aligned}$ | $\begin{aligned} & 25 / 2.4 \mathrm{~K} \\ & 25 / 3.6 \mathrm{~K} \\ & 25 / 3.6 \mathrm{~K} \\ & 25 / 4.8 \mathrm{~K} \end{aligned}$ | $\begin{aligned} & 12 / 600 \\ & 27 / 600 \\ & 18 / 600 \\ & 36 / 600 \end{aligned}$ |  |  |  |
| 1N1754 1N1755 1N1756 1N1757 | $\begin{aligned} & 5 \\ & S \\ & 5 \\ & 5 \end{aligned}$ | $\begin{aligned} & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \end{aligned}$ |  |  |  | $\begin{array}{r} 4.8 \mathrm{~K} \\ 6 \mathrm{~K} \\ 6 \mathrm{~K} \\ 7.2 \mathrm{~K} \end{array}$ | $\begin{aligned} & .37 \\ & .33 \\ & .41 \\ & .33 \end{aligned}$ | $\begin{aligned} & 25 / 4.8 \mathrm{~K} \\ & 25 / 6 \mathrm{~K} \\ & 25 / 6 \mathrm{~K} \\ & 25 / 7.2 \mathrm{~K} \end{aligned}$ | $\begin{aligned} & 24 / 600 \\ & 45 / 500 \\ & 30 / 600 \\ & 54 / 500 \end{aligned}$ |  |  |  |
| 1N1758 <br> 1N1759 <br> 1N1760 <br> 1N1761 | $\begin{aligned} & \mathrm{s} \\ & \mathrm{~S} \\ & \mathrm{~s} \\ & \mathrm{~s} \end{aligned}$ | $\begin{aligned} & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \end{aligned}$ |  |  |  | $\begin{array}{r} 7.2 K \\ 8 K \\ 12 K \\ 14 K \end{array}$ | $\begin{aligned} & .38 \\ & .29 \\ & .29 \\ & .34 \end{aligned}$ | $\begin{aligned} & 25 / 7.2 \mathrm{~K} \\ & 25 / 8 \mathrm{~K} \\ & 25 / 12 \mathrm{~K} \\ & 25 / 14 \mathrm{~K} \end{aligned}$ | $\begin{aligned} & 36 / 600 \\ & 60 / 400 \\ & 60 / 400 \\ & 52 / 500 \end{aligned}$ |  |  |  |
| 1N1762 <br> 1N1763 <br> 1N1763A <br> iN1764 | $\begin{aligned} & \mathbf{s} \\ & s \\ & s \\ & s \end{aligned}$ | $\begin{aligned} & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \end{aligned}$ |  | $\left\lvert\, \begin{aligned} & \text { TID384 } \\ & \text { TID384 } \\ & \text { TID385 } \end{aligned}\right.$ |  | $\begin{aligned} & 16 K \\ & 400 \\ & 400 \\ & 500 \end{aligned}$ | $\begin{array}{r} .29 \\ .5 \\ 1 \\ .5 \end{array}$ | $\begin{aligned} & 25 / 16 \mathrm{~K} \\ & 100 / \\ & 500 / \\ & 100 / \end{aligned}$ | $\begin{gathered} 60 / 400 \\ 3 / \\ 1.2 / \\ 3 / \end{gathered}$ |  |  |  |
| 1N1764A <br> IN1765 <br> 1N1765A <br> 1N1766 | $\begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}$ | $\begin{aligned} & \mathrm{RE} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \end{aligned}$ |  | T10385 <br> 1N4734 <br> 1N4734A <br> 1N4735 | $\begin{aligned} & \text { iw } \\ & \text { iw } \\ & \text { iw } \end{aligned}$ | 500 | 1 | 500/ | 1.21 |  | 5.6/100 5.6/100 6.2/100 | 10 5 10 |
| 1N1766A <br> 1N1767 <br> 1N1767A <br> 1N1768 | $\left\lvert\, \begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}\right.$ | $\begin{aligned} & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \end{aligned}$ |  | 1N4735A <br> 1N4736 <br> IN4736A <br> 1N4737 | $\begin{aligned} & \text { iw } \\ & \text { iw } \\ & \text { iw } \\ & \text { iw } \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 6.2 / 100 \\ & 6.8 / 100 \\ & 6.8 / 100 \\ & 7.5 / 100 \end{aligned}$ | 5 10 5 10 |
| 1N1768A <br> 1N1769 <br> IN1769A <br> 1N1770 | $\begin{aligned} & 5 \\ & 5 \\ & 5 \\ & 5 \end{aligned}$ | $\begin{aligned} & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \end{aligned}$ |  | IN4737A <br> IN4738 <br> 1N4738A <br> 1N4739 | $\begin{aligned} & \text { iw } \\ & \text { iw } \\ & \text { iw } \\ & \text { iw } \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 7.5 / 100 \\ & 8.2 / 100 \\ & 8.2 / 100 \\ & 9.1 / 50 \end{aligned}$ | $\begin{array}{r} 5 \\ 10 \\ 5 \\ 10 \end{array}$ |


| TYFE MUMDER |  |  | REMACEMENT | $\begin{aligned} & \text { FOR } \\ & \text { NEW } \\ & \text { DESNGN } \end{aligned}$ | Ratines |  |  | Chanacteristics |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  | $\begin{gathered} P_{D} \\ (\mathrm{~mW}) \end{gathered}$ | $\begin{aligned} & V_{R} \\ & (V) \end{aligned}$ | (A) | $\begin{array}{ll} \mathbf{I}_{\mathrm{R}} & \mathbf{V}_{\mathrm{R}} \\ \mu_{\mathrm{A}} & / \mathbf{V}) \end{array}$ | $\begin{array}{ll} \mathbf{V F}_{F} & \mathbf{I F}_{\mathbf{c}} \\ \text { (V) } & \text { (mA) } \end{array}$ | $\begin{aligned} & \mathbf{t}_{\boldsymbol{r}} \\ & \text { (nsi) } \end{aligned}$ | $\mathbf{V Z}_{\mathbf{Z}}$ - $\mathbf{I z}$ <br> (V) $/$ (ma) | TOL \% |
| IN1770A <br> 1N1771 <br> IN1771A <br> 1N1772 | $\left\lvert\, \begin{aligned} & 5 \\ & 5 \\ & 5 \\ & 5 \end{aligned}\right.$ | $\left\|\begin{array}{l} z 0 \\ z D \\ z D \\ z 0 \end{array}\right\|$ |  | 1N4739A <br> 1N4740 <br> IN4740A <br> 1N4741 | $\begin{aligned} & \text { iw } \\ & \text { iw } \\ & \text { iw } \\ & \text { iw } \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 9.1 / 50 \\ & 10 / 50 \\ & 10 / 50 \\ & 11 / 50 \end{aligned}$ | 5 10 5 10 |
| 1N1772A <br> 1N1773 <br> 1N1773A <br> 1N1774 | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\begin{aligned} & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \end{aligned}$ |  | $\begin{aligned} & \text { IN4741A } \\ & \text { IN4742 } \\ & \text { 1N4742A } \\ & \text { IN4743 } \end{aligned}$ | $\begin{aligned} & \text { iw } \\ & \text { iw } \\ & \text { iw } \\ & \text { iw } \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 11 / 50 \\ & 12 / 50 \\ & 12 / 50 \\ & 13 / 50 \end{aligned}$ | 5 10 5 10 |
| 1N1774A <br> 1N1775 <br> 1N1775A <br> 1N1776 | $\left[\begin{array}{l} s \\ s \\ s \\ s \end{array}\right.$ | $\begin{aligned} & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \end{aligned}$ |  | IN4743A <br> 1N4744 <br> IN4744A <br> 1N4745 | 1w <br> IW <br> IW <br> 1W |  |  |  |  |  | $\begin{aligned} & 13 / 50 \\ & 15 / 50 \\ & 15 / 50 \\ & 16 / 50 \end{aligned}$ | 5 10 5 10 |
| 1N1776A <br> 1N1777 <br> 1N1777A <br> 1N1778 | $\begin{aligned} & 5 \\ & s \\ & s \\ & s \end{aligned}$ | $\left\|\begin{array}{l} \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \end{array}\right\|$ |  | $\begin{aligned} & \text { 1N4745A } \\ & \text { 1N4746 } \\ & \text { iN4746A } \\ & \text { 1N4747 } \end{aligned}$ | $\begin{aligned} & \text { iw } \\ & \text { iw } \\ & \text { iw } \\ & \text { iw } \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 16 / 50 \\ & 18 / 50 \\ & 18 / 50 \\ & 20 / 15 \end{aligned}$ | 5 10 5 10 |
| 1N1778A <br> 1N1779 <br> 1N1779A <br> 1N1780 | $\left\lvert\, \begin{aligned} & \mathbf{s} \\ & \mathbf{S} \\ & \mathrm{S} \\ & \mathbf{s} \end{aligned}\right.$ | $\begin{aligned} & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \end{aligned}$ |  | IN4747A <br> 1N4748 <br> IN4748A <br> 1N4749 | $\begin{aligned} & \text { iw } \\ & \text { iw } \\ & \text { iw } \\ & \text { iw } \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 20 / 15 \\ & 22 / 15 \\ & 22 / 15 \\ & 24 / 15 \end{aligned}$ | 5 10 5 10 |
| 1N1780A <br> 1N1781 <br> 1N1781A <br> INI782 | $\left\lvert\, \begin{aligned} & \mathbf{s} \\ & S \\ & s \\ & s \end{aligned}\right.$ | $\begin{aligned} & \mathrm{ZD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \end{aligned}$ |  | $\left\{\begin{array}{l} \text { 1N4749A } \\ \text { 1N4750 } \\ \text { 1N4750A } \\ \text { IN4751 } \end{array}\right.$ | $\begin{aligned} & \text { iw } \\ & \text { iw } \\ & \text { iw } \\ & \text { iw } \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 24 / 15 \\ & 27 / 15 \\ & 27 / 15 \\ & 30 / 15 \end{aligned}$ | 5 10 5 10 |
| $\begin{aligned} & \text { 1N1782A } \\ & \text { 1N1783 } \\ & \text { 1N1783A } \\ & \text { 1N1784 } \end{aligned}$ | $\left\lvert\, \begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}\right.$ | $\left\lvert\, \begin{aligned} & \mathrm{ZD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \end{aligned}\right.$ |  | IN4751A 1 N4752 iN4752A | IW <br> IW <br> IW <br> IW |  |  |  |  |  | $\begin{aligned} & 30 / 15 \\ & 33 / 15 \\ & 33 / 15 \\ & 36 / 15 \end{aligned}$ | 5 10 5 10 |
| 1N1784A <br> 1N1785 <br> 1N1785A <br> 1N1786 | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\begin{aligned} & \text { ZD } \\ & \text { ZD } \\ & \text { ZD } \\ & \text { ZD } \end{aligned}$ |  |  | $\begin{aligned} & \text { iw } \\ & \text { iw } \\ & \text { iw } \\ & \text { iw } \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 36 / 15 \\ & 39 / 15 \\ & 39 / 15 \\ & 43 / 15 \end{aligned}$ | 5 10 5 10 |
| 1N1786A 1N1787 1N1787A 1N1788 | $\left\lvert\, \begin{aligned} & 5 \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\begin{aligned} & \mathrm{ZD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \end{aligned}$ |  |  | $\begin{aligned} & \text { IW } \\ & \text { 1W } \\ & \text { iW } \\ & \text { iw } \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 43 / 15 \\ & 47 / 15 \\ & 47 / 15 \\ & 51 / 15 \end{aligned}$ | 5 10 5 10 |
| 1N1788A IN1789 IN1789A 1N1790 | $\left\{\begin{array}{l} s \\ s \\ s \\ s \end{array}\right.$ | $\begin{aligned} & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \end{aligned}$ |  |  | $\begin{aligned} & \text { 1W } \\ & \text { 1w } \\ & \text { iw } \\ & \text { iw } \end{aligned}$ |  |  |  |  |  | 51/15 <br> 56/15 <br> 56/15 <br> 62/5 | $\begin{array}{r} 5 \\ 10 \\ 5 \\ 10 \end{array}$ |

## DIODE INTERCHANGEABILITY

| TYP: NUMER |  | $\begin{aligned} & \frac{3}{6} \\ & \frac{3}{3} \\ & 0 \\ & 0 \\ & 8 \end{aligned}$ | II | FORNEWDESION | RATINGS |  |  | CHARACTERISTICS |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  | $(\mathrm{mW})$ | $\mathbf{V}_{\mathbf{R}}$ <br> (V) | 1 <br> (A) | $\begin{array}{ll} \mathbf{I}_{\mathbf{R}} & \mathbf{V}_{\mathbf{R}} \\ \mu_{\mathbf{A}} & / \mathbf{V}) \end{array}$ | $\begin{array}{cc} V_{F} & F_{F} \\ (\mathrm{~V}) & /(\mathrm{mA}) \end{array}$ | $\begin{aligned} & \text { ir } \\ & \text { (ns) } \end{aligned}$ | $\begin{array}{ll} V_{z} & I_{z} \\ (V) & /(\mathrm{mA}) \end{array}$ | $70$ * |
| 1NI790A <br> 1N1791 <br> 1NI791A <br> iN1792 | $\begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}$ | $\begin{aligned} & \mathrm{ZD} \\ & \mathrm{zD} \\ & \mathrm{ZD} \\ & \mathrm{zD} \end{aligned}$ |  |  | $\begin{aligned} & 1 w \\ & 1 w \\ & 1 w \\ & 1 w \end{aligned}$ |  |  |  |  |  | $\begin{array}{r} 62 / 5 \\ 68 / 5 \\ 68 / 5 \\ 775 / 5 \end{array}$ | 5 10 5 10 |
| 1N1792A <br> 1N1793 <br> 1N1793A <br> IN1794 | $\left\lvert\, \begin{aligned} & s \\ & 5 \\ & s \\ & s \end{aligned}\right.$ | $\begin{aligned} & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{ZD} \end{aligned}$ |  |  | $\begin{aligned} & \text { IW } \\ & \text { iW } \\ & \text { iw } \\ & \text { iw } \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 75 / 5 \\ & 82 / 5 \\ & 82 / 5 \\ & 91 / 5 \end{aligned}$ | 5 10 5 10 |
| 1N1794A <br> 1N1795 <br> 1N1795A <br> 1N1796 | $\begin{aligned} & 5 \\ & 5 \\ & 5 \\ & 5 \end{aligned}$ | $\begin{aligned} & 20 \\ & z 0 \\ & 20 \\ & 20 \end{aligned}$ |  |  | $\begin{aligned} & \text { iw } \\ & \text { iw } \\ & \text { iw } \\ & \text { iw } \end{aligned}$ |  |  |  |  |  | $\begin{array}{r} 91 / 5 \\ 100 / 5 \\ 100 / 5 \\ 110 / 5 \end{array}$ | 5 10 5 10 |
| 1N1796A <br> 1N1797 <br> 1N1797A <br> 1N1798 | $\left\lvert\, \begin{aligned} & \mathbf{s} \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\begin{aligned} & \mathrm{zD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \end{aligned}$ |  |  | $\begin{aligned} & \text { iw } \\ & \text { iw } \\ & \text { iw } \\ & \text { iw } \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 110 / 5 \\ & 120 / 5 \\ & 120 / 5 \\ & 130 / 5 \end{aligned}$ | 5 10 5 10 |
| 1N1798A <br> 1N1799 <br> 1N1799A <br> 1N1800 | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\begin{aligned} & \mathrm{ZD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \end{aligned}$ |  |  | $\begin{aligned} & 1 \mathrm{w} \\ & 1 \mathrm{w} \\ & \mathrm{iw} \\ & \mathrm{iw} \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 130 / 5 \\ & 150 / 5 \\ & 150 / 5 \\ & 160 / 5 \end{aligned}$ | 5 10 5 10 |
| INIB00A <br> 1N1801 <br> IN1801A <br> 1N1802 | $\begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}$ | $\begin{aligned} & \mathrm{zO} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \end{aligned}$ |  |  | $\begin{aligned} & \text { iw } \\ & \text { iw } \\ & \text { iw } \\ & \text { iw } \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 160 / 5 \\ & 180 / 5 \\ & 180 / 5 \\ & 200 / 5 \end{aligned}$ | 5 10 5 10 |
| 1N1802A <br> 1N1839 <br> 1N1840 <br> 1N1841 | $\begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}$ | $\begin{aligned} & \mathrm{ZD} \\ & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \end{aligned}$ |  |  | 1w | $\begin{aligned} & 6.8 \\ & 10 \\ & 15 \end{aligned}$ | $\begin{aligned} & .085 \\ & .077 \\ & .063 \end{aligned}$ | $\begin{aligned} & .5 / 6.8 \\ & .5 / 10 \\ & .5 / 15 \end{aligned}$ | $\begin{aligned} & 1 / 50 \\ & 1 / 35 \\ & 1 / 23 \end{aligned}$ |  | 200/5 | 5 |
| 1N1842 <br> 1N1843 <br> IN1844 <br> 1N1845 | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\begin{aligned} & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \end{aligned}$ |  |  |  | 22 33 47 68 | $\begin{array}{r} .05 \\ .04 \\ .03 \\ .023 \end{array}$ | $\begin{aligned} & .1 / 22 \\ & .1 / 33 \\ & .1 / 47 \\ & 1 / 68 \end{aligned}$ | $\begin{aligned} & 1 / 12 \\ & 1 / 7 \\ & 1 / 4.5 \\ & 1 / 2.7 \end{aligned}$ |  |  |  |
| 1N1846 <br> 1N1847 <br> IN1848 <br> IN1849 | $\begin{aligned} & 5 \\ & 5 \\ & 5 \\ & s \end{aligned}$ | $\begin{aligned} & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \end{aligned}$ |  |  |  | $\begin{aligned} & 100 \\ & 150 \\ & 220 \\ & 330 \end{aligned}$ | .016 <br> .011 <br> .009 <br> . 007 | $\begin{aligned} & 1 / 100 \\ & 3 / 150 \\ & 5 / 220 \\ & 5 / 330 \end{aligned}$ | $\begin{aligned} & 1 / 1.5 \\ & 1 / 1 \\ & 4 / 6.5 \\ & 4 / 3 \end{aligned}$ |  |  |  |
| IN1850 <br> 1N1851 <br> IN1852 <br> 1N1853 | $\begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}$ | $\begin{aligned} & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \end{aligned}$ |  |  |  | $\begin{array}{r} 470 \\ 6.8 \\ 10 \\ 15 \end{array}$ | $\begin{aligned} & .006 \\ & .085 \\ & .077 \\ & .063 \end{aligned}$ | $\begin{aligned} & 5 / 470 \\ & .5 / 6.8 \\ & .5 / 10 \\ & .5 / 15 \end{aligned}$ | $\begin{aligned} & 4 / 2 \\ & 1 / 50 \\ & 1 / 35 \\ & 1 / 23 \end{aligned}$ |  |  |  |

## DIODE INTERCHANGEABILITY

| TYP: MUMA |  |  | TI |  | ratinos |  |  | CHARACTERISTICS |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  |  | $\mathbf{V}_{\mathbf{R}}$ <br> (V) | I <br> (A) | $\begin{array}{ll} L_{R} & \bullet V_{R} \\ \mu & /(V) \end{array}$ | $\begin{array}{cc} V_{F} & I_{F} \\ (V) & /(\mathrm{ma}) \end{array}$ | $\begin{aligned} & { }^{1 / r r} \\ & (n n) \end{aligned}$ | $\mathbf{V}_{\mathbf{z}} \cdot \mathbf{l z}_{\mathbf{z}}$ <br> (V) / (ma) | $\begin{gathered} \text { то } \\ \times \end{gathered}$ |
| iN1854 <br> 1N1855 <br> IN1856 <br> 1N1857 |  | $\begin{aligned} & R E \\ & R E \\ & R E \\ & R E \\ & R E \end{aligned}$ |  |  |  | $\begin{aligned} & 22 \\ & 33 \\ & 47 \\ & 68 \end{aligned}$ | $\begin{gathered} .05 \\ .04 \\ .03 \\ .023 \end{gathered}$ | $\begin{gathered} .1 / 22 \\ .1 / 33 \\ .1 / 47 \\ 1 / 68 \end{gathered}$ | $\begin{aligned} & 1 / 12 \\ & 1 / 7 \\ & 1 / 4.5 \\ & 1 / 2.7 \end{aligned}$ |  |  |  |
| 1N1858 1N1859 IN1860 IN1861 | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\begin{aligned} & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \end{aligned}$ |  |  |  | $\begin{aligned} & 100 \\ & 150 \\ & 220 \\ & 330 \end{aligned}$ | $\begin{aligned} & .016 \\ & .011 \\ & .009 \\ & .007 \end{aligned}$ | $\begin{aligned} & 1 / 100 \\ & 3 / 150 \\ & 5 / 220 \\ & 5 / 330 \end{aligned}$ | $\begin{aligned} & 1 / 1.5 \\ & 1 / 1 \\ & 4 / 6.5 \\ & 4 / 3 \end{aligned}$ |  |  |  |
| 1N1862 <br> 1N1863 <br> 1N1864 <br> IN1865 | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | RE <br> RE <br> RE <br> RE |  |  |  | $\begin{array}{r} 470 \\ 6.8 \\ 10 \\ 15 \end{array}$ | $\begin{aligned} & .006 \\ & .085 \\ & .077 \\ & .063 \end{aligned}$ | $\begin{aligned} & 5 / 470 \\ & .5 / 6.8 \\ & .5 / 10 \\ & .5 / 15 \end{aligned}$ | $\begin{aligned} & 4 / 2 \\ & 1 / 50 \\ & 1 / 35 \\ & 1 / 23 \end{aligned}$ |  |  |  |
| 1N1866 <br> iN1867 <br> 1N1868 <br> 1N1869 | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\begin{aligned} & R E \\ & R E \\ & R E \\ & R E \\ & R E \end{aligned}$ |  |  |  | $\begin{aligned} & 22 \\ & 33 \\ & 47 \\ & 68 \end{aligned}$ | $\begin{gathered} .05 \\ .04 \\ .03 \\ .023 \end{gathered}$ | $\begin{aligned} & .1 / 22 \\ & .1 / 33 \\ & .1 / 47 \\ & 1 / 68 \end{aligned}$ | $\begin{aligned} & 1 / 12 \\ & 1 / 7 \\ & 1 / 4.5 \\ & 1 / 2.7 \end{aligned}$ |  |  |  |
| 1N1870 1N1871 1N1872 iN1873 | $\left\lvert\, \begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{S} \\ & \mathbf{s} \end{aligned}\right.$ | $\left.\begin{array}{\|c\|} \hline R E \\ R E \\ R E \\ \operatorname{RE} \\ \operatorname{RE} \end{array} \right\rvert\,$ |  |  |  | $\begin{aligned} & 100 \\ & 150 \\ & 220 \\ & 330 \end{aligned}$ | .016 .011 .009 .007 | $\begin{aligned} & 1 / 100 \\ & 3 / 150 \\ & 5 / 220 \\ & 5 / 330 \end{aligned}$ | $\begin{aligned} & 1 / 1.5 \\ & 1 / 1 \\ & 4 / 6.5 \\ & 4 / 3 \end{aligned}$ |  |  |  |
| 1N1874 <br> 1N1875 <br> 1N1875A <br> 1N1875B | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\left.\begin{aligned} & R E \\ & \mathrm{ZD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \end{aligned} \right\rvert\,$ |  | 1N4738 <br> 1N4738A | $\begin{aligned} & \text { iw } \\ & \text { iw } \\ & \text { iw } \end{aligned}$ | 470 | . 006 | 5/470 | 4/2 |  | $\begin{aligned} & 8.2 / 25 \\ & 8.2 / 25 \\ & 8.2 / 25 \end{aligned}$ | 10 5 1 |
| 1N1876 <br> IN1876A <br> JN18768 <br> 1N1877 | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\begin{aligned} & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \end{aligned}$ |  | 1N4740 <br> IN4740A <br> 1N4742 | $\begin{aligned} & 1 \mathbf{1 w} \\ & 1 \mathbf{w} \\ & 1 \mathbf{w} \\ & 1 \mathbf{W} \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 10 / 25 \\ & 10 / 25 \\ & 10 / 25 \\ & 12 / 25 \end{aligned}$ | 10 5 1 10 |
| $\begin{aligned} & \text { 1N1877A } \\ & \text { 1N1877B } \\ & \text { 1N1878 } \\ & \text { 1N1878A } \end{aligned}$ | $\left\lvert\, \begin{aligned} & 5 \\ & 5 \\ & 5 \\ & 5 \end{aligned}\right.$ | $\left\|\begin{array}{l} \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \end{array}\right\|$ |  | IN4742A <br> IN4744 <br> IN4744A | $\begin{aligned} & \text { iw } \\ & \text { iw } \\ & \text { iw } \\ & \text { iw } \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 12 / 25 \\ & 12 / 25 \\ & 15 / 25 \\ & 15 / 25 \end{aligned}$ | 5 1 10 5 |
| 1N1878B iN1879 INI879A 1N18798 | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\left\|\begin{array}{l} \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \end{array}\right\|$ |  | $\begin{aligned} & \text { IN4746 } \\ & \text { IN4746A } \end{aligned}$ | $\begin{aligned} & \text { iw } \\ & \text { iw } \\ & \text { iw } \\ & \text { iw } \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 15 / 25 \\ & 18 / 25 \\ & 18 / 25 \\ & 18 / 25 \end{aligned}$ | 1 10 5 1 |
| 1N1880 1N1880A 1N1880B 1N1881 | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\left\|\begin{array}{l} z 0 \\ z 0 \\ z 0 \\ z D \end{array}\right\|$ |  | $\left\{\begin{array}{l} \text { 1N4748 } \\ \text { 1N4748A } \\ \text { IN4750 } \end{array}\right.$ | $\begin{aligned} & 16 \\ & 16 \\ & 1 w \\ & 10 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 22 / 8 \\ & 22 / 8 \\ & 22 / 8 \\ & 27 / 8 \end{aligned}$ | 10 5 1 10 |


| TYPE NUMRER |  | $\begin{aligned} & \frac{z}{6} \\ & \frac{2}{3} \\ & \frac{3}{3} \\ & 3 \end{aligned}$ | $\begin{gathered} \text { TI } \\ \text { REPLACEMENT } \end{gathered}$ |  | datines |  |  | CHARACTERISTICS |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  | PD (mW) | $\mathbf{V}_{\mathbf{R}}$ <br> (V) | (A) | $\begin{array}{ll} \mathbf{I}_{\mathbf{R}} & \mathbf{V}_{\mathbf{R}} \\ \mu \mathbf{A} & / \mathbf{V}) \end{array}$ | $\mathbf{V}_{\mathbf{F}}$ <br> (V) | $\begin{gathered} \mathrm{I}_{\mathbf{F}} \\ /(\mathrm{mA}) \end{gathered}$ | $\begin{aligned} & I_{V r} \\ & \text { (ns) } \end{aligned}$ | $\begin{aligned} & V_{z} \subset I_{z} \\ & (V) /(\mathrm{mA}) \end{aligned}$ | TOL * |
| 1N1881A <br> 1N18818 <br> iN1882 <br> 1N1882A | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\begin{aligned} & \mathrm{ZD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \end{aligned}$ |  | 1N4750A <br> 1N4752 <br> 1N4752A | $\begin{aligned} & \text { iw } \\ & \text { iw } \\ & \text { iw } \\ & \text { iw } \end{aligned}$ |  |  |  |  |  |  | $\begin{aligned} & 27 / 8 \\ & 27 / 8 \\ & 33 / 8 \\ & 33 / 8 \end{aligned}$ | 5 1 10 5 |
| 1N1882B <br> 1N1883 <br> 1N1883A <br> 1N18838 | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\left(\left.\begin{array}{l} \mathrm{ZD} \\ \mathrm{ZD} \\ \mathrm{ZD} \\ \mathrm{ZD} \end{array} \right\rvert\,\right.$ |  |  | IW <br> IW <br> IW <br> IW |  |  |  |  |  |  | $\begin{aligned} & 33 / 8 \\ & 39 / 8 \\ & 39 / 8 \\ & 39 / 8 \end{aligned}$ | 1 10 5 1 |
| 1N1884 1N1884A IN1884B INI885 | $\left\lvert\, \begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}\right.$ | $\begin{aligned} & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \end{aligned}$ |  |  | iw iw iw iw |  |  |  |  |  |  | $\begin{aligned} & 47 / 8 \\ & 47 / 8 \\ & 47 / 8 \\ & 56 / 8 \end{aligned}$ | $\begin{array}{r} 10 \\ 5 \\ 1 \\ 10 \end{array}$ |
| 1N1885A 1N1885B 1N1886 1N1886A | $\left\lvert\, \begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}\right.$ | $\begin{aligned} & \mathrm{ZD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \end{aligned}$ |  |  | IW IW IW IW |  |  |  |  |  |  | $56 / 8$  <br> $56 / 8$  <br> $68 / 3$  <br> $68 / 3$  | 5 1 10 5 |
| 1N1886B <br> 1N1887 <br> IN1887A <br> iN1887B | $\begin{aligned} & \mathrm{s} \\ & \mathrm{~S} \\ & \mathrm{~s} \\ & \mathrm{~s} \end{aligned}$ | $\begin{aligned} & \mathrm{ZD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \end{aligned}$ |  |  | IW <br> IW 1W IW |  |  |  |  |  |  | 68/3 <br> 82/3 <br> 82/3 <br> 82/3 | 1 10 5 1 |
| 1N1888 <br> IN1888A <br> 1N1888B <br> 1N1889 | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\begin{aligned} & \mathrm{ZD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \end{aligned}$ |  |  | $\begin{aligned} & \text { iw } \\ & \text { iw } \\ & \text { iw } \\ & \text { iw } \end{aligned}$ |  |  |  |  |  |  | $\begin{aligned} & 100 / 3 \\ & 100 / 3 \\ & 100 / 3 \\ & 120 / 3 \end{aligned}$ | 10 5 1 10 |
| 1N1889A <br> 1N1889B <br> IN1890 <br> INI890A | $\begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}$ | $\begin{aligned} & \mathrm{zo} \\ & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \end{aligned}$ |  |  | $\begin{aligned} & 1 w \\ & 1 w \\ & 1 w \\ & 1 w \end{aligned}$ |  |  |  |  |  |  | $\begin{aligned} & 120 / 3 \\ & 120 / 3 \\ & 150 / 3 \\ & 150 / 3 \end{aligned}$ | $\begin{array}{r} 5 \\ 1 \\ 10 \\ 5 \end{array}$ |
| 1N1890* <br> 1N1907 <br> 1N1908 <br> IN1909 | $\begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}$ | $\left\|\begin{array}{l} Z D \\ R E \\ R E \\ R E \end{array}\right\|$ |  | 1N4001 1N4002 iN4003 | IW | $\begin{array}{r} 50 \\ 100 \\ 200 \end{array}$ | $\begin{aligned} & 1.5 \\ & 1.5 \\ & 1.5 \end{aligned}$ | 10/50 <br> 10/100 <br> 10/200 |  | $\begin{aligned} & 1 / 1 \\ & 1 / 1 \\ & 1 / 1 \end{aligned}$ |  | 150/3 | 1 |
| 1N1910 1N1911 IN1912 1N1913 | $\begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{S} \end{aligned}$ | $\begin{aligned} & \mathbf{R E} \\ & \mathbf{R E} \\ & \mathbf{R E} \\ & \mathbf{R E} \end{aligned}$ |  | 1N4004 <br> 1N4004 <br> 1N4005 <br> 1N4005 |  | $\begin{aligned} & 300 \\ & 400 \\ & 500 \\ & 600 \end{aligned}$ | $\begin{aligned} & 1.5 \\ & 1.5 \\ & 1.5 \\ & 1.5 \end{aligned}$ | $\begin{aligned} & 10 / 300 \\ & 10 / 400 \\ & 10 / 500 \\ & 10 / 600 \end{aligned}$ |  | $\begin{aligned} & 1 / 1 \\ & 1 / 1 \\ & 1 / 1 \\ & 1 / 1 \end{aligned}$ |  |  |  |
| 1N1914 IN1915 1N1916 1N1917 | $\begin{aligned} & s \\ & 5 \\ & 5 \\ & 5 \end{aligned}$ | $\begin{gathered} R E \\ R E \\ R E \\ R E \end{gathered}$ |  | 1N4006 1N4006 IN4007 |  | $\begin{array}{r} 700 \\ 800 \\ 900 \\ 50 \end{array}$ | $\begin{array}{r} 1.5 \\ 1.5 \\ 1.5 \\ 4 \end{array}$ | $\begin{aligned} & 10 / 700 \\ & 10 / 800 \\ & 10 / 900 \\ & 10 / 50 \end{aligned}$ |  | $\begin{aligned} & 1 / 1 \\ & 1 / 1 \\ & 1 / 1 \\ & 1 / 1 \end{aligned}$ |  |  |  |


| TYPE NUMEER |  |  | $\pi$ <br> REPLACEMENT |  | RATINGS |  |  | CHARACTERISTICS |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  |  | $\mathbf{V}_{\mathbf{R}}$ <br> (V) | 1 <br> (A) | $\begin{array}{ll} \mathbf{l}_{\mathbf{R}} & \mathbf{V}_{\mathbf{R}} \\ \mu_{\mathbf{A}} & /(\mathbf{V}) \end{array}$ | $\mathbf{V}_{F} \cdot \mathbf{I}_{\mathbf{F}}$ <br> (V) $/(\mathrm{mA})$ | IT <br> (ns) | $\mathbf{V}_{\mathbf{Z}}$ - $\mathbf{z}$ <br> (V) $/(\mathrm{mA})$ | $\begin{gathered} \text { rot } \\ \% \end{gathered}$ |
| 1N1918 <br> 1N1919 <br> 1N1920 <br> 1N1921 | $\begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}$ | $\begin{aligned} & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \end{aligned}$ |  |  |  | 100 200 300 400 | 4 4 4 4 | 10/100 <br> 10/200 <br> 10/300 <br> 10/400 | $\begin{aligned} & 1 / 1 \\ & 1 / 1 \\ & 1 / 1 \\ & 1 / 1 \end{aligned}$ |  |  |  |
| 1N1922 <br> IN1923 <br> 1NI924 <br> IN1925 | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\begin{aligned} & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \end{aligned}$ |  |  |  | $\begin{aligned} & 500 \\ & 600 \\ & 700 \\ & 800 \end{aligned}$ | $\begin{aligned} & 4 \\ & 4 \\ & 4 \\ & 4 \end{aligned}$ | $\begin{aligned} & 10 / 500 \\ & 10 / 600 \\ & 10 / 700 \\ & 10 / 800 \end{aligned}$ | $\begin{aligned} & 1 / 1 \\ & 1 / 1 \\ & 1 / 1 \\ & 1 / 1 \end{aligned}$ |  |  |  |
| IN1926 <br> IN1927 <br> 1N1927A <br> IN1927B | $\begin{aligned} & 5 \\ & 5 \\ & 5 \\ & 5 \end{aligned}$ | $\left\lvert\, \begin{aligned} & R E \\ & \mathrm{ZD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \end{aligned}\right.$ |  | $\begin{array}{\|l\|l\|} \text { IN5228A } \\ \text { IN5228B } \end{array}$ | $\begin{aligned} & 200 \\ & 200 \\ & 200 \end{aligned}$ | 900 | 4 | 10/900 | $1 / 1$ |  | $\begin{aligned} & 3.9 / 5 \\ & 3.9 / 5 \\ & 3.9 / 5 \end{aligned}$ | 10 5 1 |
| 1N1928 <br> 1N1928A <br> 1N1928B <br> 1N1929 | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\begin{aligned} & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{ZD} \end{aligned}$ |  | $\begin{aligned} & \text { IN5230A } \\ & \text { IN5230B } \\ & \text { IN5232A } \end{aligned}$ | $\begin{aligned} & 200 \\ & 200 \\ & 200 \\ & 200 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 4.7 / 5 \\ & 4.7 / 5 \\ & 4.7 / 5 \\ & 5.6 / 5 \end{aligned}$ | 10 5 1 10 |
| $\begin{array}{\|l} \text { 1N1929A } \\ \text { 1N1929B } \\ \text { 1N1930 } \\ \text { 1N1930A } \end{array}$ | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\left\lvert\, \begin{aligned} & \mathrm{ZD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \end{aligned}\right.$ |  | $\left\{\begin{array}{l} \text { IN5232B } \\ \text { IN5235A } \\ \text { IN5235B } \end{array}\right.$ | $\begin{aligned} & 200 \\ & 200 \\ & 200 \\ & 200 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 5.6 / 5 \\ & 5.6 / 5 \\ & 6.8 / 5 \\ & 6.8 / 5 \end{aligned}$ | 5 1 10 5 |
| 1N1930B <br> IN1931 <br> 1N1931A <br> IN1931B | $\begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}$ | $\begin{aligned} & \mathrm{ZD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \end{aligned}$ |  | $\left\lvert\, \begin{aligned} & \text { IN5237A } \\ & \text { IN5237B } \end{aligned}\right.$ | $\begin{aligned} & 200 \\ & 200 \\ & 200 \\ & 200 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 6.8 / 5 \\ & 8.2 / 5 \\ & 8.2 / 5 \\ & 8.2 / 5 \end{aligned}$ | 1 10 5 1 |
| 1N1932 <br> IN1932A <br> 1N1932B <br> 1N1933 | $\begin{aligned} & \mathbf{s} \\ & s \\ & s \\ & s \end{aligned}$ | $\left\|\begin{array}{l} \mathrm{ZD} \\ \mathrm{ZD} \\ \mathrm{ZD} \\ \mathrm{ZD} \end{array}\right\|$ |  | $\left\{\begin{array}{l} \text { 1N5240A } \\ \text { iN5240B } \\ \text { 1N5242A } \end{array}\right.$ | $\begin{aligned} & 200 \\ & 200 \\ & 200 \\ & 200 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 10 / 5 \\ & 10 / 5 \\ & 10 / 5 \\ & 12 / 1 \end{aligned}$ | 10 5 1 10 |
| $\begin{aligned} & \text { IN1933A } \\ & \text { IN1933B } \\ & \text { IN1934 } \\ & \text { IN1934A } \end{aligned}$ | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\left.\begin{aligned} & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \end{aligned} \right\rvert\,$ |  | $\left\lvert\, \begin{aligned} & \text { 1N5242B } \\ & \text { 1N5245A } \\ & \text { 1N52458 } \end{aligned}\right.$ | $\begin{aligned} & 200 \\ & 200 \\ & 200 \\ & 200 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 12 / 1 \\ & 12 / 1 \\ & 15 / 1 \\ & 15 / 1 \end{aligned}$ | 5 1 10 5 |
| 1N1934B <br> IN1935 <br> 1N1935A <br> 1N1935B | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\begin{aligned} & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \end{aligned}$ |  | $\begin{aligned} & \text { 1N5248A } \\ & \text { iN5248B } \end{aligned}$ | $\begin{aligned} & 200 \\ & 200 \\ & 200 \\ & 200 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 15 / 1 \\ & 18 / 1 \\ & 18 / 1 \\ & 18 / 1 \end{aligned}$ | 1 10 5 1 |
| 1N1936 <br> 1N1936A <br> 1N1936B <br> 1N1937 | $\begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{S} \\ & \mathbf{s} \end{aligned}$ | $\left.\begin{aligned} & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \end{aligned} \right\rvert\,$ |  | $\begin{aligned} & \text { IN5251A } \\ & \text { IN5251B } \\ & \text { IN5254A } \end{aligned}$ | $\begin{aligned} & 200 \\ & 200 \\ & 200 \\ & 200 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 22 / 1 \\ & 22 / 1 \\ & 22 / 1 \\ & 27 / 1 \end{aligned}$ | $\begin{array}{r} 10 \\ 5 \\ 1 \\ 10 \end{array}$ |

## DIODE INTERCHANGEABILITY

| TYPE NUMBER |  | $\begin{aligned} & 3 \\ & \frac{2}{2} \\ & 5 \\ & 5 \\ & 5 \\ & 0 \end{aligned}$ | II |  | Ratines |  |  | CNARACHERStics |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  |  | $\mathbf{V}_{\mathbf{R}}$ <br> (V) | $1$ <br> (A) | $\begin{array}{ll} \mathbf{n} & \mathbf{V}_{\mathrm{R}} \\ \mu \mathrm{~A} & /(\mathrm{V}) \end{array}$ | $\begin{array}{ccc} V_{F} & i_{7} \\ \text { (V) } & 1 \mathrm{ma}) \end{array}$ | $\mathbf{t}_{\mathbf{T}}$ <br> ( n ) | $\mathbf{v}_{\mathbf{z}}$ - $\mathbf{z}_{\mathbf{Z}}$ <br> (V) $/$ (mA) | $\begin{gathered} \text { ror } \\ \% \end{gathered}$ |
| 1N1937A <br> 1N1937B <br> 1N1938 <br> INI938A | $\begin{aligned} & \hline 5 \\ & s \\ & s \\ & 5 \\ & 5 \end{aligned}$ | $\begin{aligned} & \mathrm{zO} \\ & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \end{aligned}$ |  | $\begin{aligned} & \text { 1N5254B } \\ & \text { 1N5257A } \\ & \text { 1N52578 } \end{aligned}$ | $\begin{aligned} & 200 \\ & 200 \\ & 200 \\ & 200 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 27 / 1 \\ & 27 / 1 \\ & 33 / .2 \\ & 33 / .2 \end{aligned}$ | 5 1 10 5 |
| 1N1938B 1N1939 iN1939A 1N19398 | $\begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}$ | $\begin{aligned} & \mathrm{zo} \\ & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \end{aligned}$ |  |  | $\begin{aligned} & 200 \\ & 200 \\ & 200 \\ & 200 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 33 / .2 \\ & 39 / .2 \\ & 39 / .2 \\ & 39 / .2 \end{aligned}$ | 1 10 5 1 |
| IN1940 <br> 1N1940A <br> 1N1940* <br> 1N1941 | $\begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}$ | $\begin{aligned} & \mathrm{zo} \\ & \mathrm{zo} \\ & \mathrm{zD} \\ & \mathrm{zD} \end{aligned}$ |  |  | $\begin{aligned} & 200 \\ & 200 \\ & 200 \\ & 200 \end{aligned}$ |  |  |  |  |  | 471.2 <br> $47 / .2$ <br> 47/.2 <br> 56/.2 | 10 5 1 10 |
| INI941A <br> 1N1941B <br> 1N1942 <br> 1N1942A | $\left\lvert\, \begin{aligned} & s \\ & 5 \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\begin{aligned} & \mathrm{zD} \\ & \mathrm{zo} \\ & \mathrm{zD} \\ & \mathrm{zD} \end{aligned}$ |  |  | $\begin{aligned} & 200 \\ & 200 \\ & 200 \\ & 200 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 56 / .2 \\ & 56 / .2 \\ & 68 / .2 \\ & 68 / .2 \end{aligned}$ | 5 1 10 5 |
| 1N1942B <br> 1N1943 <br> 1N1943A <br> 1N1943B | $\begin{aligned} & 5 \\ & 5 \\ & 5 \\ & 5 \end{aligned}$ | $\begin{aligned} & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \end{aligned}$ |  |  | $\begin{aligned} & 200 \\ & 200 \\ & 200 \\ & 200 \end{aligned}$ |  |  |  | - |  | $\begin{aligned} & 68 / .2 \\ & 82 / .2 \\ & 82 / .2 \\ & 82 / .2 \end{aligned}$ | 1 10 5 1 |
| IN1944 <br> iN194dA <br> 1N1944B <br> IN1945 | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\begin{aligned} & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \end{aligned}$ |  |  | $\begin{aligned} & 200 \\ & 200 \\ & 200 \\ & 200 \end{aligned}$ | - |  |  | . |  | $\begin{aligned} & 100 / .2 \\ & 100 / .2 \\ & 100 / .2 \\ & 120 / .2 \end{aligned}$ | 10 5 1 10 |
| 1N1945A <br> 1N1945 <br> IN1946 <br> 1N1946A | $\begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}$ | $\begin{aligned} & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \end{aligned}$ |  |  | $\begin{aligned} & 200 \\ & 200 \\ & 200 \\ & 200 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 120 / .2 \\ & 120 / .2 \\ & 150 / .1 \\ & 150 / .1 \end{aligned}$ | 5 1 10 5 |
| 1N1946B <br> 1N1947 <br> 1N1947A <br> 1N19478 | $\begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}$ | $\begin{aligned} & \mathrm{ZD} \\ & \mathrm{zD} \\ & \mathrm{ZD} \\ & \mathrm{zD} \end{aligned}$ |  |  | $\begin{aligned} & 200 \\ & 200 \\ & 200 \\ & 200 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 150 / .1 \\ & 180 / .1 \\ & 180 / .1 \\ & 180 / .1 \end{aligned}$ | 1 10 5 1 |
| 1N1948 <br> IN1948A <br> 1N1948B <br> 1N1949 | $\begin{aligned} & 5 \\ & s \\ & s \\ & s \end{aligned}$ | $\begin{aligned} & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \end{aligned}$ |  |  | $\begin{aligned} & 200 \\ & 200 \\ & 200 \\ & 200 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 220 / .1 \\ & 220 / .1 \\ & 220 / .1 \\ & 270 / .1 \end{aligned}$ | 10 5 1 10 |
| 1N1949A <br> 1N1949B <br> 1N1950 <br> 1N1950A | $\begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}$ | $\begin{aligned} & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \end{aligned}$ |  |  | $\begin{aligned} & 200 \\ & 200 \\ & 200 \\ & 200 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 270 / .1 \\ & 270 / .1 \\ & 330 / .1 \\ & 330 / .1 \end{aligned}$ | $\begin{array}{r} 5 \\ 1 \\ 10 \\ 5 \end{array}$ |


| TYFE |  | $\begin{aligned} & \frac{5}{3} \\ & \frac{3}{3} \\ & \frac{8}{3} \end{aligned}$ | $\begin{gathered} \text { II } \\ \text { exacement } \end{gathered}$ |  | ratines |  |  | CHARACTERESICS |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  |  | $\begin{aligned} & V_{\mathbf{R}} \\ & (\mathrm{V}) \end{aligned}$ | I <br> (A) | $\begin{array}{ll} \mathbf{L}_{\mathbf{R}} & \mathbf{V}_{\mathrm{R}} \\ \boldsymbol{\mu} \mathrm{~A} & (\mathrm{~V}) \end{array}$ | $\begin{array}{ccc} \mathbf{V}_{F} & \text { F } \\ \text { (V) } & /(\mathrm{ma}) \end{array}$ | ${ }^{\boldsymbol{f}}$ <br> ( n s) | $\mathbf{V Z}_{\mathbf{2}}$ - $\mathbf{z}$ <br> (V) / (ma) | $\begin{gathered} \text { TOR } \\ \times \end{gathered}$ |
| 1N19503 <br> 1N1951 <br> IN1951A <br> 1N19518 | $\begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}$ | $\begin{aligned} & z 0 \\ & z 0 \\ & z 0 \\ & z 0 \end{aligned}$ |  |  | $\begin{aligned} & 200 \\ & 200 \\ & 200 \\ & 200 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 330 / .1 \\ & 390 / .1 \\ & 390 / .1 \\ & 390 / .1 \end{aligned}$ | 1 10 5 1 |
| 1N1952 <br> IN1952A <br> 1N1952B <br> 1N1953 | $\left\lvert\, \begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}\right.$ | $\begin{aligned} & \mathrm{zo} \\ & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zo} \end{aligned}$ |  |  | $\begin{aligned} & 200 \\ & 200 \\ & 200 \\ & 200 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 470 / .1 \\ & 470 / .1 \\ & 470 / .1 \\ & 560 / .1 \end{aligned}$ | 10 5 1 10 |
| IN1953A <br> IN1953: <br> IN1954 <br> 1N1954A | $\left\lvert\, \begin{aligned} & 5 \\ & 5 \\ & 5 \\ & 5 \end{aligned}\right.$ | $\left\lvert\, \begin{aligned} & z 0 \\ & z 0 \\ & z 0 \\ & z 0 \end{aligned}\right.$ |  | $\left\lvert\, \begin{aligned} & \text { iN5228A } \\ & \text { iN52288 } \end{aligned}\right.$ | $\begin{aligned} & 200 \\ & 200 \\ & 400 \\ & 400 \end{aligned}$ |  |  |  |  |  | $\begin{gathered} 560 / .1 \\ 560 / .1 \\ 3.9 / 5 \\ 3.9 / 5 \end{gathered}$ | 5 1 10 5 |
| 1N19348 <br> 1N1955 <br> 1N1955A <br> 1N19558 | $\left\lvert\, \begin{aligned} & 5 \\ & 5 \\ & 5 \\ & 5 \end{aligned}\right.$ | $\begin{aligned} & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \end{aligned}$ |  | $\begin{array}{\|l} \text { IN5230A } \\ \text { IN5230 } \end{array}$ | $\begin{aligned} & 400 \\ & 400 \\ & 400 \\ & 400 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 3.9 / 5 \\ & 4.7 / 5 \\ & 4.7 / 5 \\ & 4.7 / 5 \end{aligned}$ | 1 10 5 1 |
| 1N1956 <br> 1N1956A <br> 1N19568 <br> IN1957 | $\left\lvert\, \begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}\right.$ | $\begin{aligned} & z 0 \\ & z 0 \\ & z 0 \\ & z 0 \end{aligned}$ | . | $\left\lvert\, \begin{aligned} & \text { IN5232A } \\ & \text { IN52328 } \end{aligned}\right.$ <br> 1N5235A | $\begin{array}{r} 400 \\ 400 \\ 400 \\ 400 \end{array}$ |  |  |  |  |  | $\begin{aligned} & 5.6 / 5 \\ & 5.6 / 5 \\ & 5.6 / 5 \\ & 6.8 / 5 \end{aligned}$ | 10 5 1 10 |
| 1N1957A <br> 1N1957 <br> iN1958 <br> 1N1958A | $\left\lvert\, \begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}\right.$ | $\begin{aligned} & \mathrm{zo} \\ & \mathrm{zb} \\ & \mathrm{zo} \\ & 20 \end{aligned}$ |  | $\begin{aligned} & \text { 1N52355 } \\ & \text { 1N5237A } \\ & \text { 1N5237: } \end{aligned}$ | $\begin{array}{r} 400 \\ 400 \\ 400 \\ 400 \end{array}$ |  | , |  |  |  | $\begin{aligned} & 6.8 / 5 \\ & 6.8 / 5 \\ & 8.2 / 5 \\ & 8.2 / 5 \end{aligned}$ | 5 1 10 5 |
| 1N19588 1N1959 1N1959A 1N1959 | $\left\lvert\, \begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}\right.$ | $\begin{aligned} & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zo} \end{aligned}$ |  | $\begin{aligned} & \text { IN5240A } \\ & \text { IN52408 } \end{aligned}$ | $\begin{array}{r} 400 \\ 400 \\ 400 \\ 400 \end{array}$ |  |  |  |  |  | $\begin{aligned} & 8.2 / 5 \\ & 10 / 5 \\ & 10 / 5 \\ & 10 / 5 \end{aligned}$ | 1 10 5 1 |
| IN1960 <br> 1N1960A <br> IN19608 <br> 1N1961 | $\begin{aligned} & 5 \\ & s \\ & s \\ & s \end{aligned}$ | $\begin{aligned} & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \end{aligned}$ |  | $\begin{aligned} & \text { IN5242A } \\ & \text { IN5242B } \\ & \text { IN5245A } \end{aligned}$ | $\begin{array}{r} 400 \\ 400 \\ 400 \\ 400 \end{array}$ |  |  |  |  |  | $\begin{aligned} & 12 / 1 \\ & 12 / 1 \\ & 12 / 1 \\ & 15 / 1 \end{aligned}$ | 10 5 1 10 |
| 1N1961A IN1961s 1N1962 IN1962A | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\left\|\begin{array}{l} \mathrm{ZD} \\ \mathrm{ZD} \\ \mathrm{ZD} \\ \mathrm{ZD} \end{array}\right\|$ |  | $\left\lvert\, \begin{aligned} & \text { IN52A5B } \\ & \text { IN5248A } \\ & \text { IN5248B } \end{aligned}\right.$ | $\begin{array}{r} 400 \\ 400 \\ 400 \\ 400 \end{array}$ |  |  |  |  |  | $\begin{aligned} & 15 / 1 \\ & 15 / 1 \\ & 18 / 1 \\ & 18 / 1 \end{aligned}$ | 5 1 10 5 |
| 1N1962B <br> IN1963 <br> 1N1963A <br> IN1963 | $\left\lvert\, \begin{aligned} & 5 \\ & 5 \\ & 5 \\ & 5 \end{aligned}\right.$ | $\begin{aligned} & 20 \\ & 20 \\ & 20 \\ & 20 \end{aligned}$ |  | $\begin{aligned} & \text { IN5251A } \\ & \text { IN52518 } \end{aligned}$ | $\begin{array}{r} 400 \\ 400 \\ 400 \\ 400 \end{array}$ |  |  |  |  |  | $\begin{aligned} & 18 / 1 \\ & 22 / 1 \\ & 22 / 1 \\ & 22 / 1 \end{aligned}$ | 1 10 5 1 |

## DIODE INTERCHANGEABILITY



| TYFE NuMBE | $\begin{aligned} & 3 \\ & \frac{3}{3} \\ & \frac{3}{3} \end{aligned}$ |  | TITERACEMENT | $\begin{aligned} & \text { FON } \\ & \text { NEW } \\ & \text { DEsich } \end{aligned}$ | datines |  |  | CHARACTEASTICS |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  | $\begin{gathered} \mathbf{P D}_{\mathbf{D}} \\ (\mathbf{m W}) \end{gathered}$ | $V_{R}$ <br> (V) | 1 <br> (A) | $\begin{array}{ll} \mathbf{m}_{\mathbf{R}} & \mathbf{V}_{\mathrm{R}} \\ \boldsymbol{\mu} & (\mathrm{~V}) \end{array}$ | $\left.\begin{array}{lll} V_{F} & i \end{array} \right\rvert\,$ | $\begin{aligned} & t_{r} \\ & \text { (ns) } \end{aligned}$ | $\mathbf{v}_{\mathbf{z}} \bullet \mathbf{l}_{\mathbf{z}}$ <br> (V) $/$ (mA) | $\begin{aligned} & \text { rot } \\ & \% \end{aligned}$ |
| 1N1977A <br> 1N1977B <br> 1N1978 <br> IN1978A | $\left\lvert\, \begin{aligned} & s \\ & 5 \\ & 5 \\ & 5 \end{aligned}\right.$ | $\begin{aligned} & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \end{aligned}$ |  |  | $\begin{array}{r} 400 \\ 400 \\ 400 \\ 400 \end{array}$ |  |  |  |  |  | $\begin{aligned} & 330 / .1 \\ & 330 / .1 \\ & 390 / .1 \\ & 390 / .1 \end{aligned}$ | 5 1 10 5 |
| 1N19788 <br> 1N1979 <br> 1N1979A <br> 1N19798 | $\left\lvert\, \begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}\right.$ | $\left\|\begin{array}{l} \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \end{array}\right\|$ |  |  | 400 400 400 400 |  |  |  |  |  | $390 / .1$ <br> 470/.1 <br> 470/.1 <br> 470/.1 | 1 10 5 1 |
| 1N1980 <br> 1N1980A <br> IN19808 <br> IN1981 | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\begin{aligned} & z 0 \\ & z D \\ & z D \\ & z 0 \end{aligned}$ |  | in5228A | 400 400 400 150 |  |  | - |  |  | $\begin{gathered} 560 / .1 \\ 560 / .1 \\ 560 / .1 \\ 3.9 / 5 \end{gathered}$ | 10 5 1 10 |
| IN1981A <br> IN19818 <br> IN1982 <br> 1N1982A | $\left\lvert\, \begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}\right.$ | $\begin{aligned} & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \end{aligned}$ |  | 1N52288 <br> IN5230A IN52308 | $\begin{aligned} & 150 \\ & 150 \\ & 150 \\ & 150 \end{aligned}$ |  |  | - |  |  | $\begin{aligned} & 3.9 / 5 \\ & 3.9 / 5 \\ & 4.7 / 5 \\ & 4.7 / 5 \end{aligned}$ | 5 1 10 5 |
| 1N1982B <br> 1N1983 <br> 1N1983A <br> 1N19838 | $\left\lvert\, \begin{aligned} & 5 \\ & s \\ & 5 \\ & s \end{aligned}\right.$ | $\begin{aligned} & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \end{aligned}$ |  | $\left\lvert\, \begin{aligned} & \text { IN5232A } \\ & \text { IN5232B } \end{aligned}\right.$ | $\begin{aligned} & 150 \\ & 150 \\ & 150 \\ & 150 \end{aligned}$ |  |  |  |  |  | $4.7 / 5$ <br> 5.6/5 <br> 5.6/5 <br> 5.6/5 | 1 10 5 1 |
| 1N1984 1N1984A 1N1984B 1N1985 | $\begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}$ | $\begin{aligned} & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \end{aligned}$ |  | $\begin{aligned} & \text { IN5235A } \\ & \text { IN52358 } \\ & \text { IN5237A } \end{aligned}$ | $\begin{aligned} & 150 \\ & 150 \\ & 150 \\ & 150 \end{aligned}$ |  |  |  |  |  | 6.8/5 <br> 6.8/5 <br> 6.8/5 <br> 8.2/5 | 10 5 1 10 |
| 1N1985A 1N1985B IN1986 1N1986A | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\begin{aligned} & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \end{aligned}$ |  | $\begin{aligned} & \text { IN52378 } \\ & \text { IN5240A } \\ & \text { IN5240B } \end{aligned}$ | $\begin{aligned} & 150 \\ & 150 \\ & 150 \\ & 150 \end{aligned}$ |  |  |  |  |  | $\begin{gathered} 8.2 / 5 \\ 8.2 / 5 \\ 10 / 5 \\ 10 / 5 \end{gathered}$ | 5 1 10 5 |
| IN19668 IN1987 IN1987A 1N1987B | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\begin{aligned} & \mathrm{zo} \\ & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \end{aligned}$ |  | $\begin{aligned} & \text { 1N5242A } \\ & \text { IN5242B } \end{aligned}$ | $\begin{aligned} & 150 \\ & 150 \\ & 150 \\ & 150 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 10 / 5 \\ & 12 / 1 \\ & 12 / 1 \\ & 12 / 1 \end{aligned}$ | 1 10 5 1 |
| 1N1988 <br> IN1988A <br> IN19888 <br> IN1989 | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\begin{aligned} & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \end{aligned}$ |  | IN5245A 1N52458 <br> IN5248A | $\begin{aligned} & 150 \\ & 150 \\ & 150 \\ & 150 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 15 / 1 \\ & 15 / 1 \\ & 15 / 1 \\ & 18 / 1 \end{aligned}$ | 10 5 1 10 |
| $\begin{aligned} & \text { IN1989A } \\ & \text { IN1989B } \\ & \text { IN1990 } \\ & \text { IN1990A } \end{aligned}$ | \$ | $\left.\begin{aligned} & \mathrm{ZD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \end{aligned} \right\rvert\,$ |  | $\left\{\begin{array}{l} \text { IN52488 } \\ \text { IN5251A } \\ \text { IN52518 } \end{array}\right.$ | $\begin{aligned} & 150 \\ & 150 \\ & 150 \\ & 150 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 18 / 1 \\ & 18 / 1 \\ & 22 / 1 \\ & 22 / 1 \end{aligned}$ | 5 1 10 5 |

## DIODE INTERCHANGEABILITY

| $\begin{gathered} \text { TYPE } \\ \text { NUMBER } \end{gathered}$ |  |  | $\begin{array}{\|c\|} \text { TI } \\ \text { REPLACEMENT } \end{array}$ | $\begin{gathered} \text { FOR } \\ \text { NEW } \\ \text { DESGGN } \end{gathered}$ | ${ }^{P}$ D (mW) | $\begin{gathered} \text { atinges } \\ \mathbf{V}_{\mathbf{R}} \\ \text { (V) } \end{gathered}$ | 1 <br> (A) | $\begin{array}{ll} I_{R} & V_{R} \\ \mu_{A} & (V) \end{array}$ | $\begin{array}{cc} \mathbf{v}_{\mathbf{F}} & \mathbf{l}_{\mathbf{F}} \\ (\mathbf{v}) & 1(\mathrm{~mA}) \end{array}$ | ERISTICS <br> ${ }^{1} \pi$ <br> (ns) | $\begin{array}{ccc} v_{z} & \mathrm{z} \\ (\mathrm{v}) & /(\mathrm{mA}) \end{array}$ | \% |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 1N19908 1N1991 1N1991A 1N1991B | $\left[\begin{array}{l} s \\ s \\ s \\ s \end{array}\right.$ | $\left\|\begin{array}{l} \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \end{array}\right\|$ |  | IN5254A IN5254B | $\begin{aligned} & 150 \\ & 150 \\ & 150 \\ & 150 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 22 / 1 \\ & 27 / 1 \\ & 27 / 1 \\ & 27 / 1 \end{aligned}$ | 1 10 5 1 |
| 1N1992 IN1992A 1N19928 1N1993 | $\begin{aligned} & \mathrm{s} \\ & \mathrm{~s} \\ & \mathrm{~s} \\ & \mathrm{~s} \end{aligned}$ | $\left\|\begin{array}{l} \mathrm{zD} \\ \mathrm{ZD} \\ \mathrm{zD} \\ \mathrm{ZD} \end{array}\right\|$ |  | $\begin{array}{\|l\|l\|} \hline \text { IN5257A } \\ \text { 1N5257B } \end{array}$ | $\begin{aligned} & 150 \\ & 150 \\ & 150 \\ & 150 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 33 / .2 \\ & 33 / .2 \\ & 33 / .2 \\ & 39 / .2 \end{aligned}$ | 10 5 1 10 |
| iN1993A 1N1993B IN1994 IN1994A | $\begin{aligned} & \mathrm{s} \\ & \mathrm{~s} \\ & \mathrm{~s} \\ & \mathrm{~s} \end{aligned}$ | $\begin{aligned} & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \end{aligned}$ |  |  | $\begin{aligned} & 150 \\ & 150 \\ & 150 \\ & 150 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 39 / .2 \\ & 39 / .2 \\ & 47 / .2 \\ & 47 / .2 \end{aligned}$ | 5 1 10 5 |
| 1N1994B IN1995 1N1995A 1N1995B | $\begin{aligned} & \mathrm{s} \\ & \mathrm{~s} \\ & \mathrm{~s} \\ & \mathrm{~s} \end{aligned}$ |  |  |  | $\begin{aligned} & 150 \\ & 150 \\ & 150 \\ & 150 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 47 / .2 \\ & 56 / .2 \\ & 56 / .2 \\ & 56 / .2 \end{aligned}$ | 1 10 5 1 |
| iN1995B 1N2000 1N2000A in2000B | $\begin{aligned} & s \\ & s \\ & s \\ & s \\ & s \end{aligned}$ | $\left\|\begin{array}{l} \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \end{array}\right\|$ |  |  | $\begin{aligned} & 150 \\ & 150 \\ & 150 \\ & 150 \end{aligned}$ |  |  |  |  |  | $\begin{array}{r} 56 / .2 \\ 150 / .1 \\ 150 / .1 \\ 150 / .1 \end{array}$ | 1 10 5 1 |
| 1N2001 <br> in2001A <br> 1N2001B <br> 1N2002 | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\left.\begin{aligned} & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \end{aligned} \right\rvert\,$ |  |  | $\begin{aligned} & 150 \\ & 150 \\ & 150 \\ & 150 \end{aligned}$ |  |  |  |  |  | 180/.1 <br> 180/. 1 <br> 180/. 1 <br> 220/. 1 | 10 5 1 10 |
| in2002A iN2002B IN2003 IN2003A | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\left\|\begin{array}{l} \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \end{array}\right\|$ |  |  | $\begin{aligned} & 150 \\ & 150 \\ & 150 \\ & 150 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 220 / .1 \\ & 220 / .1 \\ & 270 / .1 \\ & 270 / .1 \end{aligned}$ | 5 1 10 5 |
| 1N2003B IN2004 in2004A 1N2004B | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\begin{aligned} & \mathrm{zo} \\ & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \end{aligned}$ |  |  | $\begin{aligned} & 150 \\ & 150 \\ & 150 \\ & 150 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 270 \% .1 \\ & 330 / .1 \\ & 333 / .1 \\ & 330 / .1 \end{aligned}$ | 1 10 5 1 |
| iN2005 <br> 1N2005A <br> 1N2005E <br> 1N2006 | $\begin{aligned} & s \\ & s \\ & s \\ & s \\ & s \end{aligned}$ | $\left\|\begin{array}{l} \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \end{array}\right\|$ |  |  | $\begin{aligned} & 150 \\ & 150 \\ & 150 \\ & 150 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 390 \% .1 \\ & 390 / .1 \\ & 390 / .1 \\ & 470 / .1 \end{aligned}$ | 10 5 1 10 |
| 1N2006A 1N2006B 1N2007 1N2007A | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\left\|\begin{array}{l} \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \end{array}\right\|$ |  |  | $\begin{aligned} & 150 \\ & 150 \\ & 150 \\ & 150 \end{aligned}$ |  |  |  |  |  | 470/.1 <br> 470/. 1 <br> 560/. 1 <br> 560\%. 1 | 5 1 10 5 |


| TYPE NUMDER | 33畐3 | $\begin{aligned} & \frac{7}{6} \\ & \frac{3}{3} \\ & \frac{2}{4} \\ & \frac{3}{3} \end{aligned}$ | TI | $\begin{aligned} & \text { FOR } \\ & \text { NEW } \\ & \text { DESSCN } \end{aligned}$ | RATINES |  |  | CHARACTERISTICS |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  |  | $\mathbf{V}_{\mathbf{R}}$ <br> (V) | > I <br> (A) | $\begin{array}{ll} \mathbf{L}_{\mathrm{R}} & \bullet \mathrm{~V}_{\mathrm{R}} \\ \boldsymbol{\mu} & /(\mathrm{V}) \end{array}$ | $\begin{array}{ccc} V_{F} & \bullet & \mathbf{F} \\ (V) & /(\mathrm{m} A) \end{array}$ | $\begin{aligned} & \mathrm{IN} \\ & \text { (ns) } \end{aligned}$ | $\mathbf{V}_{\mathbf{z}}$ - $\mathbf{z}$ <br> (V) $/$ (mA) | TOL <br> \% |
| $\begin{aligned} & \text { 1N2007B } \\ & \text { 1N2013 } \\ & \text { 1N2014 } \\ & \text { 1N2015 } \end{aligned}$ | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\left\lvert\, \begin{aligned} & \mathrm{ZD} \\ & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \end{aligned}\right.$ |  | 1N4001 1N4002 1N4003 | 150 | 50 100 150 | .2 .2 .2 | $\begin{aligned} & 1 / 50 \\ & 1 / 100 \\ & 1 / 150 \end{aligned}$ | $\begin{aligned} & 1.5 / 500 \\ & 1.5 / 500 \\ & 1.5 / 500 \end{aligned}$ |  | 560/.1 | 1 |
| 1N2016 <br> 1N2017 <br> iN2018 <br> 1N2019 | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\begin{aligned} & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \end{aligned}$ |  | 1N4003 in4004 intoon 1N4004 |  | 200 250 300 350 | .2 .2 .2 .2 | $\begin{aligned} & 1 / 200 \\ & 1 / 250 \\ & 1 / 300 \\ & 1 / 350 \end{aligned}$ | $\begin{aligned} & 1.5 / 500 \\ & 1.5 / 500 \\ & 1.5 / 500 \\ & 1.5 / 500 \end{aligned}$ |  |  |  |
| $\begin{aligned} & \text { 1N2020 } \\ & \text { IN2021 } \\ & \text { IN2022 } \\ & \text { 1N2023 } \end{aligned}$ | $\begin{aligned} & \mathbf{S} \\ & \mathbf{S} \\ & \mathbf{S} \\ & \mathbf{S} \end{aligned}$ | $\begin{aligned} & \mathbf{R E} \\ & \mathbf{R E} \\ & \mathbf{R E} \\ & \mathbf{R E} \end{aligned}$ |  | 1N4004 |  | $\begin{aligned} & 400 \\ & 150 \\ & 250 \\ & 300 \end{aligned}$ | $\begin{array}{r} .2 \\ 10 \\ 10 \\ 10 \end{array}$ | $\begin{aligned} & 1 / 400 \\ & 5 \mathrm{M} / \\ & 5 \mathrm{M} / \\ & 5 \mathrm{M} / \end{aligned}$ | $\begin{aligned} & 1.5 / 500 \\ & 1.5 / \\ & 1.5 / \\ & 1.5 / \end{aligned}$ |  |  |  |
| $\begin{array}{\|l\|} \text { IN2024 } \\ \text { IN2025 } \\ \text { IN2026 } \\ \text { iN2027 } \end{array}$ | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\left.\begin{array}{\|l\|} \mathbf{R E} \\ \mathrm{RE} \\ \mathrm{RE} \\ \mathrm{RE} \end{array} \right\rvert\,$ |  |  |  | $\begin{array}{r} 350 \\ 400 \\ 50 \\ 200 \end{array}$ | $\begin{array}{r} 10 \\ 10 \\ 1 \\ 1 \end{array}$ | $\begin{aligned} & 5 \mathrm{M} / \\ & 5 \mathrm{M} / \\ & 500 / \\ & 500 / \end{aligned}$ | $\begin{aligned} & 1.5 / \\ & 1.5 / \\ & 2.0 / \\ & 2.0 / \end{aligned}$ |  |  |  |
| $\begin{aligned} & \text { 1 N2028 } \\ & \text { 1N2029 } \\ & \text { 1N2030 } \\ & \text { 1 N2031 } \end{aligned}$ | $\left\lvert\, \begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}\right.$ | $\left.\begin{array}{\|l\|} \mathbf{R E} \\ \mathrm{RE} \\ \mathrm{RE} \\ \mathrm{RE} \end{array} \right\rvert\,$ | . |  |  | $\begin{aligned} & 300 \\ & 400 \\ & 500 \\ & 600 \end{aligned}$ | $\begin{aligned} & 1 \\ & 1 \\ & 1 \\ & 1 \end{aligned}$ | $\begin{aligned} & 500 / \\ & 500 / \\ & 500 / \\ & 500 / \end{aligned}$ | $\begin{aligned} & 2.0 \prime \\ & 2.0 / \\ & 2.0 \prime \\ & 2.0 \prime \end{aligned}$ |  |  |  |
| $\begin{aligned} & \text { 1 N2032 } \\ & \text { 1 N2032A } \\ & \text { 1 N2033 } \\ & \text { 1 N2033A } \end{aligned}$ | $\begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}$ | $\left\{\begin{array}{l} \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \end{array}\right.$ |  | 1N4732 <br> 1N4732 <br> 1N4734 <br> 1N4734 | $\begin{aligned} & 750 \\ & 750 \\ & 750 \\ & 750 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 4.9 / 10 \\ & 4.5 / 10 \\ & 5.8 / 10 \\ & 5.5 / 10 \end{aligned}$ | 5 5 5 5 |
| $\begin{aligned} & \text { 1N2034 } \\ & \text { IN2034A } \\ & \text { IN2035 } \\ & \text { IN2035A } \end{aligned}$ | $\begin{aligned} & s \\ & s \\ & s \\ & s \\ & s \end{aligned}$ | $\left.\begin{aligned} & z 0 \\ & z D \\ & z 0 \\ & z 0 \end{aligned} \right\rvert\,$ |  | 1N4736 <br> IN4736 <br> IN4739 <br> IN4739 | $\begin{aligned} & 750 \\ & 750 \\ & 750 \\ & 750 \end{aligned}$ |  |  |  |  |  | $\begin{array}{r} 6.6 / 10 \\ 6.5 / 10 \\ 8.8 / 10 \\ 8 / 10 \end{array}$ | 5 5 5 5 |
| $\begin{aligned} & \text { IN2036 } \\ & \text { IN2036A } \\ & \text { 1N2037 } \\ & \text { IN2037A } \end{aligned}$ | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\left\|\begin{array}{l} \mathrm{ZD} \\ \mathrm{ZD} \\ \mathrm{ZD} \\ \mathrm{ZO} \end{array}\right\|$ |  | IN4740 <br> 1N4740 <br> 1N4743 <br> IN4743 | $\begin{aligned} & 750 \\ & 750 \\ & 750 \\ & 750 \end{aligned}$ |  |  |  |  |  | $\begin{gathered} 10.5 / 10 \\ 10 / 10 \\ 12.8 / 5 \\ 12 / 5 \end{gathered}$ | 5 5 5 5 |
| $\begin{array}{\|l} \text { 1 N2038 } \\ \text { IN2038A } \\ \text { IN2039 } \\ \text { IN2039A } \end{array}$ | 5 5 5 5 | $\left\|\begin{array}{l} z 0 \\ z 0 \\ z 0 \\ z 0 \end{array}\right\|$ |  | 1N4745 <br> 1N4745 <br> 1N4747 <br> 1N4747 | $\begin{aligned} & 750 \\ & 750 \\ & 750 \\ & 750 \end{aligned}$ |  |  |  |  |  | $\begin{array}{r} 15.8 / 5 \\ 15 / 5 \\ 19 / 5 \\ 18 / 5 \end{array}$ | 5 5 5 5 |
| 1N2040 <br> IN2040A <br> IN2054 <br> 1N2055 | $\left\lvert\, \begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}\right.$ | $\begin{aligned} & \mathrm{ZD} \\ & \mathrm{ZD} \\ & \mathrm{RE} \\ & \mathrm{RE} \end{aligned}$ |  | 1N4749 1N4749 | $\begin{aligned} & 750 \\ & 750 \end{aligned}$ |  | $\begin{aligned} & 250 \\ & 250 \end{aligned}$ | $\begin{aligned} & 55 \mathrm{M} / \\ & 55 \mathrm{M} / \end{aligned}$ | $\begin{aligned} & 1.6 / \\ & 1.6 / \end{aligned}$ |  | $\begin{array}{r} 23.5 / 5 \\ 22 / 5 \end{array}$ | 5 |

## DIODE INTERCHANGEABILITY

| TYPE number | 高 | $\begin{array}{\|l\|} \hline \\ \hline 8 \\ \frac{2}{3} \\ \frac{3}{3} \\ 3 \end{array}$ | $\frac{\text { n }}{\text { RERLCEMENT }}$ | $\begin{aligned} & \text { FOR } \\ & \text { NEW } \\ & \text { DESICN } \end{aligned}$ | $\begin{gathered} \mathrm{PD} \\ (\mathrm{~mW}) \end{gathered}$ | atmas <br> $\mathbf{V}_{\mathrm{R}}$ <br> (V) | (A) | $\begin{array}{ll} L_{R} & \bullet V_{R} \\ \mu_{\mathrm{A}} & /(\mathrm{V}) \end{array}$ | $\begin{array}{cc}  & \text { charact } \\ \mathbf{v F}_{\mathbf{F}} & \bullet \mathbf{q} \\ \text { (V) } & /(\mathrm{mA}) \end{array}$ | $\begin{gathered} \text { mestics } \\ \text { (nes) } \end{gathered}$ | $\begin{array}{llc} v_{z} & \bullet & \mathbf{z} \\ (v) & 1 & (\mathrm{ma}) \end{array}$ | $\left.\right\|_{x} ^{\text {rol }}$ |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| $\begin{aligned} & \text { 1N2056 } \\ & \text { iN2057 } \\ & \text { 1N2058 } \\ & \text { IN2059 } \end{aligned}$ | $\left[\begin{array}{l} s \\ s \\ s \\ s \\ s \end{array}\right.$ | $\begin{array}{\|l\|l\|} \hline R E \\ R E \\ R E \\ R E \\ R E \end{array}$ |  |  |  |  | $\begin{aligned} & 250 \\ & 250 \\ & 250 \\ & 250 \end{aligned}$ | $\begin{aligned} & 55 \mathrm{M} / \\ & 55 \mathrm{M} / \\ & 55 \mathrm{M} / \\ & 55 \mathrm{M} / \end{aligned}$ | $\begin{aligned} & 1.6 / \\ & 1.61 \\ & 1.61 \\ & 1.6 / \end{aligned}$ |  |  |  |
| $\begin{aligned} & \text { IN2060 } \\ & \text { 1N2061 } \\ & \text { 1N2062 } \\ & \text { 1N2063 } \end{aligned}$ | $\begin{aligned} & \mathrm{s} \\ & \mathrm{~s} \\ & \mathrm{~s} \\ & \mathbf{s} \end{aligned}$ | $\begin{aligned} & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \end{aligned}$ |  |  |  |  | $\begin{aligned} & 250 \\ & 250 \\ & 250 \\ & 250 \end{aligned}$ | $\begin{aligned} & \text { 55M/ } \\ & \text { 55M/ } \\ & \text { 55M/ } \\ & \text { 55M/ } \end{aligned}$ | $\begin{aligned} & 1.6 / \\ & 1.6 / \\ & 1.6 / \\ & 1.6 / \end{aligned}$ |  |  |  |
| 1N2064 <br> 1N2065 <br> 1N2066 <br> iN2067 |  | $\left.\begin{array}{\|l\|} \mathrm{RE} \\ \mathrm{RE} \\ \mathrm{RE} \\ \mathrm{RE} \\ \mathrm{RE} \end{array} \right\rvert\,$ |  |  |  |  | $\begin{aligned} & 250 \\ & 250 \\ & 250 \\ & 250 \end{aligned}$ | $\begin{aligned} & 55 \mathrm{M} / \\ & 55 \mathrm{M} / \\ & 55 \mathrm{M} / \\ & 55 \mathrm{M} / \end{aligned}$ | $\begin{aligned} & 1.61 \\ & 1.61 \\ & 1.61 \\ & 1.6 \% \end{aligned}$ |  |  |  |
| 1N2068 1N2069 1 N2069A 1N2070 |  | $\left\|\begin{array}{l} \mathrm{RE} \\ \mathrm{RE} \\ \mathrm{RE} \\ \mathrm{RE} \end{array}\right\|$ | 1N2069 1N2069A 1N2070 |  |  | $\begin{aligned} & 200 \\ & 200 \\ & 400 \end{aligned}$ | $\begin{gathered} 250 \\ .75 \\ .75 \\ .75 \end{gathered}$ | $\begin{aligned} & \text { 55M/ } \\ & 10 / 200 \\ & 5 / 200 \\ & 10 / 400 \end{aligned}$ | $\begin{aligned} & 1.6 / \\ & 1.2 / 500 \\ & 1.0 / 500 \\ & 1.2 / 500 \end{aligned}$ |  |  |  |
| in2070A IN2071 in2071A 1N2072 | $\begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}$ | $\left.\begin{array}{\|c\|} \mathbf{R E} \\ \mathbf{R E} \\ \mathbf{R E} \\ \mathrm{RE} \\ \mathbf{R E} \end{array} \right\rvert\,$ | in2070A <br> in2071 <br> in2071A | 1N4001 |  | $\begin{array}{r} 400 \\ 600 \\ 600 \\ 50 \end{array}$ | $\begin{aligned} & .75 \\ & .75 \\ & .75 \\ & .75 \end{aligned}$ | $5 / 400$ $10 / 600$ <br> 5/600 <br> 250/50 | $1.0 / 500$ $1.2 / 500$ <br> $1.0 / 500$ <br> 1.1/14 |  |  |  |
| 1N2073 <br> 1N2074 <br> 1N2075 <br> 1N2076 | $\left\lvert\, \begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}\right.$ | $\left\|\begin{array}{c} \mathrm{RE} \\ \mathrm{RE} \\ \mathrm{RE} \\ \mathrm{RE} \end{array}\right\|$ |  | IN4002 <br> 1 N4003 <br> iN4003 <br> 1N4004 |  | $\begin{aligned} & 100 \\ & 150 \\ & 200 \\ & 250 \end{aligned}$ | $\begin{aligned} & .75 \\ & .75 \\ & .75 \\ & .75 \end{aligned}$ | $\begin{aligned} & 250 / 100 \\ & 250 / 150 \\ & 250 / 200 \\ & 250 / 250 \end{aligned}$ | $\begin{aligned} & 1.1 / 1 \mathrm{~A} \\ & 1.1 / 1 \mathrm{~A} \\ & 1.1 / 1 \mathrm{~A} \\ & 1.1 / 1 \mathrm{~A} \end{aligned}$ |  |  |  |
| 1N2077 <br> 1N2078 <br> 1N2079 <br> IN2080 | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\left.\begin{array}{\|c\|} \mathrm{RE} \\ \mathrm{RE} \\ \mathrm{RE} \\ \mathrm{RE} \end{array} \right\rvert\,$ |  | in4004 IN4004 1N4006 1N4001 |  | $\begin{array}{r} 300 \\ 400 \\ 500 \\ 50 \end{array}$ | $\begin{array}{r} .75 \\ .75 \\ .75 \\ .5 \end{array}$ | $\begin{aligned} & 250 / 300 \\ & 250 / 400 \\ & 250 / 500 \\ & 350 / 50 \end{aligned}$ | $\begin{aligned} & 1.1 / 1 A \\ & 1.1 / 1 A \\ & 1.1 / 1 A \\ & .75 / 500 \end{aligned}$ |  |  |  |
| in208 1 <br> 1N2082 <br> 1N2083 <br> 1N2084 | $\left\lvert\, \begin{aligned} & \mathbf{s} \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\left.\begin{aligned} & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \end{aligned} \right\rvert\,$ |  | 1N4002 <br> iN4003 1N4004 1 N4004 |  | $\begin{aligned} & 100 \\ & 200 \\ & 300 \\ & 400 \end{aligned}$ | .5 .5 .5 .5 | $\begin{aligned} & 350 / 100 \\ & 350 / 200 \\ & 350 / 300 \\ & 350 / 400 \end{aligned}$ | $\begin{aligned} & .75 / 500 \\ & .75 / 500 \\ & .75 / 500 \\ & .75 / 500 \end{aligned}$ |  |  |  |
| 1N2085 IN2086 IN2088 IN2089 | $\begin{aligned} & 5 \\ & s \\ & s \\ & s \end{aligned}$ | $\begin{array}{\|l\|} \mathbf{R E} \\ \mathrm{RE} \\ \mathrm{RE} \\ \mathrm{RE} \end{array}$ |  | 1N4005 1N4005 1N4001 IN4001 |  | $\begin{aligned} & 500 \\ & 600 \\ & 500 \\ & 600 \end{aligned}$ | $\begin{aligned} & .5 \\ & .5 \\ & .75 \\ & .75 \end{aligned}$ | $\begin{aligned} & 350 / 500 \\ & 350 / 600 \\ & 500 / 500 \\ & 500 / 600 \end{aligned}$ | .75/500 .75/500 1/750 $1 / 750$ |  |  |  |
| iN2090 IN2091 1N2092 in2093 | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\left.\begin{aligned} & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \end{aligned} \right\rvert\,$ |  | IN4001 1N4002 iN4003 1N4004 |  | 50 100 200 300 | $\begin{aligned} & .5 \\ & .5 \\ & .5 \\ & .5 \end{aligned}$ | $250 / 50$ $250 / 100$ <br> 250/200 <br> 250/300 | $\begin{aligned} & .5 / 500 \\ & .5 / 500 \\ & .5 / 500 \\ & .5 / 500 \end{aligned}$ |  |  |  |

## DIODE INTERCHANGEABILITY

|  | - | $\begin{aligned} & 2 \\ & 0 \end{aligned}$ |  |  | Ratines |  |  | Characteristics |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| TYPE NUMEER | $\frac{2}{2}$ |  | RI | $\begin{aligned} & \text { FOR } \\ & \text { NEW } \\ & \text { DESICN } \end{aligned}$ | $\begin{gathered} \mathbf{P D} \\ (\mathrm{mW}) \end{gathered}$ | (V) | I <br> (A) | $\begin{array}{ll} \mathbf{I}_{\mathbf{R}} & \bullet \mathbf{V}_{\mathbf{R}} \\ \mu_{\mathrm{A}} & /(\mathbf{V}) \end{array}$ | $\mathbf{V F}_{F}$ - $\mathbf{F}$ <br> (V) $/$ (mA) | $\begin{gathered} i n \\ (m) \end{gathered}$ | $\mathbf{V}_{\mathbf{Z}}$ - $\mathbf{z}_{\mathbf{Z}}$ <br> (V) / (mA) | $\left\|\begin{array}{c} 101 \\ \% \end{array}\right\|$ |
| 1N2094 <br> 1N2095 <br> 1N2096 <br> IN2103 | $\begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}$ | $\begin{aligned} & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \end{aligned}$ |  | 1NA004 <br> 1N4005 <br> in4005 <br> IN4001 |  | $\begin{array}{r} 400 \\ 500 \\ 600 \\ 50 \end{array}$ | $\begin{array}{r} .5 \\ .5 \\ .5 \\ .75 \end{array}$ | $\begin{aligned} & 250 / 400 \\ & 250 / 500 \\ & 250 / 600 \\ & 300 / 50 \end{aligned}$ | $\begin{array}{r} .5 / 500 \\ .5 / 500 \\ .5 / 500 \\ 1.2 / 750 \end{array}$ |  |  |  |
| IN2104 1N2105 1N2106 1N2107 | $\left\lvert\, \begin{aligned} & 5 \\ & 5 \\ & 5 \\ & 5 \end{aligned}\right.$ | $\begin{aligned} & R E \\ & R E \\ & R E \\ & R E \\ & \text { RE } \end{aligned}$ |  | IN4002 <br> 1N4003 <br> IN4004 <br> iN4004 |  | $\begin{aligned} & 100 \\ & 200 \\ & 300 \\ & 400 \end{aligned}$ | $\begin{aligned} & .75 \\ & .75 \\ & .75 \\ & .75 \end{aligned}$ | $\begin{aligned} & 300 / 100 \\ & 300 / 200 \\ & 300 / 300 \\ & 300 / 400 \end{aligned}$ | $\begin{aligned} & 1.2 / 750 \\ & 1.2 / 750 \\ & 1.2 / 750 \\ & 1.2 / 750 \end{aligned}$ |  |  |  |
| $\begin{aligned} & \text { 1N2108 } \\ & \text { 1N2109 } \\ & \text { 1N2110 } \\ & \text { 1N2111 } \end{aligned}$ | $\left\lvert\, \begin{aligned} & \mathbf{s} \\ & \mathbf{S} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}\right.$ | $\begin{array}{\|l\|} R E \\ R E \\ R E \\ R E \\ R E \end{array}$ |  | $\begin{aligned} & \text { 1N4005 } \\ & \text { TID381 } \\ & \text { TD382 } \\ & \text { TID383 } \end{aligned}$ |  | $\begin{array}{r} 500 \\ 50 \\ 100 \\ 200 \end{array}$ | $\begin{array}{r} 75 \\ 2 \\ 2 \\ 2 \end{array}$ | $\begin{aligned} & 300 / 500 \\ & 300 / 50 \\ & 300 / 100 \\ & 300 / 200 \end{aligned}$ | $\begin{aligned} & 1.2 / 750 \\ & 1.2 / 750 \\ & 1.2 / 750 \\ & 1.2 / 750 \end{aligned}$ |  |  |  |
| $\begin{aligned} & \text { IN2112 } \\ & \text { 1N2113 } \\ & \text { 1N2114 } \\ & \text { 1N2115 } \end{aligned}$ | $\begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}$ | $\left\|\begin{array}{l} R E \\ R E \\ R E \\ R E \end{array}\right\|$ |  | $\begin{aligned} & \text { TID384 } \\ & \text { TD385 } \\ & \text { TD385 } \\ & \text { IN4004 } \end{aligned}$ |  | $\begin{aligned} & 300 \\ & 400 \\ & 500 \\ & 365 \end{aligned}$ | $\begin{gathered} 2 \\ 2 \\ 2 \\ .3 \end{gathered}$ | $\begin{aligned} & 300 / 300 \\ & 300 / 400 \\ & 300 / 500 \\ & 250 / \end{aligned}$ | $\begin{array}{r} 1.2 / 750 \\ 1.2 / 750 \\ 1.2 / 750 \\ .8 / 200 \end{array}$ |  |  |  |
| $\begin{aligned} & \text { 1N2116 } \\ & \text { 1N2117 } \\ & \text { 1N2139 } \\ & \text { 1N2146 } \end{aligned}$ | $\begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}$ | $\left.\begin{array}{\|l\|} \hline R E \\ \text { RE } \\ \text { RE } \\ \text { SD } \end{array} \right\rvert\,$ |  | IN4004 IN4006 <br> 1N4608 |  | $\begin{aligned} & 400 \\ & 720 \\ & 20 K \\ & 120 \end{aligned}$ | $\begin{array}{r} .75 \\ .75 \\ .052 \end{array}$ | $\begin{aligned} & 400 / \\ & 10 / 720 \\ & 200 / \\ & 1 / 50 \end{aligned}$ | $\begin{aligned} & 1.4 / 500 \\ & 1.3 / 750 \\ & 60 / \\ & 1.1 / 500 \end{aligned}$ | 100 |  |  |
| $\begin{aligned} & \text { IN2147 } \\ & \text { IN2147A } \\ & \text { IN2148 } \\ & \text { IN2148A } \end{aligned}$ | $\begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}$ | $\left.\begin{aligned} & R E \\ & R E \\ & R E \\ & R E \\ & R E \end{aligned} \right\rvert\,$ |  |  |  | 50 50 100 100 | 6 6 6 6 | $\begin{aligned} & 500 / \\ & 100 / \\ & 500 / \\ & 100 \% \end{aligned}$ | $\begin{array}{r} 1.2 / \\ 1 / \\ 1.2 / \\ 1 / \end{array}$ |  |  |  |
| $\begin{aligned} & \text { IN2149 } \\ & \text { 1N2149A } \\ & \text { IN2150 } \\ & \text { IN2150A } \end{aligned}$ | $\left\lvert\, \begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}\right.$ | $\left.\begin{array}{\|} R E \\ R E \\ R E \\ R E \end{array} \right\rvert\,$ |  |  |  | $\begin{aligned} & 200 \\ & 200 \\ & 300 \\ & 300 \end{aligned}$ | 6 6 6 6 | $\begin{aligned} & 500 / \\ & 100 / \\ & 500 / \\ & 100 / \end{aligned}$ | $\begin{gathered} 1.2 / \\ 1 / \\ 1.2 / \\ 1 / \end{gathered}$ |  |  |  |
| 1N2151 <br> 1N2151A <br> 1N2152 <br> IN2152A | $\begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}$ | $\left.\begin{aligned} & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \end{aligned} \right\rvert\,$ |  |  |  | $\begin{aligned} & 400 \\ & 400 \\ & 500 \\ & 500 \end{aligned}$ | 6 6 6 6 | $\begin{aligned} & 500 / \\ & 100 / \\ & 500 / \\ & 100 / \end{aligned}$ | $\begin{gathered} 1.2 / \\ 1 / \\ 1.2 / \\ 1 / \end{gathered}$ |  |  |  |
| $\begin{aligned} & \text { IN2153 } \\ & \text { 1N2153A } \\ & \text { IN2163 } \\ & \text { 1N2163A } \end{aligned}$ | $\left\lvert\, \begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}\right.$ | $\begin{aligned} & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \end{aligned}$ |  |  | $\begin{aligned} & \text { iw } \\ & \text { iw } \end{aligned}$ | $\begin{aligned} & 600 \\ & 600 \end{aligned}$ | 6 | $\begin{aligned} & 500 / \\ & 100 / \end{aligned}$ | $\begin{gathered} 1.2 / \\ 1 / \end{gathered}$ |  | $\begin{aligned} & 9.4 / 10 \\ & 9.4 / 10 \end{aligned}$ | 4 |
| $\begin{array}{\|l} \text { IN2164 } \\ \text { IN2164A } \\ \text { 1N2165 } \\ \text { 1N2165A } \end{array}$ | $\begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}$ | $\begin{aligned} & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \end{aligned}$ |  |  | $\begin{aligned} & \text { iw } \\ & \text { iw } \\ & \text { iw } \\ & \text { iw } \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 9.4 / 10 \\ & 9.4 / 10 \\ & 9.4 / 10 \\ & 9.4 / 10 \end{aligned}$ | 4 2 4 2 |

## DIODE INTERCHANGEABILITY

| TYPE NUMBER |  |  | $\pi$ REPLACEMENT | $\begin{aligned} & \text { FOR } \\ & \text { NEW } \\ & \text { DESICN } \end{aligned}$ | $\begin{aligned} & \mathbf{P D}_{\mathbf{D}} \\ & (\mathrm{mW}) \end{aligned}$ | TINGES <br> $V_{R}$ <br> (V) | I <br> (A) | $\begin{array}{ll} \mathbf{I}_{\mathbf{R}} & \mathbf{V}_{\mathbf{R}} \\ \mu_{\mathbf{A}} & /(\mathbf{V}) \end{array}$ | $\mathbf{V F}_{F}$ - $\mathbf{F}$ <br> (V) $/$ (ma) | $\begin{aligned} & \text { ERISTK } \\ & \text { Im } \\ & \text { (ms) } \end{aligned}$ | $\mathbf{V}_{\mathbf{Z}}: \mathbf{l}_{\mathbf{z}}$ <br> (V) $/$ (mA) | 10. * |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| $\begin{aligned} & \text { IN2166 } \\ & \text { IN2166A } \\ & \text { IN2167 } \\ & \text { IN2167A } \end{aligned}$ | $\begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & s \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}$ | $\begin{aligned} & \mathrm{ZD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \end{aligned}$ |  |  | IW iw IW iw |  |  |  |  |  | $\begin{aligned} & 9.4 / 10 \\ & 9.4 / 10 \\ & 9.4 / 10 \\ & 9.4 / 10 \end{aligned}$ | 4 2 4 2 |
| $\begin{aligned} & \text { 1N2168 } \\ & \text { 1N2168A } \\ & \text { 1N2169 } \\ & \text { 1N2169A } \end{aligned}$ | $\begin{aligned} & \mathbf{s} \\ & s \\ & s \\ & s \\ & s \end{aligned}$ | $\left\lvert\, \begin{aligned} & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \end{aligned}\right.$ |  |  | $\begin{aligned} & 16 \\ & 1 w \\ & \text { iw } \\ & 1 w \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 9.4 / 10 \\ & 9.4 / 10 \\ & 9.4 / 10 \\ & 9.4 / 10 \end{aligned}$ | 4 2 4 2 |
| $\begin{aligned} & \text { IN2170 } \\ & \text { IN2170A } \\ & \text { IN2171 } \\ & \text { IN2171A } \end{aligned}$ | $\begin{aligned} & s \\ & s \\ & s \\ & s \\ & s \end{aligned}$ | $\begin{aligned} & \mathrm{ZD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \end{aligned}$ |  |  | $\begin{aligned} & 16 \\ & \text { iw } \\ & \text { iw } \\ & \text { iw } \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 9.4 / 10 \\ & 9.4 / 10 \\ & 9.4 / 10 \\ & 9.4 / 10 \end{aligned}$ | 4 2 4 2 |
| $\begin{aligned} & \text { 1N2172 } \\ & \text { 1N2173 } \\ & \text { 1N2174 } \\ & \text { 1N2176 } \end{aligned}$ | $\begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}$ | $\begin{aligned} & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \end{aligned}$ |  |  |  | $\begin{array}{r} 50 \\ 100 \\ 200 \\ 50 \end{array}$ | $\begin{array}{r} 50 \\ 50 \\ 50 \\ 3 \end{array}$ | $\begin{aligned} & 250 / \\ & 250 / \\ & 250 / \\ & 300 / \end{aligned}$ | $\begin{aligned} & 1.5 / \\ & 1.5 / \\ & 1.5 / \\ & 1.1 / \end{aligned}$ |  |  |  |
| $\begin{array}{\|l\|} \text { 1N2177 } \\ \text { 1N2178 } \\ \text { 1N2179 } \\ \text { 1N2180 } \end{array}$ | $\begin{aligned} & 5 \\ & 5 \\ & 5 \\ & 5 \end{aligned}$ | $\begin{aligned} & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \end{aligned}$ |  |  |  | $\begin{aligned} & 100 \\ & 150 \\ & 200 \\ & 300 \end{aligned}$ | $\begin{aligned} & 3 \\ & 3 \\ & 3 \\ & 3 \end{aligned}$ | $\begin{aligned} & 300 / \\ & 300 / \\ & 300 / \\ & 300 / \end{aligned}$ | $\begin{aligned} & 1.1 / \\ & 1.1 / \\ & 1.1 / \\ & 1.1 / \end{aligned}$ |  |  |  |
| 1N2181 <br> 1N2182 <br> 1N2183 <br> 1N2184 | s | $\begin{aligned} & R E \\ & R E \\ & R E \\ & R E \\ & R E \end{aligned}$ |  |  |  | $\begin{array}{r} 400 \\ 500 \\ 600 \\ 50 \end{array}$ | $\begin{aligned} & 3 \\ & 3 \\ & 3 \\ & 3 \end{aligned}$ | $\begin{gathered} 300 / \\ 300 / \\ 300 / \\ 5 M / \end{gathered}$ | $\begin{aligned} & 1.1 / \\ & 1.1 / \\ & 1.1 / \\ & 1.5 / \end{aligned}$ |  |  |  |
| 1N2185 <br> IN2186 <br> 1N2187 <br> 1N2188 | $\begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}$ | $\begin{aligned} & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \end{aligned}$ |  |  |  | $\begin{aligned} & 100 \\ & 150 \\ & 200 \\ & 300 \end{aligned}$ | $\begin{aligned} & 3 \\ & 3 \\ & 3 \\ & 3 \end{aligned}$ | $\begin{aligned} & 5 M / \\ & 5 M / \\ & 5 M / \\ & 5 M / \end{aligned}$ | $\begin{aligned} & 1.5 / \\ & 1.5 / \\ & 1.5 / \\ & 1.5 / \end{aligned}$ |  |  |  |
| IN2189 <br> 1N2190 <br> 1N2191 <br> 1N2192 | $\begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}$ | $\begin{aligned} & \mathbf{R E} \\ & \text { RE } \\ & \text { RE } \\ & \text { RE } \end{aligned}$ |  |  |  | $\begin{aligned} & 400 \\ & 500 \\ & 600 \\ & 800 \end{aligned}$ | $\begin{aligned} & 3 \\ & 3 \\ & 3 \\ & 3 \end{aligned}$ | 5M/ <br> 5M/ <br> 5M/ <br> 5M/ | $\begin{aligned} & 1.5 / \\ & 1.5 / \\ & 1.5 / \\ & 1.5 / \end{aligned}$ |  |  |  |
| 1N2193 <br> IN2194 <br> 1N2195 <br> 1N2196 | $\begin{aligned} & 5 \\ & 5 \\ & 5 \\ & 5 \end{aligned}$ | $\left.\begin{array}{l} R E \\ R E \\ R E \\ R E \end{array}\right\}$ |  |  |  | $\begin{array}{r} 1 K \\ 50 \\ 100 \\ 150 \end{array}$ | $\begin{aligned} & 3 \\ & 6 \\ & 6 \\ & 6 \end{aligned}$ | $\begin{aligned} & 5 \mathrm{M} / \\ & 10 \mathrm{M} / \\ & 10 \mathrm{M} / \\ & 10 \mathrm{M} / \end{aligned}$ | $\begin{aligned} & 1.5 / \\ & 1.2 / \\ & 1.2 / \\ & 1.2 / \end{aligned}$ |  |  |  |
| 1N2197 <br> 1N2198 <br> 1N2199 <br> IN2200 | $\begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}$ | $\left.\begin{aligned} & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \end{aligned} \right\rvert\,$ |  |  |  | $\begin{aligned} & 200 \\ & 300 \\ & 400 \\ & 500 \end{aligned}$ | $\begin{aligned} & 6 \\ & 6 \\ & 6 \\ & 6 \end{aligned}$ | 10M/ 10M/ <br> 10M/ <br> $10 \mathrm{M} /$ | $\begin{aligned} & 1.2 / \\ & 1.2 / \\ & 1.2 / \\ & 1.2 / \end{aligned}$ |  |  |  |


| $\begin{gathered} \text { TYFE } \\ \text { MUMUER } \end{gathered}$ |  |  | II | $\begin{aligned} & \text { FOR } \\ & \text { NEW } \\ & \text { DESMON } \end{aligned}$ | Ramins |  |  | CHARACTERISTICS |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  |  | $\mathbf{V}_{\mathbf{R}}$ <br> (V) |  | $\begin{array}{ll} \mathbf{H}_{\mathbf{R}} & \mathbf{V}_{\mathrm{R}} \\ \mu \mathrm{~A} & / \mathbf{V}) \end{array}$ | $\begin{array}{cc} \mathbf{V}_{\mathbf{F}} & \mathbf{l}_{\mathbf{F}} \\ (\mathrm{V}) & /(\mathrm{mA}) \end{array}$ | $\mathrm{t}_{\mathrm{T}}$ <br> (m) | $\mathbf{V}_{\mathbf{z}} \quad$ - $\mathbf{z}$ <br> (V) $/(\mathrm{mA})$ | $\begin{aligned} & \text { TOL } \\ & \text { \% } \end{aligned}$ |
| 1N2201 <br> IN2202 <br> iN2203 <br> IN2204 | $\begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}$ | $\left.\begin{array}{\|l\|} \mathbf{R E} \\ \mathrm{RE} \\ \mathrm{RE} \\ \mathrm{RE} \end{array} \right\rvert\,$ |  |  |  | 600 800 $1 K$ 50 | $\begin{array}{r} 6 \\ 6 \\ 6 \\ 12 \end{array}$ | 10M/ <br> 10M/ <br> 10M/ <br> 10M/ | $\begin{aligned} & 1.2 / \\ & 1.2 / \\ & 1.2 / \\ & 1.2 / \end{aligned}$ |  |  |  |
| 1N2205 <br> IN2206 <br> IN2207 <br> 1N2208 | $\left\lvert\, \begin{aligned} & 5 \\ & 5 \\ & 5 \\ & 5 \end{aligned}\right.$ | $\begin{aligned} & R E \\ & R E \\ & R E \\ & R E \\ & R E \\ & R E \end{aligned}$ |  |  |  | $\begin{aligned} & 100 \\ & 150 \\ & 200 \\ & 300 \end{aligned}$ | $\begin{aligned} & 12 \\ & 12 \\ & 12 \\ & 12 \end{aligned}$ | 10M/ <br> 10w/ <br> 10M/ <br> 10M/ | $\begin{aligned} & 1.2 / \\ & 1.2 / \\ & 1.2 / \\ & 1.2 / \end{aligned}$ |  |  |  |
| $\left\lvert\, \begin{aligned} & \text { 1N2209 } \\ & \text { 1N2210 } \\ & \text { 1N2211 } \\ & \text { 1N2212 } \end{aligned}\right.$ | $\left\lvert\, \begin{aligned} & 5 \\ & 5 \\ & 5 \\ & 5 \end{aligned}\right.$ | $\begin{array}{\|l} \mathbf{R E} \\ \mathrm{RE} \\ \mathrm{RE} \\ \mathrm{RE} \end{array}$ |  |  |  | $\begin{aligned} & 400 \\ & 500 \\ & 600 \\ & 800 \end{aligned}$ | $\begin{aligned} & 12 \\ & 12 \\ & 12 \\ & 12 \end{aligned}$ | 10M/ <br> 10M/ <br> 10M/ <br> 10M/ | $\begin{aligned} & 1.2 / \\ & 1.2 / \\ & 1.2 \prime \\ & 1.2 / \end{aligned}$ |  |  |  |
| $\begin{aligned} & \text { 1N2213 } \\ & \text { 1N2214 } \\ & \text { 1N2217 } \\ & \text { 1N2218 } \end{aligned}$ | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\begin{aligned} & R E \\ & \text { ZD } \\ & R E \\ & R E \\ & R E \end{aligned}$ |  |  | iw | $\begin{array}{r} 1 K \\ 50 \\ 500 \end{array}$ | $\begin{array}{r} 12 \\ 1.5 \\ .4 \end{array}$ | 10M/ <br> 3/ <br> $3 /$ | $\begin{aligned} & 1.2 / \\ & 1.5 / \\ & 1.2 / \end{aligned}$ |  | 5.6/35 | 2 |
| $\begin{aligned} & \text { 1N2219 } \\ & \text { 1N2220 } \\ & \text { 1N2221 } \\ & \text { IN2222 } \end{aligned}$ | $\begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}$ | $\begin{aligned} & R E \\ & R E \\ & R E \\ & R E \end{aligned}$ |  |  |  | $\begin{aligned} & 500 \\ & 600 \\ & 600 \\ & 800 \end{aligned}$ | $\begin{array}{r} 1.5 \\ .4 \\ 1.5 \\ .3 \end{array}$ | $\begin{aligned} & 3 / \\ & 3 / \\ & 3 / \\ & 3 / \end{aligned}$ | $\begin{aligned} & 1.2 / \\ & 1.2 / \end{aligned}$ |  |  |  |
| $\begin{array}{\|l} \text { IN2222A } \\ \text { IN2223 } \\ \text { IN2223A } \\ \text { IN222A } \end{array}$ | $\left\lvert\, \begin{aligned} & 5 \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\begin{aligned} & R E \\ & R E \\ & R E \\ & R E \end{aligned}$ |  |  |  | 800 800 800 $1 K$ | .3 1 1 .3 | $\begin{aligned} & 3 / \\ & 3 / \\ & 3 / \\ & 3 / \end{aligned}$ | $\begin{aligned} & 1.2 / \\ & 1.2 \% \\ & \hline \end{aligned}$ |  |  |  |
| $\begin{aligned} & \text { IN222AA } \\ & \text { IN2225 } \\ & \text { 1N2225A } \\ & \text { 1N2226 } \end{aligned}$ | $\left\lvert\, \begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}\right.$ | $\begin{aligned} & R E \\ & R E \\ & R E \\ & R E \end{aligned}$ |  |  |  | $1 K$ $1 K$ $1 K$ $1.2 K$ | .3 1 1 .3 | $\begin{aligned} & 3 / \\ & 3 / \\ & 3 / \\ & 3 / \end{aligned}$ | $\begin{aligned} & 1.2 / \\ & 1.2 / \end{aligned}$ |  |  |  |
| $\begin{aligned} & \text { IN2226A } \\ & \text { IN2227 } \\ & \text { IN2227A } \\ & \text { IN2228 } \end{aligned}$ | $\begin{aligned} & s \\ & s \\ & s \\ & s \\ & s \end{aligned}$ | $\begin{gathered} \mathrm{RE} \\ \mathrm{RE} \\ \mathrm{RE} \\ \mathrm{RE} \end{gathered}$ |  |  |  | $\begin{array}{r} 1.2 \mathrm{~K} \\ 1.2 \mathrm{~K} \\ 1.2 \mathrm{~K} \\ 50 \end{array}$ | .3 1 1 1 | $\begin{aligned} & 3 / \\ & 3 / \\ & 3 / \\ & 3 / \end{aligned}$ | $\begin{aligned} & 1.2 / \\ & 1.2 / \end{aligned}$ |  |  |  |
| $\begin{aligned} & \text { IN2228A } \\ & \text { IN2229 } \\ & \text { IN2229A } \\ & \text { IN2230 } \end{aligned}$ | S 5 5 5 | $\left.\begin{array}{l} \mathbf{R E} \\ \mathbf{R E} \\ \mathbf{R E} \\ \mathrm{RE} \end{array}\right\}$ |  |  |  | 50 50 50 200 | 1.6 5 5 1 | $\begin{aligned} & 3 / \\ & 3 / \\ & 3 / \\ & 3 / \end{aligned}$ | $\begin{aligned} & 1.2 / \\ & 1.2 \% \end{aligned}$ |  |  |  |
| $\begin{aligned} & \text { 1N2230A } \\ & \text { 1N2231 } \\ & \text { 1N2231A } \\ & \text { 1N2232 } \end{aligned}$ | $\left\lvert\, \begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}\right.$ | $\begin{array}{\|l\|} \mathrm{RE} \\ \mathrm{RE} \\ \mathrm{RE} \\ \mathrm{RE} \\ \mathrm{RE} \end{array}$ |  |  |  | $\begin{aligned} & 200 \\ & 200 \\ & 200 \\ & 300 \end{aligned}$ | $\begin{array}{r} 1.6 \\ 5 \\ 5 \\ 1 \end{array}$ | $\begin{aligned} & 3 / \\ & 3 / \\ & 3 / \\ & 3 / \end{aligned}$ | $\begin{aligned} & 1.2 \% \\ & 1.2 \% \end{aligned}$ |  |  |  |

## DIODE INTERCHANGEABILITY

| TYFE NUMBER |  |  |  | $\stackrel{\text { TI }}{\text { REPLACEMENT }}$ | $\begin{gathered} \text { FOR } \\ \text { NEW } \\ \text { DESIGN } \end{gathered}$ | $P_{D}$ (mW) | atinges <br> $\mathbf{V}_{\mathbf{R}}$ <br> (V) | ! <br> (A) | $\begin{array}{cc} I_{R} & 0 V_{R} \\ \mu_{\mathrm{A}} & /(\mathrm{V}) \end{array}$ | $\begin{array}{cc}  & \text { Characti } \\ \mathbf{v}_{\mathrm{F}} & \mathbf{y}_{\mathrm{F}} \\ \text { (V) } & / \text { (mA) } \end{array}$ | $\begin{aligned} & \text { IERISTICS } \\ & \left\|\begin{array}{c} t_{I T} \\ (n s) \end{array}\right\| \end{aligned}$ | $\left\|\begin{array}{ccc} v_{z} & 1 & \mathbf{z} \\ (\mathrm{~V}) & 1 & (\mathrm{~mA}) \end{array}\right\|$ | $\begin{gathered} \text { rou. } \\ \text { \% } \end{gathered}$ |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| $\begin{aligned} & \text { 1N2232A } \\ & \text { 1N2233 } \\ & \text { IN2233A } \\ & \text { IN2234 } \end{aligned}$ | ( |  |  |  |  |  | 300 300 300 400 | 1.6 5 5 1 | $\begin{aligned} & 3 / \\ & 3 / \\ & 3 / \\ & 3 / \end{aligned}$ | 1.2/ <br> $1.2 /$ |  |  |  |
| $\begin{aligned} & \text { 1N2234A } \\ & \text { IN2235 } \\ & \text { IN2235A } \\ & \text { IN2236 } \end{aligned}$ | $\left\lvert\, \begin{aligned} & \mathbf{s} \\ & \mathbf{s} \end{aligned}\right.$ |  |  |  |  |  | 400 400 400 500 | 1.6 5 5 1 | $\begin{aligned} & 3 / \\ & 3 / \\ & 3 / \\ & 3 / \end{aligned}$ | $\begin{aligned} & 1.21 \\ & 1.21 \end{aligned}$ |  |  |  |
| $\begin{aligned} & \text { 1N2236A } \\ & \text { 1N2237 } \\ & \text { 1N2237A } \\ & \text { IN2238 } \end{aligned}$ | s |  |  |  |  |  | 500 500 500 600 | 1.6 <br> 5 <br> 5 <br> 1 | $\begin{aligned} & \mathbf{3 /} \\ & \mathbf{3 /} \\ & \mathbf{3 /} \\ & \mathbf{3 /} \end{aligned}$ | $\begin{aligned} & 1.2 / \\ & 1.2 / \end{aligned}$ |  |  |  |
| $\begin{aligned} & \text { IN2238A } \\ & \text { 1N2239 } \\ & \text { IN2239A } \\ & \text { IN2240 } \end{aligned}$ | [ | RE R RE RE R |  |  |  |  | 600 600 600 800 | $\begin{array}{r} 1.6 \\ 5 \\ 5 \\ 1.5 \end{array}$ | $\begin{aligned} & \text { 3/ } \\ & \text { 3/ } \\ & \text { 3/ } \\ & 3 / \end{aligned}$ | $\begin{aligned} & 1.21 \\ & 1.2 \% \end{aligned}$ |  |  |  |
| in2240A <br> IN2241 <br> 1N2241A <br> iN2242 | S | RE |  |  |  |  | 800 800 800 $1 K$ | $\begin{array}{r} 1.5 \\ 5 \\ 5 \\ 1.5 \end{array}$ | $\begin{aligned} & \text { 3/ } \\ & \text { 3/ } \\ & 3 / \\ & 3 / \end{aligned}$ | $\begin{aligned} & 1.2 / \\ & 1.2 / \end{aligned}$ |  |  |  |
|  | [s |  |  |  |  |  | 1 K 1 k 1 K 1.2 K | $\begin{array}{r} 1.6 \\ 5 \\ 5 \\ 1.5 \end{array}$ | $\begin{aligned} & 3 / \\ & 3 / \\ & 3 / \\ & 3 / \\ & \hline \end{aligned}$ | $\begin{aligned} & 1.2 / \\ & 1.2 / \end{aligned}$ |  |  |  |
| in224AA <br> 1N2245 <br> 1N2245A <br> IN2246 | s | $\begin{aligned} & \mathbf{R E E} \\ & \mathbf{R E} \\ & \mathbf{R E} \\ & \mathbf{R E} \end{aligned}$ |  |  |  |  | 1.2 K 1.2 K 1.2 K 50 | $\begin{array}{r} 1.6 \\ 5 \\ 5 \\ 3 \end{array}$ | $\begin{aligned} & 3 / \\ & 3 / \\ & 3 / \\ & 5 / \end{aligned}$ | $\begin{aligned} & 1.2 / \\ & 1.2 / \end{aligned}$ |  |  |  |
|  | s $s$ $s$ $s$ $s$ | RE RE RE RE |  |  |  |  | $\begin{array}{r} 50 \\ 50 \\ 50 \\ 100 \end{array}$ | $\begin{array}{r} 3 \\ 10 \\ 10 \\ 3 \end{array}$ | $\begin{aligned} & 3 / \\ & 5 / \\ & 3 / \\ & 5 / \end{aligned}$ | $\begin{aligned} & 1.2 / \\ & 1.2 / \end{aligned}$ |  |  |  |
| 1N2248A 1N2249 in2249A 1N2250 | $\left\lvert\, \begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}\right.$ | $\begin{aligned} & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \end{aligned}$ |  |  |  |  | $\begin{aligned} & 100 \\ & 100 \\ & 100 \\ & 200 \end{aligned}$ | $\begin{array}{r} 3 \\ 10 \\ 10 \\ 3 \end{array}$ | $\begin{aligned} & 3 / \\ & 5 / \\ & 3 / \\ & 5 / \end{aligned}$ | $\begin{aligned} & 1.2 / \\ & 1.2 \% \end{aligned}$ |  |  |  |
| $\begin{aligned} & \text { IN2250A } \\ & \text { IN2251 } \\ & \text { iN2251A } \\ & \text { IN2252 } \end{aligned}$ | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\left\|\begin{array}{c} R E \\ R E \\ R E \\ R E \end{array}\right\|$ |  |  |  |  | $\begin{aligned} & 200 \\ & 200 \\ & 200 \\ & 300 \end{aligned}$ | $\begin{array}{r} 3 \\ 10 \\ 10 \\ 3 \end{array}$ | $3 /$ | $\begin{aligned} & 1.2 / \\ & 1.2 \% \end{aligned}$ |  |  |  |


|  |  | \% |  |  | latines |  |  | CHARACTERUSTICS |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| $\begin{gathered} \text { TYFE } \\ \text { Nemanim } \end{gathered}$ | $\frac{B}{2}$ | $\left\|\begin{array}{l} 0 \\ 6 \\ 0 \\ 0 \end{array}\right\|$ | $\begin{gathered} n \\ n \\ \hline \end{gathered}$ |  | $\begin{gathered} \mathrm{P}_{\mathrm{D}} \\ \mathrm{fm}) \end{gathered}$ | $\mathbf{V}_{\mathbf{R}}$ (V) | 1 <br> (A) | $\begin{array}{ll} L_{R} & V_{R} \\ \mu_{\mathrm{A}} & /(\mathrm{V}) \end{array}$ | $\left.\begin{array}{cc} v_{F} & \bullet \\ (\mathrm{v}) & 1(\mathrm{mal}) \end{array} \right\rvert\,$ | $\mathbf{i}_{\pi}$ (ms) | $\begin{array}{lll} \mathbf{v}_{\mathbf{z}} & \bullet \mathbf{z} \\ (\mathbf{v}) & /(\mathrm{mA}) \end{array}$ | $\begin{gathered} \text { rot } \\ \times \end{gathered}$ |
| 1N2252A <br> 1N2253 <br> 1N2253A <br> iN225a | $\left[\begin{array}{l} s \\ s \\ s \\ s \\ s \end{array}\right.$ | $\left.\begin{gathered} \mathrm{RE} \\ \mathrm{RE} \\ \mathrm{RE} \\ \mathrm{REF} \\ \mathrm{RE} \end{gathered} \right\rvert\,$ |  |  |  | 300 300 300 400 | 3 10 10 3 |  | $\begin{aligned} & 1.2 / \\ & 1.21 \end{aligned}$ |  |  |  |
|  | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\begin{aligned} & R E \\ & R E \\ & R E \\ & R E \\ & R E \end{aligned}$ |  |  |  | 400 400 400 500 | 3 10 10 3 | $5 /$ | $1.21$ $1.21$ |  |  |  |
| 1N2256A <br> 1N2257 in2257A <br> IN2258 | s | $\left.\begin{aligned} & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \end{aligned} \right\rvert\,$ |  |  |  | $\begin{aligned} & 500 \\ & 500 \\ & 500 \\ & 600 \end{aligned}$ | $\begin{array}{r} 3 \\ 10 \\ 10 \\ 3 \end{array}$ | $\begin{aligned} & 3 / \\ & 5 / \\ & 3 / \\ & 3 / \end{aligned}$ | $\begin{aligned} & 1.21 \\ & 1.2 \% \end{aligned}$ |  |  |  |
|  | $\left\lvert\, \begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}\right.$ | $\left\|\begin{array}{l} \mathrm{RE} \\ \mathrm{RE} \\ \mathrm{RE} \\ \mathrm{RE} \end{array}\right\|$ |  |  |  | $\begin{aligned} & 600 \\ & 600 \\ & 600 \\ & 600 \end{aligned}$ | 3 10 10 3 | $\begin{aligned} & 5 / \\ & 5 / \\ & 3 / \\ & 5 / \end{aligned}$ | $\begin{aligned} & 1.2 / \\ & 1.2 / \end{aligned}$ |  |  |  |
|  | $\left\lvert\, \begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}\right.$ | $\left\|\begin{array}{c} R E \\ R E \\ R E \\ R E \\ R E \end{array}\right\|$ |  |  |  | $\begin{aligned} & 800 \\ & 800 \\ & 800 \\ & 1 K \end{aligned}$ | 3 10 10 3 | $\begin{array}{r} 3 / \\ 101 \\ 5 / \\ 101 \end{array}$ | $\begin{aligned} & 1.2 / \\ & 1.2 / \end{aligned}$ |  |  |  |
| $\left\{\begin{array}{l} \text { in2262A } \\ \text { 1N2263 } \\ \text { 1N2263A } \\ \text { in2204 } \end{array}\right.$ | $\begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}$ | $\left\|\begin{array}{l} \mathrm{RE} \\ \mathrm{RE} \\ \mathrm{RE} \\ \mathrm{RE} \end{array}\right\|$ |  |  |  | $1 K$ $1 K$ $1 K$ $1.2 K$ | 3 10 5 3 | 5/ <br> 101 | 1.2/ <br> 1.2/ |  |  |  |
| $\begin{aligned} & \text { 1N2264A } \\ & \text { IN2265 } \\ & \text { IN2265A } \\ & \text { IN2266 } \end{aligned}$ | $\begin{aligned} & \mathrm{s} \\ & \mathrm{~s} \\ & \mathrm{~s} \\ & \mathrm{~s} \end{aligned}$ | $\left\|\begin{array}{l} \mathrm{RE} \\ \mathrm{REE} \\ \mathrm{RE} \\ \mathrm{RE} \end{array}\right\|$ |  |  |  | 1.2 K 1.2 K 1.2 K 50 | 3 10 10 .3 | $\begin{array}{r} 5 / \\ 10 / \\ 5 / \\ 3 / \end{array}$ | 1.2/ <br> 1.2/ |  |  |  |
| 1N2267 IN2268 IN2269 IN2270 |  | $\left\lvert\, \begin{gathered} R E \\ R E \\ R E \\ R E \\ R E \end{gathered}\right.$ |  |  |  | 50 500 500 600 | 1 .3 1 .3 | $\begin{aligned} & 3 / \\ & 3 / \\ & 3 / \\ & 3 / \end{aligned}$ | $\begin{aligned} & 1.2 / \\ & 1.2 / \end{aligned}$ |  |  |  |
| $\begin{aligned} & 1 \mathrm{~N} 2271 \\ & \text { 1N2272 } \\ & 1 \mathrm{~N} 2273 \\ & 1 \mathrm{~N} 2274 \end{aligned}$ | $\begin{aligned} & s \\ & s \\ & s \\ & s \\ & s \end{aligned}$ | $\begin{aligned} & R E \\ & R E \\ & R E E \\ & R E E \\ & R E \end{aligned}$ |  |  |  | $\begin{array}{r} 500 \\ 50 \\ 100 \\ 200 \end{array}$ | 1 6 6 6 | $\begin{aligned} & 3 / \\ & 1 \mathrm{~m} / \\ & 1 \mathrm{~m} / \\ & 1 \mathrm{~m} / \end{aligned}$ | $\begin{aligned} & 1.21 \\ & 1.21 \\ & 1.21 \end{aligned}$ |  |  |  |
| $\begin{aligned} & \text { IN227s } \\ & \text { iN2276 } \\ & \text { iN2277 } \\ & \text { iN2278 } \end{aligned}$ | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\begin{aligned} & \text { RE } \\ & \text { RE } \\ & \text { RE } \\ & \text { RE } \end{aligned}$ |  |  |  | $\begin{aligned} & 300 \\ & 400 \\ & 500 \\ & 600 \end{aligned}$ | 6 6 6 6 | $\begin{aligned} & 1 \mathrm{~m} / \\ & 1 \mathrm{~m} / \\ & 1 \mathrm{~m} / \\ & 1 \mathrm{~m} / \end{aligned}$ | $\begin{aligned} & 1.21 \\ & 1.2 \prime \\ & 1.2 \prime \\ & 1.2 \prime \end{aligned}$ |  |  |  |


| TYPE NHMMETR |  | $\%$ |  | $\begin{aligned} & \text { FOR } \\ & \text { NEW } \\ & \text { DESICN } \end{aligned}$ | $\begin{gathered} P_{D} \\ (\mathrm{~mW}) \end{gathered}$ | atings <br> $\mathbf{V}_{\mathbf{R}}$ <br> (V) | I <br> (A) | $\begin{array}{ll} \mathbf{I}_{\mathbf{R}} & \mathbf{V}_{\mathbf{R}} \\ \mu_{\mathbf{A}} & /(\mathbf{V}) \end{array}$ | $\mathbf{V F}_{F}$ IF <br> (V) $/$ (ma) | $\begin{aligned} & t_{\mathbf{r r}} \\ & (\mathrm{n}) \end{aligned}$ | $\mathbf{v}_{\mathbf{z}} \cdot \mathbf{z}$ <br> (V) $/$ (mA) | TOM. |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| $\left\{\begin{array}{l} \text { IN2279 } \\ \text { IN2280 } \\ \text { IN2281 } \\ \text { 1 N2282 } \end{array}\right.$ | S | RE RE RE RE |  |  |  | 800 1 K 1.2 K 300 | 6 6 6 20 | 1M/ <br> $1 \mathrm{M} /$ <br> 1M/ <br> 5M/ | $\begin{aligned} & 1.2 / \\ & 1.2 / \\ & 1.2 / \\ & 1.2 / \end{aligned}$ |  |  |  |
| $\begin{aligned} & \text { 1N2283 } \\ & \text { iN2284 } \\ & \text { iN2285 } \\ & \text { iN2286 } \end{aligned}$ | $\begin{aligned} & s \\ & s \\ & s \\ & s \\ & s \end{aligned}$ | RE RE RE RE |  |  |  | $\begin{aligned} & 400 \\ & 500 \\ & 600 \\ & 800 \end{aligned}$ | $\begin{aligned} & 20 \\ & 20 \\ & 20 \\ & 20 \end{aligned}$ | 5M/ <br> 5M/ <br> 5M/ <br> 5M/ | $\begin{aligned} & 1.2 / \\ & 1.2 \prime \\ & 1.2 / \\ & 1.2 \% \end{aligned}$ |  |  |  |
| $\begin{aligned} & \text { IN2287 } \\ & \text { IN2288 } \\ & \text { IN2289 } \\ & \text { IN2289A } \end{aligned}$ | S | RE RE RE RE |  |  |  | $\begin{array}{r} 1 K \\ 1.2 K \\ 100 \\ 100 \end{array}$ | $\begin{array}{r} 20 \\ 20 \\ 1.5 \\ 1.5 \end{array}$ | $\begin{gathered} 5 M / \\ 5 M / \\ 3 / \\ 3 / \end{gathered}$ | $\begin{array}{r} 1.5 / \\ 1.5 / \\ .6 / \\ .6 / \end{array}$ |  |  |  |
| $\begin{aligned} & 1 \mathrm{~N} 2290 \\ & \text { 1 N2290A } \\ & \text { 1 N2291 } \\ & \text { IN2291A } \end{aligned}$ | S | RE RE RE RE |  |  |  | $\begin{aligned} & 100 \\ & 100 \\ & 200 \\ & 200 \end{aligned}$ | $\begin{aligned} & 5.0 \\ & 5.0 \\ & 1.5 \\ & 1.5 \end{aligned}$ | $\begin{aligned} & 3 / \\ & 3 / \\ & 3 / \\ & 3 / \end{aligned}$ | .61 <br> . $6 /$ <br> . 61 <br> $.6 /$ |  |  |  |
| $\begin{aligned} & \text { 1N2292 } \\ & \text { 1N2292A } \\ & \text { 1N2293 } \\ & \text { 1N2293A } \end{aligned}$ | S | $\left\lvert\, \begin{aligned} & R E \\ & R E \\ & R E \\ & R E \end{aligned}\right.$ |  |  |  | $\begin{aligned} & 300 \\ & 300 \\ & 400 \\ & 400 \end{aligned}$ | $\begin{aligned} & 1.5 \\ & 1.5 \\ & 1.5 \\ & 1.5 \end{aligned}$ | $\begin{aligned} & 3 / \\ & 3 / \\ & 3 / \\ & 3 / \end{aligned}$ | . $6 /$ <br> .61 <br> . $6 /$ <br> . $6 /$ |  |  |  |
| 1N2294 1N2295 <br> 1N2296 <br> 1N2297 | S | RE RE RE RE Re |  |  |  | $\begin{array}{r} 50 \\ 100 \\ 150 \\ 200 \end{array}$ | $\begin{aligned} & 22 \\ & 22 \\ & 22 \\ & 22 \end{aligned}$ | $\begin{aligned} & 1 \mathrm{M} / \\ & 1 \mathrm{M} / \\ & 1 \mathrm{M} / \\ & 1 \mathrm{M} / \end{aligned}$ | $\begin{aligned} & 1.1 / \\ & 1.1 / \\ & 1.1 / \\ & 1.1 / \end{aligned}$ |  |  |  |
| 1N2298 IN2299 IN2300 1N2301 | $\begin{aligned} & \mathbf{S} \\ & \mathbf{S} \\ & \mathbf{S} \\ & \mathbf{S} \end{aligned}$ | $\begin{aligned} & R E \\ & R E \\ & R E \\ & R E \end{aligned}$ |  |  |  | $\begin{aligned} & 250 \\ & 300 \\ & 350 \\ & 400 \end{aligned}$ | $\begin{aligned} & 22 \\ & 22 \\ & 22 \\ & 22 \end{aligned}$ | $\begin{aligned} & 1 \mathrm{M} / \\ & 1 \mathrm{M} / \\ & 1 \mathrm{M} / \\ & 1 \mathrm{M} / \end{aligned}$ | $\begin{aligned} & 1.1 / \\ & 1.1 / \\ & 1.1 / \\ & 1.1 / \end{aligned}$ |  |  |  |
| $\begin{aligned} & \text { 1N2302 } \\ & \text { iN2303 } \\ & \text { 1N2304 } \\ & \text { iN2305 } \end{aligned}$ | $\begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}$ | $\begin{aligned} & R E \\ & R E \\ & R E \\ & R E \end{aligned}$ |  |  |  | $\begin{array}{r} 50 \\ 100 \\ 150 \\ 200 \end{array}$ | $\begin{aligned} & 22 \\ & 22 \\ & 22 \\ & 22 \end{aligned}$ | $\begin{aligned} & 1 \mathrm{M} / \\ & 1 \mathrm{M} / \\ & 1 \mathrm{M} / \\ & 1 \mathrm{M} / \end{aligned}$ | $\begin{aligned} & 1.1 / \\ & 1.1 / \\ & 1.1 / \\ & 1.1 / \end{aligned}$ |  |  |  |
| in2306 <br> 1N2307 <br> 1N2308 <br> 1N2309 | S | $\begin{aligned} & R E \\ & R E \\ & R E \\ & R E \end{aligned}$ |  |  |  | $\begin{aligned} & 250 \\ & 300 \\ & 350 \\ & 400 \end{aligned}$ | $\begin{aligned} & 22 \\ & 22 \\ & 22 \\ & 22 \end{aligned}$ | 1M/ <br> 1M/ <br> IM/ <br> 1M/ | $\begin{aligned} & 1.1 / \\ & 1.1 / \\ & 1.1 / \\ & 1.1 / \end{aligned}$ |  | , |  |
| 1N2310 1N2311 IN2312 IN2313 | $\begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}$ | $\begin{aligned} & R E \\ & R E \\ & R E \\ & R E \\ & R E \end{aligned}$ |  |  |  | $\begin{array}{r} 50 \\ 100 \\ 150 \\ 200 \end{array}$ | $\begin{aligned} & \mathbf{3 5} \\ & \mathbf{3 5} \\ & \mathbf{3 5} \\ & \mathbf{3 5} \end{aligned}$ | $\begin{aligned} & 2 M / \\ & 2 M / \\ & 2 M / \\ & 2 M / \end{aligned}$ | $\begin{aligned} & 1.1 / \\ & 1.1 / \\ & 1.1 / \\ & 1.1 / \end{aligned}$ |  |  |  |

## DIODE INTERCHANGEABILITY

| TYME NUMEER |  |  | 7 REPLACEMENT | FORNEWDESIGN | ratinges |  |  | CHARACTERISTICS |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  | $\begin{gathered} \text { PD } \\ (\mathrm{mW}) \end{gathered}$ |  | (A) | $\left.\begin{array}{lll} \mathbf{I}_{\mathbf{R}} & \mathbf{V}_{\mathbf{R}} \\ \mu_{\mathrm{A}} & /(\mathrm{V}) \end{array} \right\rvert\,$ | $\mathbf{V}_{\mathbf{F}}$ - $\mathbf{I f}_{\mathbf{F}}$ <br> (v) $/(\mathrm{mA})$ | $t_{\Gamma}$ <br> (ns) | $\mathbf{V}_{\mathbf{Z}}$ - $\mathbf{I z}_{\mathbf{Z}}$ <br> (V) / (mA) | $\begin{gathered} \text { rot } \\ \% \end{gathered}$ |
| $\begin{aligned} & \text { IN2314 } \\ & \text { IN2315 } \\ & \text { 1N2316 } \\ & \text { IN2317 } \end{aligned}$ | $\begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}$ | $\begin{aligned} & \mathbf{R E} \\ & \mathbf{R E} \\ & \mathbf{R E} \\ & \mathbf{R E} \end{aligned}$ |  |  |  | $\begin{aligned} & 250 \\ & 300 \\ & 350 \\ & 400 \end{aligned}$ | $\begin{aligned} & 35 \\ & 35 \\ & 35 \\ & 35 \end{aligned}$ | $\begin{aligned} & 2 M / \\ & 2 M / \\ & 2 M / \\ & 2 M / \end{aligned}$ | $\begin{aligned} & 1.1 / \\ & 1.1 / \\ & 1.1 / \\ & 1.1 / \end{aligned}$ |  |  |  |
| 1N2318 <br> IN2319 <br> IN2320 <br> 1N2321 | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\left\|\begin{array}{l} R E \\ R E \\ R E \\ R E \end{array}\right\|$ |  |  |  | $\begin{array}{r} 50 \\ 100 \\ 150 \\ 200 \end{array}$ | $\begin{aligned} & 35 \\ & 35 \\ & 35 \\ & 35 \end{aligned}$ | $\begin{aligned} & 2 M / \\ & 2 M / \\ & 2 M / \\ & 2 M / \end{aligned}$ | $\begin{aligned} & 1.1 / / \\ & 1.1 / \\ & 1.1 / \\ & 1.1 / \end{aligned}$ |  |  |  |
| $\begin{array}{\|l\|} \text { 1N2322 } \\ \text { 1N2323 } \\ \text { 1N2324 } \\ \text { iN2325 } \end{array}$ | $\left\lvert\, \begin{aligned} & 5 \\ & 5 \\ & 5 \\ & 5 \end{aligned}\right.$ | $\begin{aligned} & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \\ & \hline \end{aligned}$ |  |  |  | $\begin{aligned} & 250 \\ & 300 \\ & 350 \\ & 400 \end{aligned}$ | $\begin{aligned} & 35 \\ & \mathbf{3 5} \\ & \mathbf{3 5} \\ & \mathbf{3 5} \end{aligned}$ | $\begin{aligned} & 2 \mathrm{M} / \\ & 2 \mathrm{M} / \\ & 2 \mathrm{M} / \\ & 2 \mathrm{M} / \end{aligned}$ | $\begin{aligned} & 1.1 / \\ & 1.1 / \\ & 1.1 / \\ & 1.1 / \end{aligned}$ |  |  |  |
| $\begin{aligned} & \text { 1N2327 } \\ & \text { iN2328 } \\ & \text { 1N2348 } \\ & \text { 1N2349 } \end{aligned}$ | $\left\lvert\, \begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}\right.$ | $\begin{aligned} & \mathrm{SD} \\ & \mathrm{SD} \\ & \mathrm{RE} \\ & \mathrm{RE} \end{aligned}$ |  |  |  | $\begin{array}{r} 1.1 K \\ 2.2 K \\ 50 \\ 100 \end{array}$ | $\begin{aligned} & 1 \\ & 3 \\ & 3 \end{aligned}$ | $\begin{aligned} & 1.5 / 750 \\ & 1.5 / 1.5 K \\ & 300 / \\ & 300 / \end{aligned}$ | $\begin{aligned} & 3.3 / 400 \\ & 3.3 / 400 \\ & 1.1 / \\ & 1.1 / \end{aligned}$ |  |  |  |
| $\left\{\begin{array}{l} \text { 1N2350 } \\ \text { 1N2357 } \\ \text { IN2358 } \\ \text { IN2359 } \end{array}\right.$ | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\begin{aligned} & R E \\ & R E \\ & R E \\ & R E \end{aligned}$ |  |  |  | $\begin{aligned} & 150 \\ & 1.4 K \\ & 1.5 K \\ & 1.6 K \end{aligned}$ | $\begin{gathered} 3 \\ .4 \\ .4 \\ .4 \end{gathered}$ | $\begin{gathered} 300 / \\ 1 / \\ 1 / \\ 1 / \end{gathered}$ | $\begin{array}{r} 1.1 / \\ 21 \\ 21 \\ 2 / \end{array}$ |  |  |  |
| $\begin{aligned} & \text { 1N2360 } \\ & \text { 1N2361 } \\ & \text { 1N2362 } \\ & \text { 1N2362A } \end{aligned}$ | $\begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}$ | $\left.\begin{array}{\|l\|} \mathrm{RE} \\ \mathrm{RE} \\ \mathrm{RE} \\ \mathrm{RE} \end{array} \right\rvert\,$ |  |  |  | $\begin{aligned} & 1.8 \mathrm{~K} \\ & 2.0 \mathrm{~K} \\ & 1.4 \mathrm{~K} \\ & 1.4 \mathrm{~K} \end{aligned}$ | .4 .4 1 5 | $\begin{aligned} & 1 / \\ & 1 / \\ & 1 / \\ & 1 / \end{aligned}$ | $\begin{aligned} & 2 / \\ & 2 / \\ & 2 / \\ & 2 / \end{aligned}$ |  |  |  |
| $\begin{aligned} & \text { IN2362B } \\ & \text { IN2363 } \\ & \text { IN2363A } \\ & \text { IN23638 } \end{aligned}$ | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\begin{array}{\|l\|} \hline R E \\ \hline \\ \hline \\ \hline \end{array}$ |  |  |  | $\begin{aligned} & 1.4 K \\ & 1.4 K \\ & 1.4 K \\ & 1.4 K \end{aligned}$ | $\begin{array}{r} 10 \\ 1 \\ 5 \\ 10 \end{array}$ | $\begin{aligned} & 1 / \\ & 1 / \\ & 1 / \\ & 1 / \end{aligned}$ | $\begin{aligned} & 2 / \\ & 2 / \\ & 2 \prime \\ & 2 \prime \end{aligned}$ |  |  |  |
| $\begin{array}{\|l} \text { 1 N2364 } \\ \text { iN2364A } \\ \text { 1N23648 } \\ \text { IN2365 } \end{array}$ | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\begin{array}{\|} \mathbf{R E} \\ \mathbf{R E} \\ \mathbf{R E} \\ \mathbf{R E} \end{array}$ |  |  |  | $\begin{aligned} & 1.5 K \\ & 1.5 K \\ & 1.5 K \\ & 1.5 K \end{aligned}$ | 1 5 10 1 | $\begin{aligned} & 1 / \\ & 1 / \\ & 1 / \\ & 1 / \end{aligned}$ | $\begin{aligned} & 2 \prime \\ & 2 \prime \\ & 2 \prime \\ & 2 \prime \end{aligned}$ |  |  |  |
| $\left\{\begin{array}{l} \text { IN2365A } \\ \text { IN23658 } \\ \text { IN2366 } \\ \text { IN2366A } \end{array}\right.$ | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\left.\begin{aligned} & R E \\ & R E \\ & R E \\ & R E \end{aligned} \right\rvert\,$ |  |  |  | $\begin{aligned} & 1.5 \mathrm{~K} \\ & 1.5 \mathrm{~K} \\ & 1.6 \mathrm{~K} \\ & 1.6 \mathrm{~K} \end{aligned}$ | 5 10 1 5 | $\begin{aligned} & 1 / \\ & 1 / \\ & 1 / \\ & 1 / \end{aligned}$ | $\begin{aligned} & 2 \prime \\ & 2 / \\ & 2 / \\ & 2 / \end{aligned}$ |  |  |  |
| $\begin{aligned} & \text { 1N2366B } \\ & \text { 1N2367 } \\ & \text { 1N2367A } \\ & \text { 1N23678 } \end{aligned}$ | $\begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}$ | $\begin{aligned} & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \\ & \hline \mathbf{R E} \end{aligned}$ |  |  |  | $\begin{aligned} & 1.6 \mathrm{~K} \\ & 1.6 \mathrm{~K} \\ & 1.6 \mathrm{~K} \\ & 1.6 \mathrm{~K} \end{aligned}$ | $\begin{array}{r} 10 \\ 1 \\ 5 \\ 10 \end{array}$ | $\begin{aligned} & 1 / \\ & 1 / \\ & 1 / \\ & 1 / \end{aligned}$ | $\begin{aligned} & 2 / \\ & 2 / \\ & 2 / \\ & 2 / \end{aligned}$ |  |  |  |


| TYPE MUMEER | E | $\begin{array}{r} z \\ \mathbf{y} \\ \mathbf{y} \\ \vdots \\ \vdots \\ 0 \end{array}$ | $\stackrel{\pi}{\text { Ti }}$ | $\begin{gathered} \text { KOR } \\ \text { NEW } \\ \text { DESICN } \end{gathered}$ | PD (mW) | $\begin{gathered} \mathbf{V A T M O S}_{\mathbf{R}} \\ \text { (V) } \end{gathered}$ | I <br> (A) | $\begin{array}{ll} \mathbf{l}_{\mathbf{R}} & \bullet V_{R} \\ \mu_{\mathrm{A}} & /(\mathrm{V}) \end{array}$ | $\left.\begin{array}{cc} c & \text { CHARACT } \\ \mathbf{v F}_{F} & 0 \\ \text { (v) } & 1 \text { (ma) } \end{array} \right\rvert\,$ |  | $\begin{array}{lll} \mathbf{v}_{\mathbf{z}} & \cdot \mathbf{z} \\ (\mathrm{V}) & /(\mathrm{mA}) \end{array}$ | $\left\|\begin{array}{c} \text { rot } \\ x \end{array}\right\|$ |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| $\begin{aligned} & \text { 1N2368 } \\ & \text { 1N2368A } \\ & \text { iN2368B } \\ & \text { iN2369 } \end{aligned}$ | S | RE <br> $\mathbf{R E}$ <br> $\mathbf{R E}$ <br> $\mathbf{R E}$ |  |  |  | 1.8 K <br> 1.8 K <br> 1.8 K <br> 1.8 K | 1 5 10 1 | $1 /$ $1 /$ $1 /$ $1 /$ | $\begin{aligned} & 2 \prime \\ & 2 \prime \\ & 2 \prime \\ & 2 \prime \\ & \hline \end{aligned}$ |  |  |  |
| $\begin{aligned} & \text { 1N2369A } \\ & \text { 1N2369B } \\ & \text { 1N2370 } \\ & \text { 1N2370A } \end{aligned}$ | s | $\begin{aligned} & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \end{aligned}$ |  |  |  | $\begin{array}{r}1.8 \mathrm{~K} \\ 1.8 \mathrm{~K} \\ 2 \mathrm{~K} \\ \hline\end{array}$ | 5 10 1 5 | $1 / 1$ $1 /$ $1 /$ | $\begin{aligned} & 21 \\ & 21 \\ & 21 \\ & 21 \end{aligned}$ |  |  |  |
| $\begin{array}{\|l\|} \text { 1N2370B } \\ \text { IN2371 } \\ \text { 1N2371A } \\ \text { 1N23718 } \end{array}$ | S | $\left\lvert\, \begin{aligned} & \mathbf{R E} \\ & \mathbf{R E} \\ & \mathbf{R E} \\ & \mathbf{R E} \end{aligned}\right.$ |  |  |  | 2K 2K 2K 2K | 10 1 5 10 | $1 /$ $1 /$ $1 /$ $1 /$ | $\begin{aligned} & 21 \\ & 21 \\ & 21 \\ & 21 \end{aligned}$ |  |  |  |
| $\begin{aligned} & \text { 1N2372 } \\ & \text { 1N2373 } \\ & \text { 1N2374 } \\ & \text { 1N2375 } \end{aligned}$ | $\begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}$ | $\left\|\begin{array}{l} R E \\ R E \\ R E \\ R E \\ R E \end{array}\right\|$ |  | 1N4005 1N4007 |  | $\begin{array}{r} 1 K \\ 600 \\ 1 K \\ 1.5 K \end{array}$ | .2 .1 .1 .1 | $\begin{aligned} & 500 / \\ & 250 / \\ & 250 / \\ & 250 / \end{aligned}$ | $\begin{array}{r} 21 \\ 3 / \\ 31 \\ 4.51 \end{array}$ |  |  |  |
| $\begin{aligned} & \text { 1N2376 } \\ & \text { 1N2377 } \\ & \text { 1N2378 } \\ & \text { 1N2379 } \end{aligned}$ | $\left\lvert\, \begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}\right.$ | $\left.\begin{aligned} & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \end{aligned} \right\rvert\,$ |  |  |  | $\begin{array}{r} 2 K \\ 2.4 K \\ 3 K \\ 4 K \end{array}$ | $\begin{array}{r} .1 \\ .075 \\ .075 \\ .05 \end{array}$ | $\begin{aligned} & 250 / \\ & 250 / \\ & 250 / \\ & 250 / \end{aligned}$ | $\begin{array}{r} 7.5 / \\ 9 / \\ 9 / \\ 15 \% \\ \hline \end{array}$ |  |  |  |
| 1N2380 <br> 1N2381 <br> 1N2382 <br> 1N2382A | $\begin{aligned} & s \\ & s \\ & s \\ & s \\ & s \end{aligned}$ | $\left.\begin{aligned} & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \end{aligned} \right\rvert\,$ |  |  |  | $\begin{array}{r} 6 K \\ 10 K \\ 4 K \\ 4 K \end{array}$ | $\begin{array}{r} .05 \\ .025 \\ .15 \\ .35 \end{array}$ | $\begin{aligned} & 250 / \\ & 250 / \\ & 200 / \\ & 200 / \end{aligned}$ | $\begin{gathered} 22 / \\ 371 \\ 18 / \\ 6 / \end{gathered}$ |  |  |  |
| 1N2383 <br> 1N2383A <br> 1N2384 <br> IN2384A | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \\ & s \end{aligned}\right.$ |  |  |  |  | OK <br> bK <br> 8K <br> 8K | $\begin{array}{r} .1 \\ .35 \\ .07 \\ .275 \end{array}$ | $\begin{aligned} & 200 / \\ & 200 / \\ & 200 / \\ & 200 / \end{aligned}$ | $\begin{gathered} 271 \\ 9 / \\ 271 \\ 121 \end{gathered}$ |  |  |  |
| 1N2385 IN2385A iN2387 1N2389 | s | $\left\|\begin{array}{l} \mathrm{RE} \\ \mathrm{RE} \\ \mathrm{ZD} \\ \mathrm{RE} \end{array}\right\|$ |  | 1N4751 | IW | $\begin{aligned} & 10 \mathrm{~K} \\ & 10 \mathrm{~K} \\ & 1.6 \mathrm{~K} \end{aligned}$ | $\begin{array}{r} .07 \\ .2 \\ .6 \end{array}$ | $\begin{aligned} & 200 / \\ & 200 / \\ & 500 \% \end{aligned}$ | $\begin{array}{r} 391 \\ 151 \\ 4.81 \end{array}$ |  | $30 / 8$ | 10 |
| IN2390 <br> 1N2391 <br> 1N2392 <br> 1N2393 | [ | $\left.\begin{aligned} & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \end{aligned} \right\rvert\,$ |  |  |  | $\begin{array}{r} 50 \\ 100 \\ 200 \\ 300 \\ \hline \end{array}$ | 1.5 1.5 1.5 1.5 | $\begin{aligned} & 300 \% \\ & 300 \% \\ & 300 \prime \\ & 300 \% \end{aligned}$ | $\begin{aligned} & 1.21 \\ & 1.2 / \\ & 1.2 / \\ & 1.2 / \end{aligned}$ |  |  |  |
| 1 N 2394 <br> 1N2395 <br> iN2396 <br> 1N2397 | $\left\{\begin{array}{l} s \\ s \\ s \\ s \end{array}\right.$ | $\left\|\begin{array}{l} \mathrm{RE} \\ \mathrm{RE} \\ \mathrm{RE} \\ \mathrm{RE} \end{array}\right\|$ |  |  |  | $\begin{aligned} & 400 \\ & 500 \\ & 600 \\ & 700 \end{aligned}$ | $\begin{aligned} & 1.5 \\ & 1.5 \\ & 1.5 \\ & 1.5 \end{aligned}$ | $\begin{aligned} & 300 / \\ & 300 / \\ & 300 / \\ & 300 / \end{aligned}$ | $\begin{aligned} & 1.21 \\ & 1.21 \\ & 1.21 \\ & 1.21 \end{aligned}$ |  |  |  |


| TYPEnumarer |  |  | $\underset{\text { REPLACEMENT }}{\text { TI }}$ | $\begin{aligned} & \text { FOR } \\ & \text { NEW } \\ & \text { DESSCN } \end{aligned}$ | patings |  |  | CHARACTERISTICS |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  | $\begin{aligned} & P_{D} \\ & (\mathrm{mw}) \end{aligned}$ | $\begin{aligned} & \mathbf{V}_{\mathbf{R}} \\ & (\mathbf{V}) \end{aligned}$ | (A) | $\begin{array}{ll} l_{R} & V_{R} \\ \mu_{\mathrm{A}} & /(\mathrm{V}) \end{array}$ | $\begin{array}{ll} \mathbf{v}_{\mathbf{F}} & e_{\mathbf{F}} \\ (\mathbf{v}) & /(\mathrm{ma}) \end{array}$ | $\begin{aligned} & t r \\ & (m s) \end{aligned}$ | $\begin{array}{ccc} v_{z} & \mathbf{z} \\ (\mathrm{v}) & 1 \mathrm{~mA}) \end{array}$ | $\frac{70 L}{x}$ |
| 1N2398 <br> 1N2399 <br> 1N2400 <br> 1N2401 | $\begin{array}{\|l} \mathbf{s} \\ \mathbf{s} \\ \mathbf{s} \\ \mathbf{s} \end{array}$ | $\left.\begin{array}{\|c\|} \hline \mathrm{RE} \\ \mathrm{RE} \\ \mathrm{RE} \\ \mathrm{RE} \end{array} \right\rvert\,$ |  |  |  | $\begin{array}{r} 800 \\ 50 \\ 100 \\ 200 \end{array}$ | $\begin{aligned} & 1.5 \\ & 1.5 \\ & 1.5 \\ & 1.5 \end{aligned}$ | $\begin{aligned} & 300 / \\ & 300 / \\ & 300 / \\ & 300 / \end{aligned}$ | $\begin{aligned} & 1.2 / \\ & 1.2 / \\ & 1.21 \\ & 1.2 / \end{aligned}$ |  |  |  |
| 1N2402 1N2403 1N2404 1N2405 | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\left.\begin{array}{\|l\|} \mathbf{R E} \\ \mathrm{RE} \\ \mathrm{RE} \\ \mathrm{RE} \end{array} \right\rvert\,$ |  |  |  | $\begin{aligned} & 300 \\ & 400 \\ & 500 \\ & 600 \end{aligned}$ | $\begin{aligned} & 1.5 \\ & 1.5 \\ & 1.5 \\ & 1.5 \end{aligned}$ | $300 /$ <br> $300 /$ <br> $300 /$ <br> 300/ | $\begin{aligned} & 1.2 / \\ & 1.2 / \\ & 1.2 / \\ & 1.2 / \end{aligned}$ |  |  |  |
| IN2406 <br> IN2407 <br> IN2408 <br> 1N2409 | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\left\|\begin{array}{l} \mathrm{RE} \\ \mathrm{RE} \\ \mathrm{RE} \\ \mathrm{RE} \end{array}\right\|$ |  |  |  | $\begin{array}{r} 700 \\ 800 \\ 50 \\ 100 \end{array}$ | $\begin{aligned} & 1.5 \\ & 1.5 \\ & 1.5 \\ & 1.5 \end{aligned}$ | $\begin{aligned} & 300 / \\ & 300 / \\ & 300 / \\ & 300 / \end{aligned}$ | $\begin{aligned} & 1.21 \\ & 1.21 \\ & 1.21 \\ & 1.21 \end{aligned}$ |  |  |  |
| 1N2410 in2411 1N2412 in2413 | $\begin{aligned} & 5 \\ & 5 \\ & 5 \\ & 5 \end{aligned}$ | $\left.\begin{array}{\|l\|} \hline \mathbf{R E} \\ \mathbf{R E} \\ \mathrm{RE} \\ \mathrm{RE} \end{array} \right\rvert\,$ |  |  |  | $\begin{aligned} & 200 \\ & 300 \\ & 400 \\ & 500 \end{aligned}$ | $\begin{aligned} & 1.5 \\ & 1.5 \\ & 1.5 \\ & 1.5 \end{aligned}$ | $\begin{aligned} & 300 / \\ & 300 / \\ & 300 / \\ & 300 / \end{aligned}$ | $\begin{aligned} & 1.2 / \\ & 1.2 / \\ & 1.2 / \\ & 1.2 / \end{aligned}$ |  |  |  |
| $\begin{aligned} & \text { IN2414 } \\ & \text { 1N2415 } \\ & \text { 1N2416 } \\ & \text { 1N2417 } \end{aligned}$ | $\begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}$ | $\left.\begin{array}{\|l\|} \mathbf{R E} \\ R E \\ R E \\ R E \\ R E \end{array} \right\rvert\,$ |  |  |  | $\begin{array}{r} 600 \\ 700 \\ 800 \\ 50 \end{array}$ | $\begin{aligned} & 1.5 \\ & 1.5 \\ & 1.5 \\ & 1.5 \end{aligned}$ | $\begin{aligned} & 300 / \\ & 300 / \\ & 300 / \\ & 300 / \end{aligned}$ | $\begin{aligned} & 1.2 / \\ & 1.2 / \\ & 1.2 / \\ & 1.2 / \end{aligned}$ |  |  |  |
| $\begin{aligned} & \text { 1N2418 } \\ & \text { 1N2419 } \\ & \text { 1N2420 } \\ & \text { IN2421 } \end{aligned}$ | $\left[\begin{array}{l} s \\ s \\ s \\ s \end{array}\right.$ | $\left.\begin{aligned} & \mathbf{R E} \\ & \mathbf{R E} \\ & \mathbf{R E} \\ & \mathbf{R E} \end{aligned} \right\rvert\,$ |  |  |  | $\begin{aligned} & 100 \\ & 200 \\ & 300 \\ & 400 \end{aligned}$ | $\begin{aligned} & 1.5 \\ & 1.5 \\ & 1.5 \\ & 1.5 \end{aligned}$ | $300 /$ <br> $300 /$ <br> $300 /$ <br> 300/ | $\begin{aligned} & 1.21 \\ & 1.21 \\ & 1.21 \\ & 1.21 \end{aligned}$ |  |  |  |
| $\left\{\begin{array}{l} \text { IN2422 } \\ \text { IN2 } 2423 \\ \text { IN2424 } \\ \text { IN2425 } \end{array}\right.$ | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\begin{aligned} & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \end{aligned}$ |  |  |  | $\begin{aligned} & 500 \\ & 600 \\ & 700 \\ & 800 \end{aligned}$ | $\begin{aligned} & 1.5 \\ & 1.5 \\ & 1.5 \\ & 1.5 \end{aligned}$ | $\begin{aligned} & 300 / \\ & 300 / \\ & 300 / \\ & 300 / \end{aligned}$ | $\begin{aligned} & 1.2 / \\ & 1.2 / \\ & 1.2 / \\ & 1.2 / \end{aligned}$ |  |  |  |
| $\begin{aligned} & \text { 1N2482 } \\ & \text { IN2483 } \\ & \text { iN2484 } \\ & \text { iN2485 } \end{aligned}$ | $\left\lvert\, \begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}\right.$ | $\begin{array}{\|l\|} \hline \mathbf{R E} \\ \mathrm{RE} \\ \mathrm{RE} \\ \mathrm{RE} \\ \mathrm{RE} \end{array}$ |  | $\begin{aligned} & \mathrm{TD} 383 \\ & \mathrm{TD} 384 \\ & \mathrm{TND} 385 \\ & \mathrm{TND} 383 \end{aligned}$ |  | $\begin{aligned} & 200 \\ & 400 \\ & 500 \\ & 200 \end{aligned}$ | $\begin{aligned} & .75 \\ & .75 \\ & .75 \\ & .75 \end{aligned}$ | $\begin{aligned} & 500 / 200 \\ & 500 / 400 \\ & 500 / 500 \\ & 500 / 200 \end{aligned}$ | $\begin{aligned} & 1.2 / 750 \\ & 1.2 / 750 \\ & 1.2 / 750 \\ & 1.2 / 750 \end{aligned}$ |  |  |  |
| $\begin{aligned} & \text { 1N2486 } \\ & \text { 1N2487 } \\ & \text { 1N2488 } \\ & \text { 1N2489 } \end{aligned}$ | $\begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}$ | $\left.\begin{aligned} & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \end{aligned} \right\rvert\,$ |  | $\begin{aligned} & \mathrm{mD} 384 \\ & \mathrm{nD} 384 \\ & \mathrm{nD} 385 \\ & \mathrm{mD} 385 \end{aligned}$ |  | $\begin{aligned} & 300 \\ & 400 \\ & 500 \\ & 600 \end{aligned}$ | $\begin{aligned} & .75 \\ & .75 \\ & .75 \\ & .75 \end{aligned}$ | $\begin{aligned} & 500 / 300 \\ & 500 / 400 \\ & 500 / 500 \\ & 500 / 600 \end{aligned}$ | $\begin{aligned} & 1.2 / 750 \\ & 1.21750 \\ & 1.2 / 750 \\ & 1.2 / 750 \end{aligned}$ |  |  |  |
| $\begin{aligned} & \text { IN2490 } \\ & \text { 1N2501 } \\ & \text { IN2502 } \\ & \text { IN2503 } \end{aligned}$ | s | $\begin{aligned} & \mathbf{R E} \\ & \mathbf{R E} \\ & \mathbf{R E} \\ & \mathbf{R E} \end{aligned}$ |  | $\left\lvert\, \begin{aligned} & \text { IN4006 } \\ & \text { IN4007 } \end{aligned}\right.$ |  | $\begin{array}{r} 1.6 \mathrm{~K} \\ 800 \\ 1 \mathrm{~K} \\ 1.2 \mathrm{~K} \end{array}$ | .5 .15 .15 .15 | $500 /$ 200/800 200/1K 200/ | $\begin{aligned} & 4.8 / \\ & 1.7 / 100 \\ & 1.7 / 100 \\ & 1.71 \end{aligned}$ |  |  |  |

## DIODE INTERCHANGEABILITY

| $\begin{gathered} \text { TYPE } \\ \text { number } \end{gathered}$ | $\begin{aligned} & \text { 를 } \\ & \text { 恶 } \end{aligned}$ |  | $\pi$ | $\begin{aligned} & \text { FOR } \\ & \text { NEW } \\ & \text { DESICN } \end{aligned}$ | PD (mW) | atinges <br> $V_{R}$ <br> (V) | (A) | $\begin{array}{ll} \mathbf{l}_{\mathbf{R}} & \mathbf{v}_{\mathbf{R}} \\ \mu_{\mathbf{A}} & /(\mathbf{V}) \end{array}$ | $\begin{array}{cc} v_{F} & 0 \\ \text { (v) } & 1 \text { (mA) } \end{array}$ |  | $\begin{array}{lll} v_{z} & \bullet & \mathbf{z} \\ (v) & /(\mathrm{ma}) \end{array}$ | $\left.\right\|^{\mathrm{TO}}$ |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| $\begin{aligned} & \text { 1N2304 } \\ & \text { 1N2505 } \\ & \text { iN2506 } \\ & \text { 1N2507 } \end{aligned}$ | S | RE RE RE RE |  | 1N4006 1N4007 |  | $\begin{array}{r} 1.5 K \\ 800 \\ 1 K \\ 1.2 K \end{array}$ | $\begin{array}{r} \hline .15 \\ .3 \\ .3 \\ .3 \end{array}$ | $\begin{aligned} & 200 / \\ & 200 / 800 \\ & 200 / 1 \mathrm{~K} \\ & 200 / \end{aligned}$ | $\begin{aligned} & 1.71 \\ & 1.71200 \\ & 1.71200 \\ & 1.71 \end{aligned}$ |  |  |  |
| $\begin{aligned} & \text { 1N2508 } \\ & \text { IN2512 } \\ & \text { IN2513 } \\ & \text { IN2514 } \end{aligned}$ | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\left.\begin{aligned} & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \end{aligned} \right\rvert\,$ |  |  |  | $\begin{aligned} & 1.5 K \\ & 100 \\ & 200 \\ & 300 \end{aligned}$ | .3 4 4 4 | $\begin{array}{r} 200 / \\ 2 \prime \\ 2 \prime \\ 21 \end{array}$ | $\begin{aligned} & 1.71 \\ & 1.1 / \\ & 1.1 / \\ & 1.1 / \end{aligned}$ |  |  |  |
| 1N2515 <br> 1N2516 <br> 1N2517 <br> iN2518 | $\left\lvert\, \begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}\right.$ | $\left\|\begin{array}{l} \mathbf{R E} \\ \mathbf{R E} \\ \mathbf{R E} \\ \mathbf{R E} \end{array}\right\|$ |  |  |  | $\begin{aligned} & 400 \\ & 500 \\ & 600 \\ & 100 \end{aligned}$ | $\begin{aligned} & 4 \\ & 4 \\ & 4 \\ & 4 \end{aligned}$ | $\begin{aligned} & 2 \prime \\ & 21 \\ & 21 \\ & 21 \end{aligned}$ | $\begin{aligned} & 1.1 / \\ & 1.1 / \\ & 1.1 / \\ & 1.1 / \end{aligned}$ |  |  |  |
| 1N2519 <br> IN2520 <br> 1N2521 <br> IN2522 | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\left.\begin{aligned} & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \end{aligned} \right\rvert\,$ |  |  |  | $\begin{aligned} & 200 \\ & 300 \\ & 400 \\ & 500 \end{aligned}$ | 4 4 4 4 | $\begin{aligned} & 21 \\ & 21 \\ & 21 \\ & 21 \end{aligned}$ | $\begin{aligned} & 1.1 / \\ & 1.1 / \\ & 1.1 / \\ & 1.1 / \end{aligned}$ |  |  |  |
| $\begin{aligned} & \text { 1N2523 } \\ & \text { 1N2524 } \\ & \text { 1N2525 } \\ & \text { 1N2526 } \end{aligned}$ | $\begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}$ | $\left\|\begin{array}{l} \mathbf{R E} \\ \mathbf{R E} \\ \mathbf{R E} \\ \mathbf{R E} \end{array}\right\|$ |  |  |  | $\begin{array}{r} 600 \\ 50 \\ 100 \\ 200 \end{array}$ | $\begin{aligned} & 4 \\ & 2.5 \\ & 2.5 \\ & 2.5 \end{aligned}$ | $\begin{array}{r} 21 \\ 500 / \\ 500 / \\ 500 / \end{array}$ | $\begin{aligned} & 1.1 / \\ & 1.21 \\ & 1.21 \\ & 1.21 \end{aligned}$ |  |  |  |
| $\begin{aligned} & \text { 1N2527 } \\ & \text { 1N2528 } \\ & \text { 1N2529 } \\ & \text { iN2530 } \end{aligned}$ | $\begin{aligned} & \mathrm{s} \\ & s \\ & s \\ & s \\ & s \end{aligned}$ | $\begin{aligned} & \mathbf{R E} \\ & \mathbf{R E} \\ & \mathbf{R E} \\ & \mathbf{R E} \\ & \mathbf{R E} \end{aligned}$ |  |  |  | $\begin{aligned} & 300 \\ & 400 \\ & 500 \\ & 600 \end{aligned}$ | $\begin{aligned} & 2.5 \\ & 2.5 \\ & 2.5 \\ & 2.5 \\ & \hline \end{aligned}$ | $\begin{aligned} & 500 / \\ & 500 / \\ & 500 / \\ & 500 / \end{aligned}$ | $\begin{aligned} & 1.2 / \\ & 1.21 \\ & 1.21 \\ & 1.21 \end{aligned}$ |  |  |  |
| $\begin{array}{\|l\|} \text { IN2531 } \\ \text { 1N2532 } \\ \text { IN2533 } \\ \text { IN2534 } \end{array}$ | s | $\left.\begin{array}{\|l\|} \mathbf{R E} \\ \mathbf{R E} \\ \mathrm{RE} \\ \mathrm{RE} \end{array} \right\rvert\,$ |  |  |  | $\begin{array}{r} 700 \\ 800 \\ 900 \\ 1 \mathrm{~K} \end{array}$ | $\begin{aligned} & 2.5 \\ & 2.5 \\ & 2.5 \\ & 2.5 \end{aligned}$ | $\begin{aligned} & 500 / \\ & 500 / \\ & 500 / \\ & 500 \% \end{aligned}$ | $\begin{aligned} & 1.2 \prime \\ & 1.21 \\ & 1.2 \prime \\ & 1.2 \prime \end{aligned}$ |  |  |  |
| $\begin{aligned} & \text { 1N2535 } \\ & \text { 1N2536 } \\ & \text { 1N2537 } \\ & \text { 1N2538 } \end{aligned}$ | [ $\begin{aligned} & \text { s } \\ & \mathbf{s} \\ & \text { s } \\ & \mathbf{s}\end{aligned}$ | $\left.\begin{array}{\|c\|} \hline \mathbf{R E} \\ \mathbf{R E} \\ \mathrm{RE} \\ \mathbf{R E} \end{array} \right\rvert\,$ |  |  |  | $\begin{array}{r} 50 \\ 100 \\ 200 \\ 300 \end{array}$ | $\begin{aligned} & 2.5 \\ & 2.5 \\ & 2.5 \\ & 2.5 \end{aligned}$ | $\begin{aligned} & 100 \prime \\ & 100 / \\ & 100 / \\ & 100 / \end{aligned}$ | $\begin{aligned} & 1 / \\ & 1 / \\ & 1 / \\ & 1 / \end{aligned}$ |  |  |  |
| 1N2539 <br> 1N2540 <br> 1N2541 <br> 1N2542 | $\left\lvert\, \begin{aligned} & \mathbf{s} \\ & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\left.\begin{aligned} & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \end{aligned} \right\rvert\,$ |  |  |  | $\begin{aligned} & 400 \\ & 500 \\ & 600 \\ & 700 \end{aligned}$ | $\begin{aligned} & 2.5 \\ & 2.5 \\ & 2.5 \\ & 2.5 \end{aligned}$ | $\begin{aligned} & 100 / \\ & 100 / \\ & 100 / \\ & 100 / \end{aligned}$ | $\begin{aligned} & 11 \\ & 1 / \\ & 1 / \\ & 11 \end{aligned}$ |  |  |  |
| 1N2543 <br> 1N2544 <br> 1N2545 <br> 1N2546 | $\left\lvert\, \begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}\right.$ | $\left.\begin{aligned} & R E \\ & R E \\ & R E \\ & R E \end{aligned} \right\rvert\,$ |  |  |  | 800 900 $1 K$ 50 | $\begin{aligned} & 2.5 \\ & 2.5 \\ & 2.5 \\ & 2.5 \end{aligned}$ | $\begin{aligned} & 100 / \\ & 100 / \\ & 100 / \\ & 1 \mathrm{M} / \end{aligned}$ | $\begin{gathered} 1 / \\ 1 / \\ 1 / \\ 1.5 / \end{gathered}$ |  |  |  |


| $\begin{aligned} & \text { TYPE } \\ & \text { Mumer, } \end{aligned}$ | $\frac{3}{2}$ |  | II | $\begin{aligned} & \text { ROR } \\ & \text { Nen } \\ & \text { DESicN } \end{aligned}$ | Ratunos |  |  | CHARACTERESTICS |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  | $\begin{gathered} P_{0} \\ (\mathrm{~mW}) \end{gathered}$ | $\mathbf{V}_{\mathbf{R}}$ <br> (V) | I <br> (A) | $\begin{array}{ll} \mathbf{L}_{\mathrm{R}} & \bullet \mathbf{V}_{\mathrm{R}} \\ \mu \mathrm{~A} & /(\mathbf{V}) \end{array}$ | $\begin{array}{lll} \mathbf{V F}_{F} & \mathbf{F}_{\mathbf{n}} \\ \text { (V) } & f(\mathrm{~m}) \end{array}$ | $\begin{aligned} & t_{\mathrm{m}} \\ & (\mathrm{~ns}) \end{aligned}$ | $\begin{array}{ll} \mathbf{V}_{\mathbf{Z}} & \mathbf{I z} \\ \text { (V) } & / \mathrm{ma}) \end{array}$ | $\begin{gathered} \text { TOL } \\ \% \end{gathered}$ |
| $\begin{aligned} & \text { IN2547 } \\ & \text { IN2548 } \\ & \text { IN2549 } \\ & \text { 1N2550 } \end{aligned}$ | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\begin{aligned} & R E \\ & R E \\ & R E \\ & R E \\ & R E \end{aligned}$ |  |  |  | 100 200 300 400 | 2.5 2.5 2.5 2.5 | $\begin{aligned} & 1 \mathrm{M} / \\ & 1 \mathrm{M} / \\ & 1 \mathrm{M} / \\ & 1 \mathrm{M} / \end{aligned}$ | $\begin{aligned} & 1.5 / \\ & 1.5 / \\ & 1.5 / \\ & 1.5 / \end{aligned}$ |  |  |  |
| 1N2551 <br> 1N2552 <br> 1N2553 <br> 1N2554 | $\left(\begin{array}{l} \mathbf{s} \\ \mathbf{s} \\ \mathbf{s} \\ \mathbf{s} \end{array}\right.$ | $\begin{aligned} & R E \\ & R E \\ & R E \\ & R E \\ & R E \end{aligned}$ |  |  |  | $\begin{aligned} & 500 \\ & 600 \\ & 700 \\ & 800 \end{aligned}$ | $\begin{aligned} & 2.5 \\ & 2.5 \\ & 2.5 \\ & 2.5 \end{aligned}$ | $\begin{aligned} & 1 \mathrm{M} / \\ & \mathrm{lm} / \\ & 1 \mathrm{M} / \\ & 1 \mathrm{M} / \end{aligned}$ | $\begin{aligned} & 1.5 / \\ & 1.5 / \\ & 1.5 / \\ & 1.5 / \end{aligned}$ |  |  |  |
| 1N2555 <br> 1N2556 <br> IN2557 <br> iN2558 | $\begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}$ | $\left.\begin{array}{\|l\|} \mathbf{R E} \\ \mathrm{RE} \\ \mathrm{RE} \\ \mathrm{RE} \\ \mathrm{RE} \end{array} \right\rvert\,$ |  |  |  | $\begin{array}{r} 900 \\ 1 K \\ 700 \\ 800 \end{array}$ | $\begin{array}{r} 2.5 \\ 2.5 \\ 6 \\ 6 \end{array}$ | $\begin{aligned} & 1 \mathrm{M} / \\ & 1 \mathrm{Mr} \\ & 500 / \\ & 500 / \end{aligned}$ | $\begin{aligned} & 1.5 / \\ & 1.5 / \\ & 1.2 \prime \\ & 1.2 / \end{aligned}$ |  |  |  |
| 1N2559 <br> 1N2560 <br> 1N2561 <br> 1N2562 | $\left\lvert\, \begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{S} \end{aligned}\right.$ | $\begin{aligned} & R E \\ & R E \\ & R E \\ & R E \\ & R E \end{aligned}$ |  |  |  | $\begin{array}{r} 900 \\ 1 K \\ 700 \\ 800 \end{array}$ | 6 6 6 6 | $\begin{aligned} & 500 / \\ & 500 / \\ & 100 / \\ & 100 / \end{aligned}$ | $\begin{aligned} & 1.2 / \\ & 1.2 / \\ & 1 / \\ & 1 / \end{aligned}$ |  |  |  |
| 1N2563 <br> 1N2564 <br> IN2565 <br> 1N2566 | $\begin{aligned} & 5 \\ & s \\ & s \\ & s \end{aligned}$ | $\begin{aligned} & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \end{aligned}$ |  |  |  | $\begin{array}{r} 900 \\ 1 K \\ 50 \\ 100 \end{array}$ | $\begin{aligned} & 6 \\ & 6 \\ & 6 \\ & 6 \end{aligned}$ | $\begin{aligned} & 100 / \\ & 100 / \\ & 1 \mathrm{M} / \\ & 1 \mathrm{M} / \end{aligned}$ | $\begin{aligned} & 1.5 / \\ & 1.5 / \\ & 1.5 / \\ & 1.5 / \end{aligned}$ |  |  |  |
| 1N2567 <br> IN2568 <br> IN2569 <br> IN2570 | $\left\lvert\, \begin{aligned} & \mathrm{s} \\ & \mathrm{~s} \\ & \mathrm{~s} \\ & \mathrm{~s} \end{aligned}\right.$ | $\begin{aligned} & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \end{aligned}$ |  |  |  | $\begin{array}{r} 200 \\ 300 \\ 400 \\ 500 \end{array}$ | $\begin{aligned} & 6 \\ & 6 \\ & 6 \\ & 6 \end{aligned}$ | $\begin{aligned} & 1 \mathrm{M} / \\ & 1 \mathrm{M} / \\ & 1 \mathrm{M} / \\ & 1 \mathrm{M} / \end{aligned}$ | $\begin{aligned} & 1.5 / \\ & 1.5 / \\ & 1.5 / \\ & 1.5 / \end{aligned}$ |  |  |  |
| $\begin{aligned} & \text { 1N2571 } \\ & \text { 1N2572 } \\ & \text { 1N2573 } \\ & \text { 1N2574 } \end{aligned}$ | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\begin{aligned} & \text { RE } \\ & R E \\ & R E \\ & R E \\ & R E \end{aligned}$ |  |  |  | $\begin{aligned} & 600 \\ & 700 \\ & 800 \\ & 900 \end{aligned}$ | $\begin{aligned} & 6 \\ & 6 \\ & 6 \\ & 6 \end{aligned}$ | $\begin{aligned} & 1 \mathrm{M} / \\ & 1 \mathrm{M} / \\ & 1 \mathrm{M} / \\ & \mathrm{IM} / \end{aligned}$ | $\begin{aligned} & 1.5 / \\ & 1.5 / \\ & 1.5 / \\ & 1.5 / \end{aligned}$ |  |  |  |
| $\begin{aligned} & \text { 1N2575 } \\ & \text { iN2576 } \\ & \text { iN2577 } \\ & \text { iN2578 } \end{aligned}$ | $\left\lvert\, \begin{aligned} & 5 \\ & 5 \\ & 5 \\ & 5 \end{aligned}\right.$ | $\begin{aligned} & R E \\ & R E \\ & R E \\ & R E \\ & R E \end{aligned}$ |  |  |  | $\begin{array}{r} 1 K \\ 50 \\ 100 \\ 200 \end{array}$ | $\begin{array}{r} 6 \\ 12 \\ 12 \\ 12 \end{array}$ | $\begin{aligned} & 1 \mathrm{M} / \\ & 1 \mathrm{M} / \\ & 1 \mathrm{M} / \\ & 1 \mathrm{M} / \end{aligned}$ | $\begin{aligned} & 1.5 / \\ & 1.2 / \\ & 1.2 / \\ & 1.2 / \end{aligned}$ |  |  |  |
| $\begin{aligned} & \text { iN2579 } \\ & \text { 1N2580 } \\ & \text { 1N2581 } \\ & \text { IN2582 } \end{aligned}$ | $\begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}$ | $\left\lvert\, \begin{aligned} & R E \\ & R E \\ & R E \\ & R E \\ & R E \end{aligned}\right.$ |  |  |  | $\begin{aligned} & 300 \\ & 400 \\ & 500 \\ & 600 \end{aligned}$ | $\begin{aligned} & 12 \\ & 12 \\ & 12 \\ & 12 \end{aligned}$ | 1M/ <br> 1M/ <br> 1M/ <br> 1M/ | $\begin{aligned} & 1.2 / \\ & 1.2 / \\ & 1.2 / \\ & 1.2 / \end{aligned}$ |  |  |  |
| $\begin{aligned} & 1 \mathrm{~N} 2583 \\ & 1 \mathrm{~N} 2584 \\ & 1 \mathrm{~N} 2585 \\ & 1 \mathrm{~N} 2586 \end{aligned}$ | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\left\lvert\, \begin{aligned} & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \end{aligned}\right.$ |  |  |  | $\begin{array}{r} 700 \\ 900 \\ 900 \\ 1 K \end{array}$ | $\begin{aligned} & 12 \\ & 12 \\ & 12 \\ & 12 \end{aligned}$ | $\begin{aligned} & 1 \mathrm{M} / \\ & 1 \mathrm{M} / \\ & \mathrm{lM} / \\ & 1 \mathrm{M} / \end{aligned}$ | $\begin{aligned} & 1.2 / \\ & 1.2 / \\ & 1.2 / \\ & 1.2 / \end{aligned}$ |  |  |  |


| TYPE NUMBER |  | $\begin{aligned} & \left.\begin{array}{c} 3 \\ \frac{0}{5} \\ \frac{3}{3} \\ \frac{5}{5} \\ 3 \\ 3 \end{array} \right\rvert\, \end{aligned}$ | 71 REPLACEMENT | $\begin{gathered} \text { FOR } \\ \text { NEW } \\ \text { DESICN } \end{gathered}$ | $\begin{gathered} \mathbf{P D}_{\mathbf{D}} \\ (\mathrm{mW}) \end{gathered}$ | TINGS <br> $V_{R}$ <br> (V) | I <br> (A) | $\begin{array}{ll} \mathbf{I}_{\mathbf{R}} & \mathbf{V}_{\mathbf{R}} \\ \mu \mathbf{A} & /(\mathbf{V}) \end{array}$ | $\mathbf{V}_{\mathbf{F}}$ © $\mathbf{I F}_{\mathbf{F}}$ <br> (V) 1 (mA) | $I_{r}$ <br> (ns) | $V_{z} \div \mathbf{l}_{\mathbf{z}}$ <br> (V) $/(\mathrm{mA})$ | TOL * |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 1N2587 <br> 1N2588 <br> iN2589 <br> IN2590 | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\begin{aligned} & R E \\ & R E \\ & R E \\ & R E \\ & R E \end{aligned}$ |  |  |  | $\begin{array}{r} 50 \\ 100 \\ 200 \\ 300 \end{array}$ | $\begin{aligned} & 12 \\ & 12 \\ & 12 \\ & 12 \end{aligned}$ | $\begin{aligned} & 200 / \\ & 200 / \\ & 200 / \\ & 200 \prime \end{aligned}$ | $\begin{aligned} & 1 / \\ & 1 / \\ & 1 / \\ & 1 / \end{aligned}$ |  |  |  |
| 1N2591 <br> 1N2592 <br> 1N2593 <br> 1N2594 | $\begin{aligned} & \mathrm{S} \\ & \mathrm{~S} \\ & \mathrm{~s} \\ & \mathrm{~S} \end{aligned}$ | $\left.\begin{aligned} & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \end{aligned} \right\rvert\,$ |  |  |  | $\begin{aligned} & 400 \\ & 500 \\ & 600 \\ & 700 \end{aligned}$ | $\begin{aligned} & 12 \\ & 12 \\ & 12 \\ & 12 \end{aligned}$ | $\begin{aligned} & 200 / \\ & 200 / \\ & 200 / \\ & 200 / \end{aligned}$ | $\begin{aligned} & 1 / \\ & 1 / \\ & 1 / \\ & 1 / \end{aligned}$ |  |  |  |
| 1N2595 <br> 1N2596 <br> 1N2597 <br> 1N2598 | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\left.\begin{aligned} & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \end{aligned} \right\rvert\,$ |  |  |  | $\begin{array}{r} 800 \\ 900 \\ 1 K \\ 50 \end{array}$ | $\begin{aligned} & 12 \\ & 12 \\ & 12 \\ & 12 \end{aligned}$ | $\begin{gathered} 200 / \\ 200 / \\ 200 / \\ 2 M / \end{gathered}$ | $\begin{gathered} 1 / \\ 1 / \\ 1 / \\ 1.5 / \end{gathered}$ |  |  |  |
| $\begin{aligned} & \text { iN2599 } \\ & \text { IN2600 } \\ & \text { 1N2601 } \\ & \text { IN2602 } \end{aligned}$ | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\begin{aligned} & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \end{aligned}$ |  |  |  | $\begin{aligned} & 100 \\ & 200 \\ & 300 \\ & 400 \end{aligned}$ | $\begin{aligned} & 12 \\ & 12 \\ & 12 \\ & 12 \end{aligned}$ | $\begin{aligned} & 2 M / \\ & 2 M / \\ & 2 M / \\ & 2 M / \end{aligned}$ | $\begin{aligned} & 1.5 / \\ & 1.5 / \\ & 1.5 / \\ & 1.5 / \end{aligned}$ |  |  |  |
| 1N2603 <br> 1N2604 <br> 1 N2605 <br> 1N2606 | $\begin{aligned} & s \\ & s \\ & s \\ & s \\ & s \end{aligned}$ | $\begin{aligned} & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \end{aligned}$ |  |  |  | $\begin{aligned} & 500 \\ & 600 \\ & 700 \\ & 800 \end{aligned}$ | $\begin{aligned} & 12 \\ & 12 \\ & 12 \\ & 12 \end{aligned}$ | $\begin{aligned} & 2 M / \\ & 2 M / \\ & 2 M / \\ & 2 M / \end{aligned}$ | $\begin{aligned} & 1.5 / \\ & 1.5 / \\ & 1.5 / \\ & 1.5 / \end{aligned}$ |  |  |  |
| $\begin{aligned} & \text { 1N2607 } \\ & \text { 1N2608 } \\ & \text { 1N2609 } \\ & \text { IN2610 } \end{aligned}$ | $\begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}$ | $\begin{aligned} & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \end{aligned}$ |  | $\left\{\begin{array}{l} \text { 1N4001 } \\ \text { 1N4002 } \end{array}\right.$ |  | $\begin{array}{r} 900 \\ 1 K \\ 50 \\ 100 \end{array}$ | $\begin{array}{r} 12 \\ 12 \\ .75 \\ .75 \end{array}$ | $\begin{aligned} & 2 M / \\ & 2 M / \\ & 10 / 50 \\ & 10 / 100 \end{aligned}$ | $\begin{aligned} & 1.5 / \\ & 1.5 / \\ & 1.1 / 500 \\ & 1.1 / 500 \end{aligned}$ |  |  |  |
| 1N2611 <br> 1N2612 <br> 1N2613 <br> in2614 | $\begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}$ | $\left\lvert\, \begin{aligned} & R E \\ & R E \\ & R E \\ & R E \\ & R E \end{aligned}\right.$ |  | 1N4003 1N4004 1N4004 1N4005 |  | $\begin{aligned} & 200 \\ & 300 \\ & 400 \\ & 500 \end{aligned}$ | $\begin{aligned} & .75 \\ & .75 \\ & .75 \\ & .75 \end{aligned}$ | 10/200 <br> 10/300 <br> 10/400 <br> $10 / 500$ | 1.1/500 <br> 1.1/500 <br> $1.1 / 500$ <br> $1.1 / 500$ |  |  |  |
| IN2615 1N2616 IN2617 1N2618 | $\left\{\begin{array}{l} 5 \\ 5 \\ s \\ 5 \end{array}\right.$ | $\left\|\begin{array}{l} R E \\ R E \\ \operatorname{RE} \\ \mathrm{RE} \end{array}\right\|$ |  |  |  | $\begin{array}{r} 600 \\ 800 \\ 1 K \\ 1.2 K \end{array}$ | $\begin{aligned} & .75 \\ & .75 \\ & .75 \\ & .75 \end{aligned}$ | $\begin{aligned} & 10 / 600 \\ & 10 / 800 \\ & 10 / 1 \mathrm{~K} \\ & 10 / \end{aligned}$ | $1.1 / 500$ <br> $1.1 / 500$ <br> $1.1 / 500$ <br> $1.1 /$ |  |  |  |
| $\begin{aligned} & \text { IN2619 } \\ & \text { IN2620 } \\ & \text { IN2620A } \\ & \text { IN26208 } \end{aligned}$ | $\begin{aligned} & 5 \\ & 5 \\ & 5 \\ & 5 \end{aligned}$ | $\begin{aligned} & R E \\ & R D \\ & R D \\ & R D \end{aligned}$ |  |  | $\begin{aligned} & 750 \\ & 750 \\ & 750 \end{aligned}$ | 1.5K | . 75 | 10/ | $1.1 /$ |  | 9.7/10 <br> 9.7/10 <br> $9.7 / 10$ |  |
| $\begin{aligned} & \text { IN262I } \\ & \text { 1 N2621A } \\ & \text { 1N2621B } \\ & \text { IN2622 } \end{aligned}$ | $\begin{aligned} & 5 \\ & s \\ & s \\ & 5 \end{aligned}$ | $\left\|\begin{array}{l} R D \\ R D \\ R D \\ R D \end{array}\right\|$ |  |  | $\begin{aligned} & 750 \\ & 750 \\ & 750 \\ & 750 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 9.7 / 10 \\ & 9.7 / 10 \\ & 9.7 / 10 \\ & 9.7 / 10 \end{aligned}$ |  |


| TYPE NUMDER |  | $\left.\begin{aligned} & \frac{3}{2} \\ & \frac{2}{3} \\ & \frac{2}{2} \\ & 3 \\ & 3 \end{aligned} \right\rvert\,$ | $\begin{gathered} \text { TI } \\ \text { REPLACEMENI } \end{gathered}$ |  | ratinos |  |  | CHARACTERISTICS |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  | $\begin{gathered} P_{D} \\ (\mathrm{~mW}) \end{gathered}$ | $\begin{array}{l\|l} \mathbf{V}_{\mathbf{R}} \\ (\mathbf{V}) \end{array}$ | I <br> (A) | $\begin{array}{ll} \mathbf{R} & \bullet \mathbf{V}_{\mathrm{R}} \\ \mu \mathrm{~A} & /(\mathbf{V}) \end{array}$ | $\begin{array}{cc} \mathbf{V F F}_{F} & \mathbf{F}_{\mathrm{F}} \\ \text { (V) } & / \mathrm{mA}) \end{array}$ | $\begin{aligned} & \mathrm{Im} \\ & \text { (ns) } \end{aligned}$ | $\begin{array}{lll} \mathbf{v}_{\mathbf{z}} & \bullet \mathbf{z} \\ \text { (V) } & / \mathrm{ma}) \end{array}$ | $\begin{gathered} \text { rot } \\ \% \end{gathered}$ |
| $\begin{aligned} & \text { IN2622A } \\ & \text { IN2622B } \\ & \text { IN2623 } \\ & \text { IN2623A } \end{aligned}$ | $\begin{aligned} & \mathbf{s} \\ & \mathrm{s} \\ & \mathrm{~s} \\ & \mathrm{~s} \end{aligned}$ | $\begin{aligned} & R D \\ & R D \\ & R D \\ & R D \end{aligned}$ |  |  | $\begin{aligned} & 750 \\ & 750 \\ & 750 \\ & 750 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 9.7 / 10 \\ & 9.7 / 10 \\ & 9.7 / 10 \\ & 9.7 / 10 \end{aligned}$ |  |
| $\begin{aligned} & \text { IN2623B } \\ & \text { IN2624 } \\ & \text { 1N2624A } \\ & \text { 1N2624B } \end{aligned}$ | $\left\lvert\, \begin{aligned} & \mathbf{S} \\ & \mathbf{S} \\ & \mathbf{S} \\ & \mathbf{S} \end{aligned}\right.$ | $\begin{aligned} & R D \\ & R D \\ & R D \\ & R D \end{aligned}$ |  |  | $\begin{aligned} & 750 \\ & 750 \\ & 750 \\ & 750 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 9.7 / 10 \\ & 9.7 / 10 \\ & 9.7 / 10 \\ & 9.7 / 10 \end{aligned}$ |  |
| $\begin{aligned} & \text { IN2625 } \\ & \text { iN2625A } \\ & \text { iN2625B } \\ & \text { iN2626 } \end{aligned}$ | $\left\lvert\, \begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}\right.$ | $\left\|\begin{array}{l} R D \\ R D \\ R D \\ R D \end{array}\right\|$ |  |  | $\begin{aligned} & 750 \\ & 750 \\ & 750 \\ & 750 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 9.4 / 10 \\ & 9.4 / 10 \\ & 9.4 / 10 \\ & 9.4 / 10 \end{aligned}$ |  |
| $\begin{aligned} & \text { IN2626A } \\ & \text { IN26268 } \\ & \text { IN2629 } \\ & \text { IN2630 } \end{aligned}$ | $\left\lvert\, \begin{aligned} & \mathbf{S} \\ & \mathbf{S} \\ & \mathbf{G} \\ & \mathbf{S} \end{aligned}\right.$ | $\begin{aligned} & R D \\ & R D \\ & R D \\ & S D \\ & R E \end{aligned}$ |  | 1N4305 | $\begin{aligned} & 750 \\ & 750 \end{aligned}$ | $\begin{array}{r} 5 \\ 1.5 K \end{array}$ | . 085 | 500/ | 2.2/ |  | $\begin{aligned} & 9.4 / 10 \\ & 9.4 / 10 \end{aligned}$ |  |
| $\begin{aligned} & \text { 1N2631 } \\ & \text { 1N2632 } \\ & \text { 1N2633 } \\ & \text { 1N2634 } \end{aligned}$ | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\left.\begin{array}{\|l\|} \mathbf{R E} \\ \mathrm{RE} \\ \mathrm{RE} \\ \mathrm{RE} \end{array} \right\rvert\,$ |  |  |  | $\begin{aligned} & 1.6 \mathrm{~K} \\ & 2.8 \mathrm{~K} \\ & 1.6 \mathrm{~K} \\ & 1.8 \mathrm{~K} \end{aligned}$ | $\begin{aligned} & .6 \\ & .2 \\ & .6 \\ & .6 \end{aligned}$ | $\begin{aligned} & 500 / \\ & 500 / \\ & 500 / \\ & 500 / \end{aligned}$ | $\begin{aligned} & 3 / \\ & 6 / \\ & 3 / \\ & 3 / \end{aligned}$ |  |  |  |
| $\begin{aligned} & \text { 1N2635 } \\ & \text { IN2636 } \\ & \text { 1N2637 } \\ & \text { IN2638 } \end{aligned}$ | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\left.\begin{array}{\|l\|} \mathbf{R E} \\ \mathrm{RE} \\ \mathrm{RE} \\ \mathrm{RE} \end{array} \right\rvert\,$ |  |  |  | $\begin{gathered} 1.5 K \\ 1.5 K \\ 10 K \\ 100 \end{gathered}$ | $\begin{array}{r} .085 \\ .085 \\ .25 \\ 1.5 \end{array}$ | $\begin{aligned} & 500 / \\ & 500 / \\ & 500 / \\ & 300 / \end{aligned}$ | $\begin{gathered} 2.2 / \\ 2.2 / \\ 28 / \\ 1.3 / \end{gathered}$ |  |  |  |
| $\begin{array}{\|l\|} \text { 1N2641 } \\ \text { 1N2644 } \\ \text { 1N2647 } \\ \text { 1N2650 } \end{array}$ | $\begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}$ | $\left.\begin{array}{\|l\|} \mathbf{R E} \\ \mathrm{RE} \\ \mathrm{RE} \\ \mathrm{RE} \end{array} \right\rvert\,$ |  |  |  | $\begin{aligned} & 200 \\ & 300 \\ & 400 \\ & 600 \end{aligned}$ | $\begin{aligned} & 1.5 \\ & 1.5 \\ & 1.5 \\ & 1.5 \end{aligned}$ | $\begin{aligned} & 300 / \\ & 300 / \\ & 300 / \\ & 300 / \end{aligned}$ | $\begin{aligned} & 1.3 / \\ & 1.3 / \\ & 1.3 / \\ & 2.6 / \end{aligned}$ |  |  |  |
| $\begin{aligned} & \text { 1N2653 } \\ & \text { iN2656 } \\ & \text { 1N2659 } \\ & \text { 1N2662 } \end{aligned}$ | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\begin{aligned} & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \end{aligned}$ |  |  |  | $\begin{array}{r} 800 \\ 1.2 \mathrm{~K} \\ 1.6 \mathrm{~K} \\ 2 \mathrm{~K} \end{array}$ | $\begin{aligned} & 1.5 \\ & 1.5 \\ & 1.5 \\ & 1.5 \end{aligned}$ | $\begin{aligned} & 300 / \\ & 800 / \\ & 800 / \\ & 800 / \end{aligned}$ | $\begin{aligned} & 2.6 / \\ & 3.9 / \\ & 5.2 / \\ & 6.5 / \end{aligned}$ |  |  |  |
| $\begin{aligned} & \text { IN2664 } \\ & \text { 1N2666 } \\ & \text { 1N2667 } \\ & \text { 1N2668 } \end{aligned}$ | S $\mathbf{S}$ $\mathbf{S}$ $\mathbf{S}$ | $\begin{aligned} & R E \\ & R E \\ & R E \\ & R E \\ & R E \end{aligned}$ |  |  |  | $\begin{array}{r} 2.4 K \\ 3.2 K \\ 4 K \\ 4.8 K \end{array}$ | $\begin{aligned} & 1.5 \\ & 1.5 \\ & 1.5 \\ & 1.5 \end{aligned}$ | $\begin{aligned} & 800 / \\ & 800 / \\ & 800 / \\ & 800 / \end{aligned}$ | $\begin{aligned} & 7.8 / \\ & 10 / \\ & 13 / \\ & 15 / \end{aligned}$ |  |  |  |
| $\begin{aligned} & \text { IN2669 } \\ & \text { IN2673 } \\ & \text { IN2677 } \\ & \text { IN2S81 } \end{aligned}$ | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\begin{aligned} & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \end{aligned}$ |  |  |  | $\begin{aligned} & 100 \\ & 200 \\ & 300 \\ & 400 \end{aligned}$ | $\begin{aligned} & 3.6 \\ & 3.6 \\ & 3.6 \\ & 3.6 \end{aligned}$ | $\begin{aligned} & 300 / \\ & 300 / \\ & 300 / \\ & 300 / \end{aligned}$ | $\begin{aligned} & 1.3 / \\ & 1.3 / \\ & 1.3 / \\ & 1.3 / \end{aligned}$ |  |  |  |

## DIODE INTERCHANGEABILITY



| TVPE MUMBER |  |  | N | $\begin{aligned} & \text { FOR } \\ & \text { NEW } \\ & \text { DESNEN } \end{aligned}$ | Ratinges |  |  | Characteristics |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  | $\begin{gathered} \text { PD } \\ (\mathrm{mW}) \end{gathered}$ | $\begin{aligned} & \mathbf{V}_{\mathbf{R}} \\ & (\mathrm{V}) \end{aligned}$ | 1 <br> (A) | $\begin{array}{ccc} \mathbf{L} & \mathbf{V}_{\mathrm{R}} \\ \mu \mathbf{A} & /(\mathrm{V}) \end{array}$ | $\begin{array}{ll} \mathbf{V}_{F} & =\mathbf{I F}_{\mathbf{F}} \\ (\mathrm{V}) & /(\mathrm{m}) \end{array}$ | $\begin{gathered} t_{\mathrm{rr}} \\ (\mathrm{~ns}) \end{gathered}$ | $\mathbf{v}_{\mathbf{z}}-\mathbf{z}_{\mathbf{z}}$ <br> (V) $/$ (mA) | $\begin{gathered} \text { rot } \\ \times \end{gathered}$ |
| $\begin{aligned} & \text { 1N2767A } \\ & \text { IN2768 } \\ & \text { IN2768A } \\ & \text { IN2769 } \end{aligned}$ | $\begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}$ | $\begin{aligned} & R D \\ & R D \\ & R D \\ & R D \end{aligned}$ |  |  |  |  |  |  |  |  | $\begin{array}{r} 20.4 / 7.5 \\ 27.2 / 7.5 \\ 27.2 / 7.5 \\ 34 / 7.5 \end{array}$ | 5 5 5 5 |
| $\begin{array}{\|l} \text { IN2769A } \\ \text { IN2770 } \\ \text { IN2770A } \\ \text { IN2772 } \end{array}$ | $\begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}$ | $\begin{aligned} & R D \\ & R D \\ & R D \\ & R D \\ & R E \end{aligned}$ |  |  |  | 700 | . 5 |  | 1.8/ |  | $\begin{array}{r} 34 / 7.5 \\ 40.8 / 7.5 \\ 40.8 / 7.5 \end{array}$ | 5 5 5 |
| 1N2773 <br> 1N2774 <br> 1N2775 <br> 1N2776 | $\left\lvert\, \begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}\right.$ | $\begin{aligned} & R E \\ & R E \\ & R E \\ & R E \\ & R E \end{aligned}$ | . |  |  | $\begin{array}{r} 800 \\ 900 \\ 1 K \\ 1.1 K \end{array}$ | .5 .5 .5 .5 |  | $\begin{aligned} & 1.8 / \\ & 1.8 / \\ & 1.8 / \\ & 1.8 / \end{aligned}$ |  |  |  |
| $\begin{aligned} & \text { 1N2777 } \\ & \text { 1N2778 } \\ & \text { 1N2779 } \\ & \text { 1N2780 } \end{aligned}$ | $\begin{aligned} & s \\ & s \\ & s \\ & s \\ & s \end{aligned}$ | $\left.\begin{aligned} & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \end{aligned} \right\rvert\,$ |  |  |  | $\begin{aligned} & 1.2 \mathrm{~K} \\ & 1.3 \mathrm{~K} \\ & 1.4 \mathrm{~K} \\ & 1.5 \mathrm{~K} \end{aligned}$ | .5 .5 .5 .5 |  | $\begin{aligned} & 1.8 / \\ & 1.8 / \\ & 1.8 / \\ & 1.8 / \end{aligned}$ |  |  |  |
| $\begin{array}{\|l\|} \hline 1 \text { N2781 } \\ \text { 1N2790 } \\ \text { 1N2791 } \\ \text { 1N2793 } \end{array}$ | $\begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}$ | $\left.\begin{array}{\|l\|} \mathrm{RE} \\ \mathrm{RD} \\ \mathrm{SD} \\ \mathrm{RE} \end{array} \right\rvert\,$ |  | 1N647 | IW | $\begin{array}{r} 1.6 \mathrm{~K} \\ 350 \\ 50 \end{array}$ | $.5$ $5$ | $\begin{gathered} 50 \mathrm{~N} / \\ 5 \mathrm{M} / \end{gathered}$ | $\begin{aligned} & 1.8 / \\ & \\ & 1.3 / 50 \\ & 1.2 / \end{aligned}$ | 44 | 8.5/2U | 10 |
| $\begin{aligned} & \text { 1N2794 } \\ & \text { 1N2795 } \\ & \text { 1N2796 } \\ & \text { 1N2797 } \end{aligned}$ | $\begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}$ | $\left.\begin{array}{\|l\|} \mathbf{R E} \\ \mathrm{RE} \\ \mathrm{RE} \\ \mathrm{RE} \end{array} \right\rvert\,$ |  |  |  | $\begin{aligned} & 100 \\ & 150 \\ & 200 \\ & 250 \end{aligned}$ | 5 5 5 5 | 5M/ <br> 5M/ <br> 5M/ <br> 5M/ | $\begin{aligned} & 1.2 / \\ & 1.2 / \\ & 1.2 / \\ & 1.2 / \end{aligned}$ |  |  |  |
| 1N2798 <br> 1N2799 <br> 1N2800 <br> 1N2801 | $\begin{aligned} & \mathbf{s} \\ & \mathbf{S} \\ & \mathbf{S} \\ & \mathbf{G} \end{aligned}$ | $\left.\begin{array}{\|l\|} \mathrm{RE} \\ \mathrm{RE} \\ \mathrm{RE} \\ \mathrm{SD} \end{array} \right\rvert\,$ |  |  |  | $\begin{array}{r} 300 \\ 350 \\ 400 \\ 20 \end{array}$ | 5 5 5 | 5M/ <br> 5M/ <br> 5M/ <br> 2/ | 1.2/ <br> 1.2/ <br> 1.2/ <br> .36/5 | 50 U |  |  |
| $\begin{aligned} & \text { 1N2803 } \\ & \text { 1N2847 } \\ & \text { 1N2848 } \\ & \text { 1N2849 } \end{aligned}$ | $\begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}$ | $\begin{aligned} & R E \\ & R E \\ & R E \\ & R E \\ & R E \end{aligned}$ |  |  |  | $\begin{aligned} & 400 \\ & 100 \\ & 200 \\ & 300 \end{aligned}$ | $\begin{array}{r} 250 \\ 1.5 \\ 1.5 \\ 1.5 \end{array}$ | $\begin{aligned} & 36 \mathrm{M} / \\ & 300 / \\ & 200 / \\ & 200 / \end{aligned}$ | $\begin{aligned} & 1.2 / \\ & 2 / \\ & 2 / \\ & 2 / \end{aligned}$ |  |  |  |
| $\begin{aligned} & \text { 1N2850 } \\ & \text { iN2851 } \\ & \text { 1N2852 } \\ & \text { iN2855 } \end{aligned}$ | $\begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}$ | $\begin{aligned} & \mathbf{R E} \\ & \mathbf{R E} \\ & \mathbf{R E} \\ & \mathbf{R E} \end{aligned}$ |  |  |  | $\begin{aligned} & 400 \\ & 500 \\ & 600 \\ & 600 \end{aligned}$ | $\begin{aligned} & 1.5 \\ & 1.5 \\ & 1.5 \\ & 250 \end{aligned}$ | $\begin{aligned} & 200 / \\ & 200 / \\ & 200 / \\ & 25 M / \end{aligned}$ | $\begin{array}{r} 21 \\ 21 \\ 21 \\ 1.21 \end{array}$ |  |  |  |
| $\left\lvert\, \begin{aligned} & \text { IN2856 } \\ & \text { IN2857 } \\ & \text { IN2858 } \\ & \text { IN2858A } \end{aligned}\right.$ | $\left\lvert\, \begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}\right.$ | $\begin{aligned} & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \end{aligned}$ |  | IN4001 1N4001 |  | $\begin{array}{r} 800 \\ 1 K \\ 50 \\ 50 \end{array}$ | $\begin{array}{r} 250 \\ 250 \\ .75 \\ 1 \end{array}$ | $\begin{aligned} & 10 \mathrm{M} / \\ & 15 \mathrm{M} / \\ & 300 / 50 \\ & 300 / 50 \end{aligned}$ | $\begin{aligned} & 1.2 / \\ & 1.2 / \\ & 1.2 / 500 \\ & 1.2 / 1 \mathrm{~A} \end{aligned}$ |  |  |  |

## DIODE INTERCHANGEABILITY

| TYPE NUMEER |  |  | II REPLACEMENT |  | PD (mW) | atings <br> $\mathbf{V}_{\mathbf{R}}$ <br> (V) | I <br> (A) | $\begin{array}{ll} \mathbf{I}_{\mathrm{R}} & \bullet \mathbf{V}_{\mathrm{R}} \\ \mu_{\mathrm{A}} & /(\mathrm{V}) \end{array}$ | CMARACTE <br> $\mathbf{V F}_{\mathrm{F}}$ - $\mathbf{1 F}$ <br> (V) 1 (ma) | RISHIC <br> trr <br> ( n ) | $\begin{array}{ll} \mathbf{V}_{\mathbf{Z}} & \mathbf{Z} \\ (\mathbf{V}) & / \mathrm{ma}) \end{array}$ | $\left\{\begin{array}{c} \mathrm{TOL} \\ \% \end{array}\right.$ |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| $\begin{array}{\|l\|} \hline \text { 1N2859 } \\ \text { 1N2859A } \\ \text { 1N2860 } \\ \text { 1N2860A } \end{array}$ | S S S S | $\begin{array}{\|l\|l} \hline R E \\ \mathbf{R E} \\ \hline \mathbf{R E} \\ \hline \mathbf{R E} \end{array}$ |  | 1N4002 <br> IN4002 <br> 1N4003 <br> IN4003 |  | $\begin{aligned} & 100 \\ & 100 \\ & 200 \\ & 200 \end{aligned}$ | $\begin{array}{r} .75 \\ 1 \\ .75 \\ 1 \end{array}$ | $\begin{aligned} & 300 / 100 \\ & 300 / 100 \\ & 300 / 200 \\ & 300 / 200 \end{aligned}$ | $\begin{aligned} & 1.2 / 500 \\ & 1.2 / 1 \mathrm{~A} \\ & 1.2 / 500 \\ & 1.2 / 1 \mathrm{~A} \end{aligned}$ |  |  |  |
| $\begin{aligned} & \text { 1N2861 } \\ & \text { 1N2861A } \\ & \text { IN2862 } \\ & \text { IN2862A } \end{aligned}$ | S $\begin{aligned} & \text { S } \\ & \mathbf{S} \\ & \mathbf{S} \\ & \mathbf{S}\end{aligned}$ | $\begin{aligned} & R E \\ & R E \\ & R E \\ & \text { RE } \\ & R E \end{aligned}$ |  | 1N4004 iN4004 1N4004 1N4004 |  | $\begin{aligned} & 300 \\ & 300 \\ & 400 \\ & 400 \end{aligned}$ | $\begin{array}{r} .75 \\ 1 \\ .75 \\ 1 \end{array}$ | $\begin{aligned} & 300 / 300 \\ & 300 / 300 \\ & 300 / 400 \\ & 300 / 400 \end{aligned}$ | $\begin{aligned} & 1.2 / 500 \\ & 1.2 / 1 A \\ & 1.2 / 500 \\ & 1.2 / 1 A \end{aligned}$ |  |  |  |
| 1N2863 <br> IN2863A <br> IN2864 <br> IN2864A | S <br> $\mathbf{S}$ <br> $\mathbf{S}$ <br> $\mathbf{S}$ | RE <br> RE <br> RE <br> RE |  | 1N4005 <br> iN4005 <br> 1N4005 <br> 1N4005 |  | $\begin{aligned} & 500 \\ & 500 \\ & 600 \\ & 600 \end{aligned}$ | $\begin{array}{r} .75 \\ 1 \\ .75 \\ 1 \end{array}$ | $\begin{aligned} & 200 / 500 \\ & 300 / 500 \\ & 200 / 600 \\ & 300 / 800 \end{aligned}$ | $\begin{aligned} & 1.2 / 500 \\ & 1.2 / 1 \mathrm{~A} \\ & 1.2 / 500 \\ & 1.2 / 1 \mathrm{~A} \end{aligned}$ |  |  |  |
| IN2865 <br> 1N2866 <br> 1N2867 <br> 1N2868 | $\begin{aligned} & \mathrm{S} \\ & \mathrm{~S} \\ & \mathrm{~S} \\ & \mathrm{~s} \end{aligned}$ | $\begin{aligned} & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \end{aligned}$ |  |  |  | $\begin{array}{r} 1 K \\ 1.5 K \\ 1 K \\ 1.5 K \end{array}$ | $\begin{aligned} & .7 \\ & .7 \\ & .7 \\ & .7 \end{aligned}$ | $\begin{aligned} & 100 / \\ & 100 / \\ & 100 / \\ & 100 / \end{aligned}$ | $\begin{aligned} & 2.5 / \\ & 2.5 / \\ & 2.5 / \\ & 2.5 / \end{aligned}$ |  |  |  |
| 1N2878 <br> 1N2879 <br> iN2880 <br> 1N2881 | $\begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}$ | $\begin{array}{\|l\|} \hline S D \\ S D \\ S D \\ S D \end{array}$ | 1N2878 <br> 1N2879 <br> 1N2880 <br> IN2881 |  |  | $\begin{array}{r} 700 \\ 700 \\ 1 K \\ 1 K \end{array}$ |  | . $5 /$ <br> . $5 /$ <br> .5/ <br> . $5 /$ | $\begin{aligned} & 2 / 250 \\ & 2 / 250 \\ & 2 / 250 \\ & 2 / 250 \end{aligned}$ |  |  |  |
| 1N2882 <br> 1N2883 <br> 1N2884 <br> 1N2885 | $\begin{aligned} & \mathrm{s} \\ & \mathrm{~s} \\ & \mathrm{~s} \\ & \mathrm{~s} \end{aligned}$ | $\left\|\begin{array}{l} \text { SD } \\ \text { SD } \\ S D \\ S D \end{array}\right\|$ | 1N2882 <br> 1N2883 <br> 1N2884 <br> 1N2885 |  |  | $\begin{aligned} & 500 \\ & 500 \\ & 400 \\ & 400 \end{aligned}$ |  | $\begin{aligned} & .5 / \\ & .5 / \\ & .5 / \\ & .5 / \end{aligned}$ | $\begin{aligned} & 3 / 250 \\ & 3 / 250 \\ & 4 / 250 \\ & 4 / 250 \end{aligned}$ |  |  |  |
| 1N2886 <br> 1N2887 <br> 1N2888 <br> 1N2889 | $\begin{aligned} & \mathbf{s} \\ & s \\ & s \\ & s \end{aligned}$ | $\begin{array}{\|l\|} S D \\ S D \\ S D \\ S D \\ S D \end{array}$ | $\begin{aligned} & \text { 1N2886 } \\ & \text { 1N2887 } \\ & \text { 1N2888 } \\ & \text { 1N2889 } \end{aligned}$ |  |  | $\begin{aligned} & 500 \\ & 500 \\ & 750 \\ & 750 \end{aligned}$ |  | .5/ <br> .5/ <br> .5/ <br> .5/ | $\begin{aligned} & 3 / 250 \\ & 3 / 250 \\ & 5 / 250 \\ & 5 / 250 \end{aligned}$ |  |  |  |
| 1N2890 <br> 1N2891 <br> 1N2892 <br> 1N2893 | $\begin{aligned} & s \\ & S \\ & S \\ & S \end{aligned}$ | $\left.\begin{aligned} & \mathrm{SD} \\ & \mathrm{SD} \\ & \mathrm{SD} \\ & \mathrm{SD} \end{aligned} \right\rvert\,$ | $\begin{aligned} & \text { 1N2890 } \\ & \text { 1 N2891 } \\ & \text { 1N2892 } \\ & \text { 1N2893 } \end{aligned}$ |  |  | $\begin{array}{r} 2 K \\ 2 K \\ 100 \\ 100 \end{array}$ |  | $\begin{aligned} & .5 / \\ & .5 / \\ & .5 / \\ & .5 / \end{aligned}$ | $\begin{aligned} & 4 / 250 \\ & 4 / 250 \\ & 6 / 250 \\ & 6 / 250 \end{aligned}$ |  |  |  |
| 1N2894 <br> 1 N2895 <br> iN2896 <br> 1N2897 | $\begin{aligned} & 5 \\ & 5 \\ & 5 \\ & 5 \end{aligned}$ | $\begin{aligned} & \mathrm{SD} \\ & \mathrm{SD} \\ & \mathrm{SD} \\ & \mathrm{SD} \end{aligned}$ | $\begin{aligned} & \text { IN2894 } \\ & \text { 1 N2895 } \\ & \text { IN2896 } \\ & \text { IN2897 } \end{aligned}$ |  |  | $\begin{aligned} & 450 \\ & 450 \\ & 500 \\ & 500 \end{aligned}$ |  | $\begin{aligned} & .5 / \\ & .5 / \\ & .5 / \\ & .5 / \end{aligned}$ | $\begin{aligned} & 7 / 250 \\ & 7 / 250 \\ & 5 / 250 \\ & 5 / 250 \end{aligned}$ |  |  |  |
| 1N2898 <br> 1N2899 <br> 1N2900 <br> IN2901 | $\begin{aligned} & 5 \\ & s \\ & s \\ & s \end{aligned}$ | $\begin{array}{\|l\|} \text { SD } \\ \text { SD } \\ \text { SD } \\ \text { SD } \end{array}$ | $\begin{aligned} & \text { IN2898 } \\ & \text { IN2899 } \\ & \text { IN2900 } \\ & \text { 1 N2901 } \end{aligned}$ |  |  | $\begin{array}{r} 800 \\ 800 \\ 3 K \\ 3 K \end{array}$ |  | $\begin{aligned} & .5 / \\ & .5 / \\ & .5 / \\ & .5 / \end{aligned}$ | $\begin{aligned} & 8 / 250 \\ & 8 / 250 \\ & 6 / 250 \\ & 6 / 250 \end{aligned}$ |  |  |  |

## DIODE INTERCHANGEABILITY

| TYPE Numer | $\frac{3}{\frac{2}{2}}$ |  | n |  | Ratines |  |  | CHARACTERISTHCS |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  | $\begin{gathered} P D \\ (\mathrm{~mW}) \end{gathered}$ | $\mathbf{v}_{\mathbf{R}}$ <br> (V) | I <br> (A) | $\begin{array}{ll} \mathbf{I}_{\mathbf{R}} & \oplus \mathbf{V}_{\mathrm{R}} \\ \mu_{\mathrm{A}} & /(\mathrm{V}) \end{array}$ | $\begin{array}{cc} \mathbf{V}_{\mathrm{F}} & \mathrm{~F} \\ \text { (v) } & / \mathrm{mA}) \end{array}$ | $\begin{aligned} & i n t \\ & (n s) \end{aligned}$ | $\mathbf{V}_{\mathbf{Z}} \quad \mathbf{I z}_{\mathbf{2}}$ <br> (V) $/$ (ma) | $\begin{aligned} & \text { rot } \\ & \times \end{aligned}$ |
| 1N2902 <br> IN2903 <br> in2904 <br> IN2905 | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\left\|\begin{array}{l} \text { SD } \\ s 0 \\ S D \\ s D \end{array}\right\|$ | 1N2902 <br> 1N2903 <br> 1N2904 <br> 1N2905 |  |  | 150 150 500 500 |  | .5/ <br> . $5 /$ <br> . $5 /$ <br> .5/ | $\begin{aligned} & 9 / 250 \\ & 9 / 250 \\ & 7 / 250 \\ & 7 / 250 \end{aligned}$ |  |  |  |
| 1N2906 <br> IN2907 <br> 1N2908 <br> 1N2909 | $\begin{aligned} & 5 \\ & 5 \\ & 5 \\ & 5 \end{aligned}$ | $\begin{aligned} & \text { SD } \\ & S D \\ & S D \\ & S D \end{aligned}$ | 1N2906 <br> IN2907 <br> 1 N2908 <br> 1 N2909 |  |  | 500 500 850 850 |  | .5/ <br> .5/ <br> . $5 /$ <br> . $5 /$ | $\begin{aligned} & 10 / 250 \\ & 10 / 250 \\ & 11 / 250 \\ & 11 / 250 \end{aligned}$ |  |  |  |
| 1N2910 <br> 1N2911 <br> iN2912 <br> IN2913 | $\begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}$ | $\begin{aligned} & s o \\ & s 0 \\ & s 0 \\ & s 0 \\ & s D \end{aligned}$ | 1N2910 <br> iN2911 <br> 1N2912 <br> 1N2913 |  |  | $4 K$ $4 K$ 200 200 |  | $\begin{aligned} & .5 / \\ & .5 / \\ & .5 / \\ & .5 / \end{aligned}$ | $\begin{array}{r} 8 / 250 \\ 8 / 250 \\ 12 / 250 \\ 12 / 250 \end{array}$ |  |  |  |
| 1N2914 <br> IN2915 <br> 1N2916 <br> IN2917 | $\begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}$ | $\begin{aligned} & \text { SD } \\ & \text { SD } \\ & \text { SD } \\ & \text { SD } \end{aligned}$ | $\left\{\begin{array}{l} \text { 1N2914 } \\ \text { 1N2915 } \\ \text { 1N2916 } \\ \text { 1N2917 } \end{array}\right.$ |  |  | $\begin{aligned} & 500 \\ & 500 \\ & 550 \\ & 550 \end{aligned}$ |  | .5/ <br> .5/ <br> .5/ <br> .5/ | $\begin{array}{r} 9 / 250 \\ 9 / 250 \\ 13 / 250 \\ 13 / 250 \end{array}$ |  |  |  |
| IN2918 <br> 1N2919 <br> 1N2920 <br> 1N2921 | $\left\lvert\, \begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}\right.$ | $\left\lvert\, \begin{aligned} & \text { SD } \\ & \text { SD } \\ & S D \\ & S D \end{aligned}\right.$ | 1N2918 <br> 1N2919 <br> IN2920 <br> IN2921 |  |  | $5 K$ $5 K$ 500 500 |  | $\begin{aligned} & .5 / \\ & .5 / \\ & .5 / \\ & .5 / \end{aligned}$ | $\begin{aligned} & 10 / 250 \\ & 10 / 250 \\ & 11 / 250 \\ & 11 / 250 \end{aligned}$ |  |  |  |
| 1N2922 <br> IN2923 <br> IN2924 <br> IN2925 | $\left\lvert\, \begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}\right.$ | $\begin{aligned} & \text { SD } \\ & \text { SD } \\ & \text { SD } \\ & \text { SD } \end{aligned}$ | 1N2922 <br> 1N2923 <br> 1 N2924 <br> 1N2925 |  |  | $\begin{array}{r} 6 K \\ 6 K \\ 500 \\ 500 \end{array}$ |  | $\begin{aligned} & .5 / \\ & .5 / \\ & .5 / \\ & .5 / \end{aligned}$ | $\begin{aligned} & 12 / 250 \\ & 12 / 250 \\ & 13 / 250 \\ & 13 / 250 \end{aligned}$ |  |  |  |
| $\begin{aligned} & \text { 1N2938 } \\ & \text { IN3016 } \\ & \text { 1N3016A } \\ & \text { 1N3016B } \end{aligned}$ | $\left\lvert\, \begin{aligned} & \mathbf{s} \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\begin{aligned} & 20 \\ & 20 \\ & 20 \\ & 20 \end{aligned}$ |  | 1N4736 <br> 1N4736 <br> 1N4736A | $\begin{aligned} & \text { 2W } \\ & \text { IW } \\ & \text { iW } \\ & \text { iW } \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & .9 / 100 \\ & 6.8 / 37 \\ & 6.8 / 37 \\ & 6.8 / 37 \end{aligned}$ | 15 20 10 5 |
| $\begin{aligned} & 1 N 3017 \\ & \text { 1N3017A } \\ & \text { 1N3017B } \\ & 1 N 3018 \end{aligned}$ | $\begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}$ | $\begin{aligned} & 20 \\ & 20 \\ & 20 \\ & 20 \end{aligned}$ |  | 1N4737 <br> 1N4737 <br> 1N4737A <br> 1N4738 | $\begin{aligned} & \text { iw } \\ & \text { iw } \\ & \text { iw } \\ & \text { iw } \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 7.5 / 34 \\ & 7.5 / 34 \\ & 7.5 / 34 \\ & 8.2 / 31 \end{aligned}$ | 20 10 5 20 |
| $\begin{aligned} & \text { 1N3018A } \\ & \text { IN30188 } \\ & \text { 1N3019 } \\ & \text { 1N3019A } \end{aligned}$ | $\begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}$ | $\left\|\begin{array}{l} \mathrm{ZD} \\ \mathrm{ZD} \\ \mathrm{ZD} \\ \mathrm{ZD} \end{array}\right\|$ |  | IN4738 <br> IN4738A <br> IN4739 <br> 1N4739 | $\begin{aligned} & 1 w \\ & 1 w \\ & 1 w \\ & 1 w \end{aligned}$ |  |  | . |  |  | $\begin{aligned} & 8.2 / 31 \\ & 8.2 / 31 \\ & 9.1 / 38 \\ & 9.1 / 38 \end{aligned}$ | 10 5 20 10 |
| $\begin{aligned} & \text { 1N30198 } \\ & \text { iN3020 } \\ & \text { iN3020A } \\ & \text { IN30208 } \end{aligned}$ | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\begin{aligned} & \mathrm{ZD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \end{aligned}$ |  | $\begin{aligned} & \text { 1NA739A } \\ & \text { 1N4740 } \\ & \text { IN4740 } \\ & \text { IN4740A } \end{aligned}$ | $\begin{aligned} & \text { iw } \\ & \text { iw } \\ & \text { iw } \\ & \text { iw } \end{aligned}$ |  |  |  |  |  | $\begin{array}{r} 9.1 / 38 \\ 10 / 25 \\ 10 / 25 \\ 10 / 25 \end{array}$ | 5 20 10 5 |

## DIODE INTERCHANGEABILITY



| TYFE mumber |  |  | TI | $\begin{aligned} & \text { FOR } \\ & \text { NEW } \\ & \text { DESMON } \end{aligned}$ | RATINGS |  |  | CHARACTERISTICS |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  | PD <br> (mW) | $\mathbf{V}_{\mathbf{R}}$ <br> (V) | (A) | $\begin{array}{ll} \mathbf{L}_{\mathbf{R}} & \mathbf{V}_{\mathbf{R}} \\ \boldsymbol{\mu} \mathbf{A} & /(\mathbf{V}) \end{array}$ | $\begin{array}{ll} \mathbf{V}_{F} & \mathbf{I F}_{\mathbf{F}} \\ (\mathrm{V}) & /(\mathrm{mA}) \end{array}$ | $\begin{aligned} & I_{r r} \\ & \text { (ns) } \end{aligned}$ | $\begin{array}{ll} \mathbf{V}_{\mathbf{Z}} & \mathbf{Z} \\ \text { (V) } & (\mathrm{mA}) \end{array}$ | $\begin{aligned} & 101 \\ & \times \end{aligned}$ |
| IN3034A <br> IN30348 <br> iN3035 <br> 1N3035A | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\left\|\begin{array}{l} \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{ZD} \end{array}\right\|$ |  |  | $\begin{aligned} & \text { 1w } \\ & \text { 1w } \\ & \text { iw } \\ & \text { iw } \end{aligned}$ |  |  |  |  |  | 39/6.5 <br> 39/6.5 <br> 43/6 <br> 43/6 | $\begin{array}{r} 10 \\ 5 \\ 20 \\ 10 \end{array}$ |
| 1N30358 <br> 1N3036 <br> 1N3036A <br> IN3036B | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\left.\begin{aligned} & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \end{aligned} \right\rvert\,$ |  |  | $\begin{aligned} & \text { iw } \\ & \text { iw } \\ & \text { iw } \\ & \text { iw } \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 43 / 6 \\ & 47 / 5.5 \\ & 47 / 5.5 \\ & 47 / 5.5 \end{aligned}$ | 5 20 10 5 |
| $\begin{aligned} & \text { 1N3037 } \\ & \text { 1N3037A } \\ & \text { 1N30378 } \\ & \text { 1N3038 } \end{aligned}$ | $\begin{aligned} & 5 \\ & 5 \\ & 5 \\ & 5 \end{aligned}$ | $\left\|\begin{array}{l} \mathrm{zo} \\ \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \end{array}\right\|$ |  |  | $\begin{aligned} & \text { iw } \\ & \text { iw } \\ & \text { iw } \\ & \text { iw } \end{aligned}$ |  |  |  |  |  | 51/5 <br> 51/5 <br> 51/5 <br> 56/4.5 | $\begin{array}{r} 20 \\ 10 \\ 5 \\ 20 \end{array}$ |
| $\begin{array}{\|l} \text { 1N3038A } \\ \text { IN30388 } \\ \text { 1N3039 } \\ \text { 1N3039A } \end{array}$ | $\left\lvert\, \begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}\right.$ | $\begin{aligned} & \mathrm{zD} \\ & \mathrm{zo} \\ & \mathrm{zD} \\ & \mathrm{zD} \end{aligned}$ |  |  | $\begin{aligned} & \text { iw } \\ & \text { iw } \\ & \text { iw } \\ & \text { iw } \end{aligned}$ |  |  |  |  |  | 56/4.5 <br> 56/4.5 <br> 62/4 <br> 62/4 | $\begin{array}{r} 10 \\ 5 \\ 20 \\ 10 \end{array}$ |
| $\begin{array}{\|l} \text { IN30398 } \\ \text { IN3040 } \\ \text { IN3040A } \\ \text { IN3040B } \end{array}$ | $\left\lvert\, \begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}\right.$ | $\left\lvert\, \begin{aligned} & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{ZD} \\ & \mathrm{zD} \end{aligned}\right.$ |  |  | $\begin{aligned} & \text { iw } \\ & 1 \mathbf{1 w} \\ & \text { iw } \\ & \text { iw } \end{aligned}$ |  |  |  |  |  | 62/4 <br> 68/3.7 <br> 68/3.7 <br> 68/3.7 | 5 20 10 5 |
| $\begin{aligned} & \text { IN3041 } \\ & \text { IN3041A } \\ & \text { IN3041B } \\ & \text { IN3O42 } \end{aligned}$ | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\left\|\begin{array}{l} \mathrm{ZD} \\ \mathrm{ZD} \\ \mathrm{ZD} \\ \mathrm{ZD} \end{array}\right\|$ |  |  | $\begin{aligned} & \text { iw } \\ & \text { iw } \\ & \text { iw } \\ & \text { iw } \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 75 / 3.3 \\ & 75 / 3.3 \\ & 75 / 3.3 \\ & 82 / 3 \end{aligned}$ | 20 10 5 20 |
| $\begin{aligned} & 1 N 3042 A \\ & \text { 1N3042B } \\ & \text { 1N3043 } \\ & \text { IN3043A } \end{aligned}$ | $\left\lvert\, \begin{aligned} & 5 \\ & 5 \\ & 5 \\ & 5 \end{aligned}\right.$ | $\left\|\begin{array}{l} \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \end{array}\right\|$ |  |  | $\begin{aligned} & \text { iw } \\ & \text { iw } \\ & \text { iw } \\ & \text { iw } \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 82 / 3 \\ & 82 / 3 \\ & 91 / 2.8 \\ & 91 / 2.8 \end{aligned}$ | 10 5 20 10 |
| $\begin{aligned} & \text { IN3O438 } \\ & \text { IN3O44 } \\ & \text { IN3044A } \\ & \text { 1N3O4AB } \end{aligned}$ | $\left\lvert\, \begin{aligned} & \mathbf{S} \\ & \mathbf{S} \\ & \mathbf{S} \\ & \mathbf{S} \end{aligned}\right.$ | $\left.\begin{aligned} & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \end{aligned} \right\rvert\,$ |  |  | $\begin{aligned} & \text { iw } \\ & \text { iw } \\ & \text { iw } \\ & \text { iw } \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 91 / 2.8 \\ & 100 / 2 \\ & 100 / 2 \\ & 100 / 2 \end{aligned}$ | 5 20 10 5 |
| $\begin{aligned} & \text { IN3O45 } \\ & \text { IN3045A } \\ & \text { IN3O45B } \\ & \text { IN3O46 } \end{aligned}$ | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\begin{aligned} & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \end{aligned}$ |  |  | $\begin{aligned} & \text { iw } \\ & \text { iw } \\ & \text { iw } \\ & \text { iw } \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 110 / 2.3 \\ & 110 / 2.3 \\ & 110 / 2.3 \\ & 120 / 2 \end{aligned}$ | 20 10 5 20 |
| $\begin{aligned} & \text { IN3046A } \\ & \text { IN30468 } \\ & \text { IN3047 } \\ & \text { IN3047A } \end{aligned}$ | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\left\|\begin{array}{l} \mathrm{ZD} \\ \mathrm{ZD} \\ \mathrm{ZD} \\ \mathrm{ZD} \end{array}\right\|$ |  |  | $\begin{aligned} & \text { iw } \\ & \text { iw } \\ & \text { iw } \\ & \text { iw } \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 120 / 2 \\ & 120 / 2 \\ & 130 / 1.9 \\ & 130 / 1.9 \end{aligned}$ | 10 5 20 10 |

## DIODE INTERCHANGEABILITY

| $\begin{gathered} \text { TYPE } \\ \text { Numberin } \end{gathered}$ |  |  | $\left\lvert\, \begin{array}{\|c\|} \text { TI } \\ \text { RERLACEMENT } \end{array}\right.$ | $\begin{gathered} \text { FOR } \\ \text { NEW } \\ \text { DESCN } \end{gathered}$ | $\begin{gathered} P_{D} \\ (m W) \end{gathered}$ | nnes <br> $\mathbf{V}_{\mathrm{R}}$ <br> (V) | (A) | $\begin{array}{ll} I_{R} & \bullet V_{R} \\ \mu_{A} & /(V) \end{array}$ | $\begin{array}{cc}  & \text { characte } \\ \mathbf{v F}_{\mathbf{F}} & \bullet \\ \text { (V) } & / \text { (mA) } \end{array}$ | RISTIC <br> ${ }^{\dagger}$ <br> (ns) | $\begin{array}{ccc} v_{z} & 1 & \mathbf{z} \\ (\mathrm{v}) & /(\mathrm{ma}) \end{array}$ | $\begin{aligned} & \text { rot } \\ & \% \end{aligned}$ |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 1N30478 IN3048 1N3048A 1N30488 | $\text { } \begin{aligned} & s \\ & s \\ & s \\ & s \\ & s \end{aligned}$ | $\left\|\begin{array}{l} \mathrm{zD} \\ \mathrm{ZD} \\ \mathrm{zD} \\ \mathrm{ZD} \end{array}\right\|$ |  |  | $\begin{aligned} & \text { iw } \\ & \text { iw } \\ & \text { iw } \\ & \text { iw } \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 130 / 1.9 \\ & 150 / 1.7 \\ & 150 / 1.7 \\ & 150 / 1.7 \end{aligned}$ | 5 20 10 5 |
| 1N304P <br> 1N3049A <br> in304P8 <br> iN3050 | $\begin{aligned} & \mathrm{s} \\ & \mathrm{~s} \\ & \mathrm{~s} \\ & \mathrm{~s} \end{aligned}$ | $\left.\begin{aligned} & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zo} \\ & \mathrm{zD} \end{aligned} \right\rvert\,$ |  |  | iw 10 $1 w$ $1 w$ $1 w$ |  |  |  |  |  | $\begin{aligned} & 160 / 1.6 \\ & 160 / 1.6 \\ & 160 / 1.6 \\ & 180 / 1.4 \end{aligned}$ | 20 10 5 20 |
| in3050A iN3050 1N3051 1N3051A | $\begin{aligned} & \mathrm{s} \\ & \mathrm{~s} \\ & \mathrm{~s} \\ & \mathrm{~s} \end{aligned}$ | $\left\|\begin{array}{l} \mathrm{zo} \\ \mathrm{zo} \\ 20 \\ 20 \end{array}\right\|$ |  |  | $\begin{aligned} & \text { iw } \\ & \text { iw } \\ & 1 w \\ & i w \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 180 / 1.4 \\ & 180 / 1.4 \\ & 200 / 1.2 \\ & 200 / 1.2 \end{aligned}$ | $\begin{array}{r} 10 \\ 5 \\ 20 \\ 10 \end{array}$ |
| 1N30518 <br> 1N3052 <br> 1N3053 <br> 1N3054 | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\left.\begin{aligned} & \mathrm{ZO} \\ & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \end{aligned} \right\rvert\,$ |  |  | iw | $\begin{aligned} & 12 K \\ & 14 K \\ & 16 K \end{aligned}$ | $\begin{aligned} & .1 \\ & .1 \\ & . \end{aligned}$ | $\begin{aligned} & 200 / \\ & 200 / \\ & 200 / \end{aligned}$ | $\begin{aligned} & 701 \\ & 751 \\ & 85 \end{aligned}$ |  | 200/1.2 | 5 |
| 1N3055 <br> IN3056 <br> IN3057 <br> IN3058 | $\begin{aligned} & 5 \\ & 5 \\ & 5 \\ & 5 \end{aligned}$ | $\begin{array}{\|l\|} \mathrm{RE} \\ \mathrm{RE} \\ \mathrm{RE} \\ \mathrm{RE} \\ \mathrm{RE} \end{array}$ |  |  |  | $\begin{aligned} & 18 K \\ & 20 K \\ & 22 K \\ & 24 K \end{aligned}$ | .1 .1 .1 .1 | $\begin{aligned} & 200 / \\ & 200 / \\ & 200 \prime \\ & 200 / \end{aligned}$ | $\begin{array}{r} 85 / \\ 90 / \\ 95 / \\ 100 / \end{array}$ |  |  |  |
| IN3059 <br> 1N3060 <br> IN3061 <br> 1N3062 | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\left\|\begin{array}{l} \mathrm{RE} \\ \mathrm{RE} \\ \mathrm{RE} \\ \mathrm{SD} \end{array}\right\|$ |  | 1N4305 |  | 26K 28k 30K 75 | $\begin{aligned} & 1 \\ & \hline .1 \\ & \hline . \end{aligned}$ | 2001 <br> 200/ <br> 200/ <br> .1/50 | $\begin{aligned} & 105 / \\ & 120 / \\ & 125 / \\ & 1 / 20 \end{aligned}$ | 2 |  |  |
| IN3063 IN3064 IN3065 1N3066 | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\left\|\begin{array}{l} \text { SD } \\ \text { SD } \\ \text { SD } \\ \text { SD } \end{array}\right\|$ |  | 1N4305 1N4454 1N4305 1N4305 |  | 75 75 75 75 |  | $\begin{aligned} & .1 / 50 \\ & .1 / 50 \\ & .1 / 50 \\ & .1 / 50 \end{aligned}$ | $\begin{array}{r} .85 / 10 \\ 1 / 10 \\ 1 / 20 \\ 1 / 10 \end{array}$ | 2 4 2 2 |  |  |
| 1N3067 <br> IN3068 <br> 1N3069 <br> iN3070 | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\begin{array}{\|l\|} \hline \text { SD } \\ \text { SD } \\ \text { SD } \\ \text { SD } \end{array}$ | 1N3070 | 1 N4148 <br> 1N4148 <br> 1N4148 |  | $\begin{array}{r} 30 \\ 30 \\ 65 \\ 200 \end{array}$ |  | $\begin{aligned} & .1 / 20 \\ & .1 / 20 \\ & .1 / 50 \\ & .1 / 175 \end{aligned}$ | $\begin{aligned} & 1 / 5 \\ & 1 / 5 \\ & 1 / 50 \\ & 1 / 100 \end{aligned}$ | 2 50 50 50 |  |  |
| 1N3071 <br> 1N3072 <br> 1N3073 <br> 1N3074 | $\left\lvert\, \begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}\right.$ | $\left.\begin{aligned} & \mathrm{SD} \\ & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \end{aligned} \right\rvert\,$ |  | 1N3070 1N4001 1N4002 1N4003 |  | $\begin{array}{r} 200 \\ 50 \\ 100 \\ 150 \end{array}$ | $\begin{aligned} & .2 \\ & .2 \\ & .2 \end{aligned}$ | $\begin{aligned} & 1 / 175 \\ & 1 / 50 \\ & 1 / 100 \\ & 1 / 150 \end{aligned}$ | $\begin{array}{r} 1 / 100 \\ 1.5 / 500 \\ 1.5 / 500 \\ 1.5 / 500 \end{array}$ | 50 |  |  |
| 1N3075 <br> 1N3076 <br> 1N3077 <br> 1N3078 | $\left\lvert\, \begin{aligned} & \mathbf{s} \\ & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\begin{aligned} & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \end{aligned}$ |  | 1N4003 iN4004 1N4004 iN4004 |  | $\begin{aligned} & 200 \\ & 250 \\ & 300 \\ & 350 \end{aligned}$ | $\begin{aligned} & .2 \\ & .2 \\ & .2 \\ & .2 \end{aligned}$ | $\begin{aligned} & 1 / 200 \\ & 1 / 250 \\ & 1 / 300 \\ & 1 / 350 \end{aligned}$ | 1.5/500 1.5/500 1.5/500 1.5/500 |  |  |  |


| TYF: Mumasit |  |  | $\begin{gathered} \text { II } \\ \text { REPLACEMBNT } \end{gathered}$ | $\begin{aligned} & \text { FOR } \\ & \text { NEW } \\ & \text { DESICN } \end{aligned}$ | rathess |  |  | CHARACTERISTICS |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  |  | $\begin{aligned} & \mathbf{V}_{\mathbf{R}} \\ & (\mathbf{V}) \end{aligned}$ | I <br> (A) | $\begin{array}{ll} \mathbf{N}_{\mathrm{R}} & \bullet \mathrm{~V}_{\mathrm{R}} \\ \mu_{\mathrm{A}} & /(\mathrm{V}) \end{array}$ | $\begin{array}{cc} V_{f} & V_{F} \\ \text { (V) } & /(\mathrm{mA}) \end{array}$ | $\begin{aligned} & t_{r r} \\ & (n *) \end{aligned}$ | $\mathbf{V}_{\mathbf{Z}} \quad \mathbf{l}_{\mathbf{Z}}$ <br> (V) $/$ (mA) | $\begin{aligned} & \text { rot } \\ & \text { \% } \end{aligned}$ |
| 1N3079 <br> iN3080 <br> IN3081 <br> IN3082 | $\begin{aligned} & \hline s \\ & s \\ & s \\ & s \end{aligned}$ | $\begin{aligned} & \hline R E \\ & R E \\ & R E \\ & R E \\ & R E \end{aligned}$ |  | IN4004 1N4005 1N4005 1N4003 |  | 400 500 600 200 | .2 .2 .2 . | $\begin{array}{r} 1 / 400 \\ 1 / 500 \\ 1 / 600 \\ 200 / 200 \end{array}$ | $\begin{aligned} & 1.5 / 500 \\ & 1.5 / 500 \\ & 1.5 / 500 \\ & 1.2 / 200 \end{aligned}$ |  |  |  |
| 1N3083 <br> IN3084 <br> IN3085 <br> 1N3086 | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\begin{aligned} & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \end{aligned}$ |  | $\begin{aligned} & \text { IN4004 } \\ & \text { iN4005 } \end{aligned}$ |  | $\begin{aligned} & 400 \\ & 600 \\ & 100 \\ & 200 \end{aligned}$ | $\begin{array}{r} .5 \\ .5 \\ 150 \\ 150 \end{array}$ | $\begin{aligned} & 200 / 400 \\ & 200 / 600 \\ & 40 \mathrm{M} / \\ & 40 \mathrm{~m} / \end{aligned}$ | $\begin{aligned} & 1.2 / 200 \\ & 1.2 / 200 \\ & 1.1 / \\ & 1.1 / \end{aligned}$ |  |  |  |
| 1N3087 <br> in3088 <br> 1N3089 <br> 1N3090 | $\left\lvert\, \begin{aligned} & 5 \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\begin{aligned} & \text { RE } \\ & R E \\ & R E \\ & R E \\ & R E \end{aligned}$ |  |  |  | $\begin{aligned} & 300 \\ & 400 \\ & 500 \\ & 600 \end{aligned}$ | $\begin{aligned} & 150 \\ & 150 \\ & 150 \\ & 150 \end{aligned}$ | $\begin{aligned} & 40 \mathrm{~m} / \\ & 40 \mathrm{~m} / \\ & 40 \mathrm{~m} / \\ & 40 \mathrm{~m} / \end{aligned}$ | $\begin{aligned} & 1.1 / \\ & 1.1 / \\ & 1.1 / \\ & 1.1 / \end{aligned}$ |  |  |  |
| iN3091 <br> 1N3092 <br> 1N3097 <br> 1N3098 | $\left\lvert\, \begin{aligned} & \mathbf{S} \\ & \mathbf{G} \\ & \mathbf{G} \\ & \mathbf{S} \end{aligned}\right.$ | $\begin{aligned} & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{SD} \\ & \mathrm{ZD} \end{aligned}$ | - | 1N4305 | 1w | $\begin{array}{r} 800 \\ 1 K \\ 30 \end{array}$ | $\begin{aligned} & 150 \\ & 150 \end{aligned}$ | $\begin{aligned} & 40 \mathrm{w} / \\ & 40 \mathrm{~W} / \\ & 2 / 30 \end{aligned}$ | $\begin{aligned} & 1.1 / \\ & 1.1 / \\ & .5 / 10 \end{aligned}$ |  | 120/3 | 20 |
| $\begin{aligned} & \text { 1N3098A } \\ & \text { IN3099 } \\ & \text { 1N3099A } \\ & \text { IN3100 } \end{aligned}$ | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\begin{aligned} & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \end{aligned}$ |  |  | $\begin{aligned} & 1 w \\ & 16 \\ & 16 \\ & 1 w \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 120 / 3 \\ & 150 / 3 \\ & 150 / 3 \\ & 180 / 3 \end{aligned}$ | 10 20 10 20 |
| $\begin{aligned} & \text { IN3100A } \\ & \text { IN3101 } \\ & \text { IN3101A } \\ & \text { IN3106 } \end{aligned}$ | $\left\lvert\, \begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}\right.$ | $\begin{aligned} & \mathrm{ZD} \\ & \mathrm{zD} \\ & \mathrm{ZD} \\ & \mathrm{RE} \end{aligned}$ |  | IN4006 | $\begin{aligned} & \text { iw } \\ & \text { iw } \\ & \text { iw } \end{aligned}$ | 800 | . 75 | 100/ | 1.6/750 |  | $\begin{aligned} & 180 / 3 \\ & 220 / 3 \\ & 220 / 3 \end{aligned}$ | $\begin{aligned} & 10 \\ & 20 \\ & 10 \end{aligned}$ |
| $\begin{aligned} & \text { IN3107 } \\ & \text { IN3108 } \\ & \text { IN3109 } \\ & \text { IN31 } 10 \end{aligned}$ | $\left\lvert\, \begin{aligned} & 5 \\ & s \\ & s \\ & G \end{aligned}\right.$ | $\left\|\begin{array}{l} R E \\ R E \\ R E \\ S D \end{array}\right\|$ |  | IN4305 |  | $\begin{array}{r} 1.2 K \\ 800 \\ 1.2 K \\ 8 \end{array}$ | $\begin{array}{r} .5 \\ 1.5 \\ .7 \end{array}$ | 100/ <br> 100/ <br> 100/ <br> 20/8 | $3.2 /$ <br> 1.61 <br> 3.2/ <br> .45/5 |  |  |  |
| $\begin{array}{\|l\|l\|} \text { 1N3112 } \\ \text { 1N3121 } \\ \text { IN3122 } \\ \text { 1N3123 } \end{array}$ | $\begin{aligned} & \mathbf{S} \\ & \mathbf{G} \\ & \mathbf{G} \\ & \mathbf{s} \end{aligned}$ | $\left.\begin{aligned} & 20 \\ & s D \\ & s 0 \\ & s D \\ & s D \end{aligned} \right\rvert\,$ |  | IN4737A <br> 1N4305 <br> 1N4305 <br> IN4305 | Iw | 50 20 40 |  | 3.5/50 <br> 4.5/20 <br> . $/ 40$ | $\begin{gathered} .25 / .1 \\ .3 / 1 \\ 1.5 / 10 \end{gathered}$ |  | 7.4/120 | 5 |
| 1N3124 <br> IN3125 <br> 1N3139 <br> 1N3140 | $\begin{aligned} & \mathbf{S} \\ & G \\ & S \\ & S \end{aligned}$ | $\begin{array}{\|l\|} \hline \text { SD } \\ \text { SD } \\ \text { RE } \\ \text { RE } \end{array}$ |  | 1N4151 <br> 1N4305 |  | $\begin{array}{r} 40 \\ 40 \\ 50 \\ 100 \end{array}$ | $\begin{aligned} & 70 \\ & 70 \end{aligned}$ | $\begin{aligned} & .1 / 40 \\ & 100 / 40 \\ & 15 \mathrm{M} / \\ & 15 \mathrm{M} / \end{aligned}$ | $\begin{aligned} & 1 / 20 \\ & .4 / 5 \\ & 1.5 / \\ & 1.5 / \end{aligned}$ |  |  |  |
| 1N3141 <br> IN3142 <br> IN3144 <br> 1N3145 | $\left\lvert\, \begin{aligned} & s \\ & \mathbf{S} \\ & \mathbf{G} \\ & \mathbf{G} \end{aligned}\right.$ | $\left\lvert\, \begin{aligned} & R E \\ & R E \\ & R E \\ & S D \\ & S D \end{aligned}\right.$ |  | 1Na305 <br> 1N4305 |  | 150 200 20 65 | $\begin{aligned} & 70 \\ & 70 \end{aligned}$ | $\begin{gathered} 15 \mathrm{M} / \\ 15 \mathrm{M} / \\ 20 / \\ 25 / \end{gathered}$ | $\begin{aligned} & 1.5 / \\ & 1.5 / \\ & .3 / 1 \\ & .45 / 10 \end{aligned}$ |  |  |  |

## DIODE INTERCHANGEABILITY

| TYFE Mumber |  |  | 7 RELACEMENT | $\begin{aligned} & \text { FOR } \\ & \text { NEW } \\ & \text { DESIGN } \end{aligned}$ | PD (mW) | Atings <br> $\mathbf{V}_{\mathbf{R}}$ <br> (V) |  | $\begin{array}{ll} \mathbf{I}_{\mathbf{R}} & \mathbf{V}_{\mathbf{R}} \\ \mu \mathrm{A} & /(\mathbf{V}) \end{array}$ | $\mathbf{V F}_{F}$ 牛 <br> (V) $/$ (mA) | RISTIC <br> trr <br> ( n s) | $\mathbf{V}_{\mathbf{z}}$ (1) <br> (V) / (mA) | $\left.\right\|^{\mathrm{TOL}}$ |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 1N3146 <br> 1N3147 <br> 1N3148 <br> 1N3154 | $\begin{aligned} & \mathbf{G} \\ & \mathbf{S} \\ & \mathbf{S} \\ & \mathbf{S} \end{aligned}$ | $\begin{aligned} & \hline S D \\ & S D \\ & R D \\ & R D \end{aligned}$ | $\Gamma$ | 1N4154 1N4448 | 400 | 20 |  | 100/ | $\begin{aligned} & 1 / 50 \\ & 1 / 100 \end{aligned}$ |  | $\begin{aligned} & 8.5 / 10 \\ & 8.8 / 10 \end{aligned}$ | 5 |
| $\begin{aligned} & \text { 1N315AA } \\ & \text { 1N3155 } \\ & \text { 1N3155A } \\ & \text { 1N3156 } \end{aligned}$ | $\begin{aligned} & \mathbf{s} \\ & s \\ & s \\ & 5 \end{aligned}$ | $\begin{aligned} & R D \\ & R D \\ & R D \\ & R D \end{aligned}$ |  |  | $\begin{aligned} & 400 \\ & 400 \\ & 400 \\ & 400 \end{aligned}$ |  |  |  |  |  | 8.8/10 <br> 8.8/10 <br> 8.8/10 <br> 8.8/10 | 5 5 5 5 |
| $\begin{aligned} & \text { 1N3156A } \\ & \text { 1N3157 } \\ & \text { 1N3157A } \\ & \text { IN3159 } \end{aligned}$ | $\begin{aligned} & s \\ & s \\ & s \\ & G \end{aligned}$ | $\begin{aligned} & \mathrm{RD} \\ & \mathrm{RD} \\ & \mathrm{RD} \\ & \mathrm{SD} \end{aligned}$ |  | 1 N 4305 | $\begin{array}{r} 400 \\ 400 \\ 400 \end{array}$ | 15 |  | 100/10 | .45/10 | 300 | 8.8/10 <br> 8.8/10 <br> 8.8/10 | 5 5 5 |
| 1N3160 1N3161 1N3162 1N3163 | $\begin{aligned} & \mathbf{G} \\ & \mathbf{S} \\ & \mathbf{S} \\ & \mathbf{S} \end{aligned}$ | $\begin{aligned} & \mathrm{SD} \\ & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \\ & \hline \end{aligned}$ |  | 1N4305 |  | $\begin{array}{r} 60 \\ 50 \\ 100 \\ 150 \end{array}$ | $\begin{aligned} & 240 \\ & 240 \\ & 240 \end{aligned}$ | $\begin{aligned} & 12 / \\ & 16 \mathrm{M} / \\ & 16 \mathrm{M} / \\ & 16 \mathrm{M} / \end{aligned}$ | $\begin{aligned} & .45 / 10 \\ & 1.3 / \\ & 1.3 / \\ & 1.3 / \end{aligned}$ |  |  |  |
| 1N3164 1N3165 1N3166 1N3167 | S | $\begin{aligned} & R E \\ & R E \\ & R E \\ & R E \end{aligned}$ |  |  |  | $\begin{aligned} & 200 \\ & 250 \\ & 300 \\ & 350 \end{aligned}$ | $\begin{aligned} & 240 \\ & 240 \\ & 240 \\ & 240 \end{aligned}$ | 16M/ <br> 16M/ <br> $16 \mathrm{M} /$ <br> 16M/ | $\begin{aligned} & 1.3 / \\ & 1.3 / \\ & 1.3 / \\ & 1.3 / \end{aligned}$ |  |  |  |
| 1N3168 <br> 1N3169 <br> 1N3170 <br> 1N3171 | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | RE RE RE RE |  |  |  | $\begin{aligned} & 400 \\ & 500 \\ & 600 \\ & 700 \end{aligned}$ | $\begin{aligned} & 240 \\ & 240 \\ & 240 \\ & 240 \end{aligned}$ | $16 \mathrm{M} /$ <br> $16 \mathrm{M} /$ <br> $16 \mathrm{M} /$ <br> 16M/ | $\begin{aligned} & 1.3 / \\ & 1.3 / \\ & 1.3 / \\ & 1.9 / \end{aligned}$ |  |  |  |
| 1N3171A <br> 1N3172 <br> 1N3172A <br> 1N3173 | $\begin{aligned} & \mathbf{s} \\ & \mathbf{S} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}$ | $\begin{aligned} & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \end{aligned}$ |  |  |  | 700 <br> 800 <br> 800 <br> 900 | $\begin{aligned} & 240 \\ & 240 \\ & 240 \\ & 240 \end{aligned}$ | 16M/ <br> $16 \mathrm{M} /$ <br> $16 \mathrm{M} /$ <br> 16M/ | $\begin{aligned} & 1.91 \\ & 1.91 \\ & 1.91 \\ & 1.91 \end{aligned}$ |  |  |  |
| IN3173A <br> IN3174 <br> 1N3174A <br> 1N3175 | $\begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}$ | $\begin{aligned} & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \end{aligned}$ |  |  |  | $\begin{array}{r} 900 \\ 1 K \\ 1 K \\ 1.2 K \end{array}$ | $\begin{aligned} & 240 \\ & 240 \\ & 240 \\ & 240 \end{aligned}$ | $\begin{aligned} & 16 \mathrm{M} / \\ & 16 \mathrm{M} / \\ & 16 \mathrm{M} / \\ & 15 \mathrm{M} / \end{aligned}$ | $\begin{aligned} & 1.91 \\ & 1.9 / \\ & 1.91 \\ & 1.41 \end{aligned}$ |  |  |  |
| IN3176 <br> 1N3177 <br> 1N3179 <br> 1N3180 | $\begin{aligned} & \mathbf{s} \\ & \mathbf{S} \\ & \mathbf{S} \\ & \mathbf{s} \end{aligned}$ | $\begin{array}{\|l\|} \mathbf{R E} \\ \mathrm{RE} \\ \mathrm{SD} \\ \mathrm{SD} \end{array}$ |  | $\begin{aligned} & \text { 1N4938 } \\ & \text { 1N4938 } \end{aligned}$ |  | $\begin{aligned} & 1.4 K \\ & 1.6 K \\ & 240 \\ & 130 \end{aligned}$ | $\begin{aligned} & 240 \\ & 240 \end{aligned}$ | $\begin{aligned} & 15 M / \\ & 15 M / \\ & 10 / 200 \\ & 5 / 100 \end{aligned}$ | 1.4/ <br> 1.4/ <br> $1 / 100$ <br> 1.5/500 |  |  |  |
| 1N3181 <br> IN3190 <br> 1N3191 <br> 1N3192 | $\begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}$ | $\begin{aligned} & \mathrm{ZD} \\ & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \end{aligned}$ |  | 1N4737 <br> 1N4004 <br> INeOO5 <br> IN645 | 600 | $\begin{aligned} & 400 \\ & 600 \\ & 200 \end{aligned}$ | 1 | $\begin{array}{r} 5 / 400 \\ 5 / 600 \\ 10 / 200 \end{array}$ | $\begin{gathered} 1.1 / 1 A \\ 1.1 / 1 A \\ 1 / 100 \end{gathered}$ |  | 7.7/14 | 10 |

## DIODE INTERCHANGEABILITY

| TYPEnumber |  |  | $\underset{\text { Remacement }}{\text { II }}$ | $\begin{aligned} & \text { FOR } \\ & \text { NEW } \\ & \text { DESVCN } \end{aligned}$ | RATMNSS |  |  | Characteristics |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  | $\begin{gathered} P_{D} \\ (\mathrm{mw}) \end{gathered}$ | $\mathbf{V}_{\mathrm{R}}$ <br> (V) | (A) | $\begin{array}{ll} n & V_{R} \\ \mu & /(V) \end{array}$ | $\mathbf{V F}_{\mathrm{F}}$ - $\mathrm{IF}_{\mathrm{F}}$ <br> (V) $/$ (ma) | $t_{r}$ <br> (ns) | $\begin{array}{ccc} \mathbf{v}_{\mathbf{z}} & \bullet \mathbf{z} \\ (\mathrm{V}) & /(\mathrm{mA}) \end{array}$ | $\begin{aligned} & \text { ror } \\ & \% \end{aligned}$ |
| $\left\lvert\, \begin{aligned} & \text { IN3193 } \\ & \text { IN3194 } \\ & \text { iN3195 } \\ & \text { IN3196 } \end{aligned}\right.$ | $\begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}$ | $\begin{array}{l\|} \mathbf{R E} \\ \mathbf{R E} \\ \mathbf{R E} \\ \mathbf{R E} \end{array}$ |  | $\begin{aligned} & \text { IN4003 } \\ & \text { INA004 } \\ & \text { IN4005 } \\ & \text { INH006 } \end{aligned}$ |  | $\begin{aligned} & 200 \\ & 400 \\ & 600 \\ & 800 \end{aligned}$ | $\begin{aligned} & .75 \\ & .75 \\ & .75 \\ & .75 \end{aligned}$ | $\begin{aligned} & 5 / 200 \\ & 5 / 200 \\ & 5 / 200 \\ & 5 / 200 \end{aligned}$ | $\begin{aligned} & 1.2 / 750 \\ & 1.2 / 750 \\ & 1.2 / 750 \\ & 1.2 / 750 \end{aligned}$ |  |  |  |
| 1N3197 <br> 1N3198 <br> 1N3199 <br> 1N3200 | $\begin{aligned} & \mathbf{G} \\ & \mathbf{S} \\ & \mathbf{S} \\ & \mathbf{S} \end{aligned}$ | $\left.\begin{aligned} & \mathrm{SD} \\ & \mathrm{ZD} \\ & \mathrm{RD} \\ & \mathrm{RD} \end{aligned} \right\rvert\,$ |  | 1N4148 | $\begin{aligned} & 400 \\ & 270 \\ & 270 \end{aligned}$ | 30 |  | 50/10 | .4/5 | 300 | $\begin{array}{r} 2.25 / 10 \\ 8.8 / 10 \\ 8.8 / 10 \end{array}$ | 2 5 5 |
| $\begin{aligned} & \text { 1N3201 } \\ & \text { 1N3202 } \\ & \text { 1N3203 } \\ & \text { 1N3204 } \end{aligned}$ | $\left[\begin{array}{l} s \\ s \\ G \\ \mathbf{G} \end{array}\right.$ | $\begin{aligned} & R D \\ & R D \\ & \text { RD } \\ & \text { SD } \\ & \text { SD } \end{aligned}$ |  | 1N4305 IN4305 | $\begin{aligned} & 270 \\ & 270 \end{aligned}$ | $\begin{aligned} & 25 \\ & 60 \end{aligned}$ |  | $\begin{aligned} & 50 / 25 \\ & 50 / 25 \end{aligned}$ | $\begin{aligned} & .5 / 35 \\ & .4 / 35 \end{aligned}$ | $\begin{aligned} & 300 \\ & 300 \end{aligned}$ | $\begin{aligned} & 8.8 / 10 \\ & 8.8 / 10 \end{aligned}$ | $\begin{aligned} & 5 \\ & 5 \end{aligned}$ |
| 1N3206 iN3207 1N3208 IN3209 | $\begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}$ | $\begin{array}{\|l\|} \hline \mathbf{S D} \\ \mathrm{SD} \\ \mathrm{RE} \\ \mathrm{RE} \end{array}$ |  | IN4531 in4607 |  | $\begin{array}{r} 80 \\ 50 \\ 50 \\ 100 \end{array}$ | $\begin{aligned} & 15 \\ & 15 \end{aligned}$ | $\begin{aligned} & 30 \mathrm{~N} / 20 \\ & 50 \mathrm{~N} / 20 \\ & 10 \mathrm{~m} / \\ & 10 \mathrm{~m} / \end{aligned}$ | $\begin{aligned} & 1 / 10 \\ & 1 / 150 \\ & 1.5 / \\ & 1.5 / \end{aligned}$ | 4 |  |  |
| $\begin{aligned} & \text { 1N3210 } \\ & \text { 1N3211 } \\ & \text { 1N3212 } \\ & \text { 1N3213 } \end{aligned}$ | $\begin{aligned} & \mathrm{s} \\ & \mathrm{~s} \\ & \mathrm{~s} \\ & \mathrm{~s} \\ & \hline \end{aligned}$ | $\begin{array}{\|l\|} \hline \mathbf{R E} \\ \mathbf{R E} \\ \mathbf{R E} \\ \mathbf{R E} \\ \mathbf{R E} \end{array}$ |  |  |  | $\begin{aligned} & 200 \\ & 300 \\ & 400 \\ & 500 \end{aligned}$ | $\begin{aligned} & 15 \\ & 15 \\ & 15 \\ & 15 \end{aligned}$ | $10 \mathrm{M} /$ <br> 10M/ <br> 10M/ <br> 10M/ | $\begin{aligned} & 1.5 / \\ & 1.5 / \\ & 1.5 / \\ & 1.5 / \end{aligned}$ |  |  |  |
| $\begin{aligned} & \text { IN3214 } \\ & \text { IN3215 } \\ & \text { 1N3223 } \\ & \text { IN3225 } \end{aligned}$ | $\begin{array}{\|l} s \\ s \\ s \\ s \\ s \end{array}$ | $\left\|\begin{array}{l} \text { RE } \\ \text { SD } \\ \text { SD } \\ \text { SD } \end{array}\right\|$ |  | $\begin{aligned} & 1 \mathrm{~N} 4152 \\ & \text { 1N4938 } \\ & \text { 1NA148 } \end{aligned}$ |  | $\begin{array}{r} 600 \\ 80 \\ 150 \\ 40 \end{array}$ | 15 | $\begin{aligned} & 10 \mathrm{M} / 1 \\ & 10 / 50 \\ & 20 / 125 \\ & 33 / 10 \end{aligned}$ | $\begin{gathered} 1.5 / \\ .7 / 1 \\ 1.5 / 4 \\ 1 / 5 \end{gathered}$ | $\begin{aligned} & 800 \\ & 500 \end{aligned}$ |  |  |
| $\begin{aligned} & \text { 1N3227 } \\ & \text { 1N3228 } \\ & \text { 1N3229 } \\ & \text { 1N3230 } \end{aligned}$ | $\begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}$ | $\mathbf{R E}$ <br> $\mathbf{R E}$ <br> $\mathbf{R E}$ <br> $\mathbf{R E}$ <br> $\mathbf{R E}$ |  | $\begin{aligned} & \text { IN4002 } \\ & \text { IN4003 } \\ & \text { iN4004 } \\ & \text { in } 4005 \end{aligned}$ |  | $\begin{aligned} & 100 \\ & 200 \\ & 400 \\ & 600 \end{aligned}$ | .5 .5 .5 .5 | $\begin{aligned} & 250 / 100 \\ & 250 / 200 \\ & 250 / 400 \\ & 250 / 600 \end{aligned}$ | $\begin{aligned} & 3.3 / 500 \\ & 3.3 / 500 \\ & 3.3 / 500 \\ & 3.3 / 500 \end{aligned}$ |  |  |  |
| $\begin{array}{\|l\|} \hline \text { 1N3231 } \\ \text { 1N3232 } \\ \text { 1N3233 } \\ \text { 1N3234 } \end{array}$ | $\begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}$ | $\begin{array}{\|c\|} \hline \mathbf{R E} \\ \mathbf{R E} \\ \mathbf{R E} \\ \mathbf{R E} \\ \mathbf{R E} \\ \mathbf{R E} \end{array}$ |  | $\begin{array}{\|l\|l\|l\|} \hline \text { IN4008 } \\ \text { in4007 } \end{array}$ |  | $\begin{array}{r} 800 \\ 1 K \\ 1.2 K \\ 1.5 \mathrm{~K} \end{array}$ | .5 .5 .5 .5 | $\begin{aligned} & 250 / 800 \\ & 250 / 1 \mathrm{~K} \\ & 250 / \\ & 250 / \end{aligned}$ | $\begin{aligned} & 3.3 / 500 \\ & 3.3 / 500 \\ & 3.3 / \\ & 3.3 / \end{aligned}$ |  |  |  |
| $\begin{array}{\|l\|l\|} \text { IN3235 } \\ \text { IN3236 } \\ \text { 1N3237 } \\ \text { 1N3238 } \end{array}$ | $\begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}$ | $\begin{array}{\|c\|} \mathrm{RE} \\ \mathrm{RE} \\ \mathrm{RE} \\ \mathrm{RE} \end{array}$ |  | $\left\lvert\, \begin{array}{\|l\|l\|l\|} \hline \text { IN4001 } \\ \text { IN4002 } \end{array}\right.$ |  | $\begin{array}{r} 1.8 K \\ 2 K \\ 50 \\ 100 \end{array}$ | .5 .5 .75 .75 | $\begin{aligned} & 250 / \\ & 250 / \\ & 250 / 50 \\ & 250 / 100 \end{aligned}$ | $\begin{aligned} & 3.3 / \\ & 3.3 / \\ & 2.2 / 750 \\ & 2.2 / 750 \end{aligned}$ |  |  |  |
| 1N3239 1N3240 1N3241 1N3242 | $\left\lvert\, \begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}\right.$ | $\left\|\begin{array}{l} \mathrm{RE} \\ \mathbf{R E} \\ \mathbf{R E} \\ \mathbf{R E} \end{array}\right\|$ |  | $\begin{aligned} & \text { iN4003 } \\ & \text { iN4004 } \\ & \text { in } 4005 \\ & \text { iN4006 } \end{aligned}$ |  | $\begin{aligned} & 200 \\ & 400 \\ & 600 \\ & 800 \end{aligned}$ | $\begin{aligned} & .75 \\ & .75 \\ & .75 \\ & .75 \end{aligned}$ | $\begin{aligned} & 250 / 200 \\ & 250 / 400 \\ & 250 / 600 \\ & 250 / 800 \end{aligned}$ | $\begin{aligned} & 2.21750 \\ & 2.21750 \\ & 2.2 / 750 \\ & 2.2 / 750 \end{aligned}$ |  |  |  |

## DIODE INTERCHANGEABILITY

| TYPE NUMEER |  | $\begin{aligned} & \frac{3}{6} \\ & \frac{2}{6} \\ & \frac{2}{2} \\ & \frac{2}{2} \\ & 3 \end{aligned}$ | $\begin{gathered} \text { TI } \\ \text { RERLACEMBNT } \end{gathered}$ | $\begin{aligned} & \text { FOR } \\ & \text { NEW } \\ & \text { DESIGN } \end{aligned}$ | RATHNOS |  |  | CHARACTERISTICS |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  |  | $\mathbf{V}_{\mathbf{R}}$ <br> (V) | I <br> (A) | $\begin{array}{ll} \mathbf{I}_{\mathbf{R}} & \mathbf{V}_{\mathbf{R}} \\ \mu \mathbf{A} & / \mathbf{V}) \end{array}$ | $\mathbf{V F}_{F}$ - $\mathbf{I F}_{\mathbf{F}}$ <br> (v) $/(\mathrm{mA})$ | $t_{\pi}$ $\text { ( } \mathrm{n} \text { ) }$ | $\mathbf{V}_{\mathbf{Z}}$ e $\mathbf{I z}_{\mathbf{Z}}$ <br> (V) $/$ (mA) | $\left\lvert\, \begin{gathered} 701 \\ \% \end{gathered}\right.$ |
| $\begin{aligned} & \text { 1N3243 } \\ & \text { 1N3244 } \\ & \text { 1N3245 } \\ & \text { 1N3246 } \end{aligned}$ | $\begin{array}{\|l} \hline s \\ s \\ s \\ s \end{array}$ | $\begin{array}{\|l\|} \hline R E \\ R E \\ R E \\ R E \end{array}$ |  | 1N4007 <br> 1N4001 |  | 1 K 1.2 K 1.5 K 50 | .75 .75 .75 1 | $\begin{aligned} & 250 / 1 K \\ & 250 / 50 \end{aligned}$ | $\begin{aligned} & 2.2 / 750 \\ & 2.2 / 750 \\ & 2.2 / 750 \\ & 1.1 / 1 \mathrm{~A} \end{aligned}$ |  |  |  |
| $\begin{aligned} & \text { 1N3247 } \\ & \text { IN3248 } \\ & \text { IN3249 } \\ & \text { IN3250 } \end{aligned}$ | $\begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}$ | $\begin{aligned} & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \end{aligned}$ |  | 1N4002 <br> 1N4003 <br> 1N4004 <br> 1N4005 |  | 100 200 400 600 | 1 1 1 | $\begin{aligned} & 250 / 100 \\ & 250 / 200 \\ & 250 / 400 \\ & 250 / 600 \end{aligned}$ | 1.1/1A <br> 1.1/1A <br> 1.1/1A <br> 1.1/1A |  |  |  |
| 1N3251 <br> IN3252 <br> 1N3253 <br> IN3254 | $\begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}$ | $\begin{aligned} & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \end{aligned}$ |  | 1N4006 <br> 1N4007 <br> 1N4003 <br> IN4004 |  | $\begin{array}{r} 800 \\ 1 K \\ 200 \\ 400 \end{array}$ | $\begin{array}{r} 1 \\ 1 \\ .75 \\ .75 \end{array}$ | $\begin{aligned} & 250 / 800 \\ & 250 / 1 K \\ & 200 / 200 \\ & 200 / 400 \end{aligned}$ | $\begin{aligned} & 1.1 / 1 \mathrm{~A} \\ & 1.1 / 1 \mathrm{~A} \\ & 1.2 / 750 \\ & 1.2 / 750 \end{aligned}$ |  |  |  |
| $\begin{aligned} & \text { IN3255 } \\ & \text { 1N3256 } \\ & \text { IN3257 } \\ & \text { IN3258 } \end{aligned}$ | $\begin{aligned} & s \\ & s \\ & s \\ & s \\ & s \end{aligned}$ | RE <br> RE <br> SD <br> SD | . | IN4005 iN4006 1N4449 1N4448 |  | $\begin{array}{r} 600 \\ 800 \\ 80 \\ 80 \end{array}$ | $.75$ | $\begin{aligned} & 200 / 600 \\ & 200 / 800 \\ & 25 N / 50 \\ & 25 N / 50 \end{aligned}$ | $\begin{gathered} 1.2 / 750 \\ 1.2 / 750 \\ 1 / 30 \\ 1 / 100 \end{gathered}$ | 3 |  |  |
| IN3260 <br> IN3261 <br> 1N3262 <br> 1N3263 | $\begin{aligned} & \mathrm{s} \\ & \mathrm{~s} \\ & \mathrm{~s} \\ & \mathrm{~s} \end{aligned}$ | $\begin{aligned} & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \end{aligned}$ |  |  |  | $\begin{array}{r} 50 \\ 100 \\ 150 \\ 200 \end{array}$ | $\begin{aligned} & 160 \\ & 160 \\ & 160 \\ & 160 \end{aligned}$ | $\begin{aligned} & 12 \mathrm{M} / \\ & 12 \mathrm{M} / \\ & 12 \mathrm{M} / \\ & 12 \mathrm{M} / \end{aligned}$ | $\begin{aligned} & 1.6 / \\ & 1.6 / \\ & 1.6 / \\ & 1.6 / \end{aligned}$ |  |  |  |
| 1N3264 1N3265 IN3266 IN3267 | $\begin{aligned} & \mathrm{S} \\ & \mathrm{~s} \\ & \mathrm{~s} \\ & \mathrm{~s} \end{aligned}$ | $\begin{aligned} & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \end{aligned}$ |  |  |  | $\begin{aligned} & 250 \\ & 300 \\ & 350 \\ & 400 \end{aligned}$ | $\begin{aligned} & 160 \\ & 160 \\ & 160 \\ & 160 \end{aligned}$ | $\begin{aligned} & 12 \mathrm{M} / \\ & 12 \mathrm{M} / \\ & 12 \mathrm{M} / \\ & 12 \mathrm{M} / \end{aligned}$ | $\begin{aligned} & 1.6 / \\ & 1.6 / \\ & 1.6 / \\ & 1.6 / \end{aligned}$ |  |  |  |
| 1N3268 <br> 1N3269 <br> 1N3270 <br> 1N3271 | $\begin{aligned} & \mathrm{S} \\ & \mathrm{~s} \\ & \mathrm{~s} \\ & \mathrm{~s} \end{aligned}$ | $\begin{aligned} & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \end{aligned}$ |  |  |  | $\begin{aligned} & 500 \\ & 600 \\ & 700 \\ & 800 \end{aligned}$ | $\begin{aligned} & 160 \\ & 160 \\ & 160 \\ & 160 \end{aligned}$ | $\begin{aligned} & 12 \mathrm{M} / \\ & 12 \mathrm{M} / \\ & 12 \mathrm{M} / \\ & 12 \mathrm{M} / \end{aligned}$ | $\begin{aligned} & 1.6 / \\ & 1.6 / \\ & 1.6 / \\ & 1.6 / \end{aligned}$ |  |  |  |
| 1N3272 <br> 1N3273 <br> 1N3274 <br> iN3275 | $\begin{aligned} & \mathrm{s} \\ & 5 \\ & 5 \\ & 5 \end{aligned}$ | $\left.\begin{aligned} & R E \\ & R E \\ & R E \\ & R E \end{aligned} \right\rvert\,$ |  |  |  | $\begin{array}{r} 900 \\ 1 \mathrm{~K} \\ 1.2 \mathrm{~K} \\ 1.4 \mathrm{~K} \end{array}$ | $\begin{aligned} & 160 \\ & 160 \\ & 160 \\ & 160 \end{aligned}$ | $\begin{aligned} & 12 \mathrm{M} / \\ & 12 \mathrm{M} / \\ & 12 \mathrm{M} / \\ & 12 \mathrm{M} / \end{aligned}$ | $\begin{aligned} & 1.6 / \\ & 1.6 / \\ & 1.6 / \\ & 1.6 / \end{aligned}$ |  |  |  |
| 1N3276 <br> 1N3277 <br> 1N3278 <br> 1N3279 | $\begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}$ | $\begin{aligned} & R E \\ & R E \\ & R E \\ & R E \\ & R E \end{aligned}$ |  | $\begin{array}{\|l\|} \text { IN4003 } \\ \text { IN4OO4 } \\ \text { IN4005 } \end{array}$ |  | $\begin{array}{r} 1.6 K \\ 200 \\ 400 \\ 600 \end{array}$ | $\begin{array}{r} 160 \\ .75 \\ .75 \\ .75 \end{array}$ | $\begin{aligned} & 12 \mathrm{M} / \\ & 5 / 200 \\ & 5 / 400 \\ & 5 / 600 \end{aligned}$ | $\begin{aligned} & 1.6 / \\ & 1.3 / 750 \\ & 1.3 / 750 \\ & 1.3 / 750 \end{aligned}$ |  |  |  |
| IN3280 <br> 1N3281 <br> 1N3282 <br> 1N3283 | $\begin{aligned} & 5 \\ & S \\ & 5 \\ & 5 \end{aligned}$ | $\begin{aligned} & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \end{aligned}$ |  | IN4006 1N4007 IN4007 |  | $\begin{array}{r} 800 \\ 1 K \\ 1 K \\ 1.5 K \end{array}$ | $\begin{array}{r} .75 \\ .75 \\ .1 \\ .1 \end{array}$ | $\begin{aligned} & 5 / 800 \\ & 5 / 1 K \\ & 1 / 1 K \\ & 1 / \end{aligned}$ | $\begin{aligned} & 1.3 / 750 \\ & 1.3 / 750 \\ & 3.7 / 100 \\ & 3.7 / \end{aligned}$ |  |  |  |


| TYPE NUMEER |  |  | $\begin{gathered} \text { II } \\ \text { REPLACEMENT } \end{gathered}$ |  | ratings |  |  | CHARACTERISTICS |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  | $P_{D}$ (mW) | $\mathbf{V}_{\mathbf{R}}$ <br> (V) | (A) | $\begin{array}{lll} \mathbf{L}_{\mathbf{R}} & \bullet & \mathbf{V}_{\mathbf{R}} \\ \mu \mathbf{A} & /(\mathbf{V}) \end{array}$ | $\begin{array}{ll} \mathbf{V F}_{F} & \mathrm{I}_{\mathbf{F}} \\ (\mathrm{V}) & /(\mathrm{mA}) \end{array}$ | $t_{\pi}$ <br> (ns) | $\mathbf{V}_{\mathbf{Z}} \bullet \mathbf{I z}_{\mathbf{Z}}$ <br> (V) $/$ (mA) | $\begin{gathered} \text { rot } \\ \times \end{gathered}$ |
| 1N3284 <br> IN3285 <br> 1N3286 <br> 1N3287 | $\begin{aligned} & \mathbf{S} \\ & \mathbf{S} \\ & \mathbf{S} \\ & \mathbf{G} \end{aligned}$ | $\begin{array}{l\|} \hline R E \\ R E \\ R E \\ R E \end{array}$ |  |  |  | 2 K 2.5 K 3 K 6 | .1 .1 .1 | $\begin{gathered} 1 / \\ 1 / \\ 1 / \\ 15 / \end{gathered}$ | $\begin{aligned} & 3.7 / \\ & 3.7 / \\ & 3.7 / \\ & .32 / 1 \end{aligned}$ |  |  |  |
| $\begin{array}{\|l} \text { 1N3287W W } \\ \text { 1N3288 } \\ \text { 1N3288A } \\ \text { 1N3289 } \end{array}$ | [ $\begin{aligned} & \mathbf{G} \\ & \mathbf{S} \\ & \mathbf{S} \\ & \mathbf{S}\end{aligned}$ | $\begin{aligned} & \mathrm{SD} \\ & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \end{aligned}$ |  |  |  | $\begin{array}{r} 6 \\ 100 \\ 100 \\ 200 \end{array}$ | $\begin{aligned} & 100 \\ & 100 \\ & 100 \end{aligned}$ | $\begin{aligned} & 15 / \\ & 24 \mathrm{M} / \\ & 24 \mathrm{M} / \\ & 24 \mathrm{M} / \end{aligned}$ | $\begin{aligned} & .32 / 1 \\ & 1.5 / \\ & 1.2 / \\ & 1.5 / \end{aligned}$ |  |  |  |
| $\begin{array}{\|l} \text { IN3289A } \\ \text { 1N3290 } \\ \text { IN3290A } \\ \text { IN3291 } \end{array}$ | S | $\begin{aligned} & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \end{aligned}$ |  |  |  | $\begin{aligned} & 200 \\ & 300 \\ & 300 \\ & 400 \end{aligned}$ | $\begin{aligned} & 100 \\ & 100 \\ & 100 \\ & 100 \end{aligned}$ | $\begin{aligned} & 24 \mathrm{M} / \\ & 24 \mathrm{M} / \\ & 24 \mathrm{M} / \\ & 24 \mathrm{M} / \end{aligned}$ | $\begin{aligned} & 1.2 / \\ & 1.5 / \\ & 1.2 / \\ & 1.5 / \end{aligned}$ |  |  |  |
| $\begin{aligned} & \text { 1N3291A } \\ & \text { 1N3292 } \\ & \text { 1N3292A } \\ & \text { 1N3292B } \end{aligned}$ | S S S 5 | $\begin{aligned} & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \end{aligned}$ |  |  |  | $\begin{aligned} & 400 \\ & 500 \\ & 500 \\ & 500 \end{aligned}$ | $\begin{aligned} & 100 \\ & 100 \\ & 100 \\ & 100 \end{aligned}$ | $\begin{aligned} & 24 \mathrm{M} / \\ & 21 \mathrm{M} / \\ & 21 \mathrm{M} / \\ & 21 \mathrm{M} / \end{aligned}$ | $\begin{aligned} & 1.2 / \\ & 1.5 / \\ & 1.2 / \\ & 1.5 / \end{aligned}$ |  |  |  |
| $\begin{array}{\|l} \text { 1N3293 } \\ \text { 1N3293A } \\ \text { 1N3294 } \\ \text { IN3294A } \end{array}$ | S | $\begin{aligned} & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \end{aligned}$ |  |  |  | $\begin{aligned} & 600 \\ & 600 \\ & 800 \\ & 800 \end{aligned}$ | $\begin{aligned} & 100 \\ & 100 \\ & 100 \\ & 100 \end{aligned}$ | $\begin{aligned} & 17 \mathrm{M} / \\ & 17 \mathrm{M} / \\ & 13 \mathrm{M} / \\ & 13 \mathrm{M} / \end{aligned}$ | $\begin{aligned} & 1.5 / \\ & 1.2 / \\ & 1.5 / \\ & 1.2 / \end{aligned}$ |  |  |  |
| $\begin{aligned} & \text { 1N3295 } \\ & \text { IN3295A } \\ & \text { 1N3296 } \\ & \text { 1N3296A } \end{aligned}$ | S | $\begin{aligned} & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \end{aligned}$ |  |  |  | $\begin{array}{r} 1 K \\ 1 K \\ 1.2 K \\ 1.2 K \end{array}$ | $\begin{aligned} & 100 \\ & 100 \\ & 100 \\ & 100 \end{aligned}$ | $11 \mathrm{M} /$ <br> $11 \mathrm{M} /$ <br> 9M/ <br> 9M/ | $\begin{aligned} & 1.5 / \\ & 1.2 / \\ & 1.5 / \\ & 1.2 / \end{aligned}$ |  |  |  |
| $\begin{aligned} & \text { IN3297 } \\ & \text { 1N3297A } \\ & \text { 1N3298 } \\ & \text { 1N3298A } \end{aligned}$ | S | $\begin{aligned} & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{SD} \\ & \mathrm{SD} \end{aligned}$ |  | 1N4608 1N4608 |  | 1.4 K <br> 1.4 K <br> 70 <br> 70 | $\begin{aligned} & 100 \\ & 100 \end{aligned}$ | $\begin{aligned} & 7 M / \\ & 7 M / \\ & .2 / 60 \\ & .2 / 60 \end{aligned}$ | $\begin{aligned} & 1.5 / \\ & 1.2 / \\ & .9 / 500 \\ & .9 / 500 \end{aligned}$ | $\begin{array}{r} 200 \\ 20 \end{array}$ |  |  |
| IN3354 <br> iN3355 <br> 1N3356 <br> 1N3357 | S | $\begin{aligned} & R E \\ & R E \\ & R E \\ & R E \\ & R E \end{aligned}$ |  |  |  | 10 15 25 50 | 3 3 3 3 | $\begin{aligned} & 20 \% \\ & 20 \% \\ & 10 / \\ & 10 \% \end{aligned}$ | $\begin{aligned} & 1.2 / \\ & 1.2 / \\ & 1.2 / \\ & 1.2 / \end{aligned}$ |  |  |  |
| 1N3358 <br> 1N3359 <br> 1N3360 <br> 1N3361 | $\begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}$ | $\begin{aligned} & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \end{aligned}$ |  |  |  | $\begin{array}{r} 75 \\ 100 \\ 150 \\ 200 \end{array}$ | $\begin{aligned} & 3 \\ & 3 \\ & 3 \\ & 3 \end{aligned}$ | $\begin{aligned} & 10 \% \\ & 10 \% \\ & 10 \% \\ & 10 \% \end{aligned}$ | $\begin{aligned} & 1.2 / \\ & 1.2 / \\ & 1.2 / \\ & 1.2 / \end{aligned}$ |  |  |  |
| 1N3362 <br> 1N3363 <br> 1N3364 <br> 1N3365 | $\begin{aligned} & \mathbf{s} \\ & \mathbf{S} \\ & \mathbf{S} \\ & \mathbf{S} \end{aligned}$ | $\begin{aligned} & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \end{aligned}$ |  |  |  | $\begin{aligned} & 300 \\ & 400 \\ & 500 \\ & 600 \end{aligned}$ | $\begin{aligned} & 3 \\ & 3 \\ & 3 \\ & 3 \end{aligned}$ | $\begin{aligned} & 10 / \\ & 10 / \\ & 10 / \\ & 10 / \end{aligned}$ | $\begin{aligned} & 1.2 / \\ & 1.2 / \\ & 1.2 / \\ & 1.2 / \end{aligned}$ |  |  |  |


| $\begin{gathered} \text { TYPE } \\ \text { Numater } \end{gathered}$ |  |  | $\underset{\text { REDLACEMENT }}{\pi}$ | $\begin{gathered} \text { FOR } \\ \text { NEW } \\ \text { DESION } \end{gathered}$ |  | tings <br> $\mathbf{v}_{\mathbf{R}}$ <br> (V) | (A) | $\begin{array}{ll} l_{R} & V_{R} \\ \mu_{\mathrm{A}} & /\left(V_{1}\right) \end{array}$ | $\mathbf{V F}_{\mathbf{F}} \cdot \mathbf{F}_{\mathbf{F}}$ <br> (V) $/$ (ma) | aristic <br> ${ }^{1}$ <br> (m) | $\begin{array}{lll} v_{z} & 0 & \mathbf{z} \\ (v) & f(\mathrm{mal}) \end{array}$ | $\left.\right\|_{x} ^{102}$ |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 1N3366 1N3367 1N3368 1N3369 | $\begin{aligned} & \mathrm{s} \\ & \mathrm{~s} \\ & \mathrm{~s} \\ & \mathrm{~s} \end{aligned}$ | $\left.\begin{array}{\|l\|} \mathbf{R E} \\ \mathbf{R E} \\ \mathbf{R E} \\ \mathbf{R E} \end{array} \right\rvert\,$ |  |  |  | 700 800 900 $1 K$ | 3 3 3 3 | $\begin{aligned} & 10 / \\ & 10 / \\ & 10 / \\ & 25 / \end{aligned}$ | $\begin{array}{r} 1.2 \prime \\ 2 / \\ 2 \prime \\ 2.5 / \end{array}$ |  |  |  |
| 1N3370 <br> 1N3371 <br> 1N3372 <br> 1N3373 | $\left\lvert\, \begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}\right.$ | $\left\|\begin{array}{l} \mathrm{RE} \\ \mathrm{RE} \\ \mathrm{RE} \\ \mathrm{RE} \end{array}\right\|$ |  |  |  | $\begin{array}{r} 1.2 \mathrm{~K} \\ 1.5 \mathrm{~K} \\ 10 \\ 25 \end{array}$ | $\begin{array}{r} 3 \\ 3 \\ 20 \\ 20 \end{array}$ | $\begin{array}{r} 25 / \\ 25 / \\ 315 / \\ 315 / \end{array}$ | $\begin{gathered} 2.5 / \\ 2.5 / \\ 1 / \\ 1 / \end{gathered}$ |  |  |  |
| 1N3374 <br> 1N3375 <br> 1N3376 <br> 1N3377 | $\left\lvert\, \begin{aligned} & \mathrm{s} \\ & \mathrm{~s} \\ & \mathrm{~s} \\ & \mathrm{~s} \end{aligned}\right.$ | $\begin{aligned} & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \end{aligned}$ |  |  |  | $\begin{array}{r} 50 \\ 100 \\ 150 \\ 200 \end{array}$ | $\begin{aligned} & 20 \\ & 20 \\ & 20 \\ & 20 \end{aligned}$ | $\begin{aligned} & 315 / \\ & 315 / \\ & 315 / \\ & 315 / \end{aligned}$ | $\begin{aligned} & 1 / \\ & 1 / \\ & 1 / \\ & 1 / \end{aligned}$ |  |  |  |
| $\begin{aligned} & \text { 1N3378 } \\ & \text { 1N3379 } \\ & \text { 1N3380 } \\ & \text { IN3381 } \end{aligned}$ | $\left\lvert\, \begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}\right.$ | $\begin{aligned} & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{SD} \end{aligned}$ |  |  |  | $\begin{array}{r} 300 \\ 400 \\ 500 \\ 15 \end{array}$ | $\begin{aligned} & 20 \\ & 20 \\ & 20 \end{aligned}$ | $\begin{gathered} 315 / \\ 315 / \\ 315 / \\ 10 / \end{gathered}$ | $\begin{aligned} & 1 / \\ & 1 / \\ & 1 / \\ & 1 / 500 \end{aligned}$ |  |  |  |
| $\left\lvert\, \begin{aligned} & \text { 1N3382 } \\ & \text { iN3383 } \\ & \text { iN3384 } \\ & \text { iN3385 } \end{aligned}\right.$ | $\left[\begin{array}{l} s \\ s \\ s \\ s \\ s \end{array}\right.$ | $\begin{aligned} & \text { SD } \\ & \text { SD } \\ & \text { SD } \\ & \text { SD } \end{aligned}$ |  |  |  | $\begin{array}{r} 15 \\ 50 \\ 75 \\ 100 \end{array}$ |  | $\begin{aligned} & 101 \\ & 101 \\ & 101 \\ & 201 \end{aligned}$ | $\begin{aligned} & 1 / 500 \\ & 1 / 500 \\ & 1 / 500 \\ & 1 / 500 \end{aligned}$ |  |  |  |
| 1N3386 1N3387 1N3388 1N3389 | $\left[\begin{array}{l} s \\ s \\ s \\ s \end{array}\right.$ | $\begin{array}{l\|} \hline \text { SD } \\ \text { SD } \\ \text { SD } \\ \text { SD } \end{array}$ |  |  |  | $\begin{aligned} & 150 \\ & 200 \\ & 250 \\ & 300 \end{aligned}$ |  | $\begin{aligned} & 20 / \\ & 20 / \\ & 25 / \\ & 25 / \end{aligned}$ | $\begin{aligned} & 1 / 500 \\ & 1 / 500 \\ & 1 / 500 \\ & 1 / 500 \end{aligned}$ |  |  |  |
| 1N3390 <br> 1N3391 <br> 1 13392 <br> 1 13393 | $\left[\begin{array}{l} s \\ s \\ s \\ s \\ s \end{array}\right.$ | $\left\|\begin{array}{l} \mathrm{SD} \\ \mathrm{SD} \\ \mathrm{zD} \\ \mathrm{zD} \end{array}\right\|$ |  |  | $\begin{aligned} & 500 \\ & 500 \end{aligned}$ | $\begin{aligned} & 400 \\ & 500 \end{aligned}$ |  | $\begin{aligned} & 251 \\ & 25 / \end{aligned}$ | $\begin{aligned} & 1 / 500 \\ & 1 / 500 \end{aligned}$ |  | $\begin{aligned} & 1.5 / 50 \\ & 1.8 / 50 \end{aligned}$ | $\begin{aligned} & 10 \\ & 10 \end{aligned}$ |
| 1N3394 <br> 1N3395 <br> 1N3396 <br> 1N3397 | $\begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}$ |  |  |  | $\begin{aligned} & 500 \\ & 500 \\ & 500 \\ & 500 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 2.2 / 50 \\ & 2.7 / 50 \\ & 3.3 / 30 \\ & 3.9 / 30 \end{aligned}$ | 10 10 10 10 |
| 1N3398 iN3399 1N3400 1N3401 | $\begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}$ | $\left\|\begin{array}{l} \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \end{array}\right\|$ |  |  | $\begin{aligned} & 500 \\ & 500 \\ & 500 \\ & 500 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 4.7 / 30 \\ & 5.6 / 20 \\ & 6.8 / 20 \\ & 8.2 / 10 \end{aligned}$ | 10 <br> 10 <br> 10 <br> 10 |
| 1N3402 <br> 1N3403 <br> 1N3404 <br> 1N3405 | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\left\|\begin{array}{l} \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \end{array}\right\|$ |  |  | $\begin{aligned} & 500 \\ & 500 \\ & 500 \\ & 500 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 10 / 10 \\ & 12 / 10 \\ & 15 / 10 \\ & 18 / 10 \end{aligned}$ | $\begin{aligned} & 10 \\ & 10 \\ & 10 \\ & 10 \end{aligned}$ |


|  |  | $\begin{aligned} & \frac{7}{0} \\ & \frac{3}{6} \\ & \frac{3}{3} \\ & \frac{3}{3} \\ & 3 \end{aligned}$ | 7 <br> remacement | $\begin{aligned} & \text { FOR } \\ & \text { NEW } \\ & \text { DESIGN } \end{aligned}$ | $\begin{gathered} \mathbf{P} \\ (\mathrm{mW}) \end{gathered}$ | $V_{R}$ <br> (V) | I <br> (A) | $\begin{array}{ll} H_{R} & \bullet V_{n} \\ \mu & f(V) \end{array}$ | $\begin{array}{ccc} V_{f} & \mid f \\ \text { (V) } & /(\mathrm{ma}) \end{array}$ | RISTIC <br> $\pi$ <br> (ms) | $\mathbf{V z}_{\mathbf{z}}$ - $\mathbf{z}$ <br> (V) $/$ (mA) |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 1N3406 <br> 1N3407 <br> 1N3468 <br> 1N3409 | $\begin{aligned} & \mathbf{s} \\ & \mathbf{S} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}$ | $\begin{aligned} & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \end{aligned}$ |  |  | 500 500 500 500 |  |  |  |  |  | $\begin{aligned} & 22 / 3 \\ & 27 / 3 \\ & 33 / 3 \\ & 39 / 1.5 \end{aligned}$ | 10 10 10 10 |
| 1N3410 <br> 1N3411 <br> IN3412 <br> 1N3413 | $\begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}$ | $\left\|\begin{array}{l} \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \end{array}\right\|$ |  |  | 500 500 500 500 |  |  |  |  |  | $\begin{aligned} & 47 / 1.5 \\ & 6.2 / 1 \\ & 6.8 / 1 \\ & 7.5 / 1 \end{aligned}$ | $\begin{aligned} & 10 \\ & 10 \\ & 10 \\ & 10 \end{aligned}$ |
| 1N3414 <br> IN3415 <br> iN3416 <br> 1N3417 | $\begin{aligned} & s \\ & s \\ & s \\ & s \\ & s \end{aligned}$ | $\begin{aligned} & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \end{aligned}$ |  |  | $\begin{aligned} & 500 \\ & 500 \\ & 500 \\ & 500 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 8.2 / 1 \\ & 10 / 1 \\ & 12 / 1 \\ & 15 / 1 \end{aligned}$ | $\begin{aligned} & 10 \\ & 10 \\ & 10 \\ & 10 \end{aligned}$ |
| 1N3418 <br> 1N3419 <br> 1N3420 <br> 1N3421 | $\begin{aligned} & \mathbf{s} \\ & s \\ & s \\ & s \end{aligned}$ | $\begin{aligned} & \mathrm{zo} \\ & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \end{aligned}$ |  |  | $\begin{aligned} & 500 \\ & \mathbf{5 0 0} \\ & \mathbf{5 0 0} \\ & \mathbf{5 0 0} \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 18 / 1 \\ & 22 / 1 \\ & 27 / 1 \\ & 30 / 1 \end{aligned}$ | $\begin{aligned} & 10 \\ & 10 \\ & 10 \\ & 10 \end{aligned}$ |
| IN3422 <br> 1N3423 <br> IN3424 <br> 1N3425 | $\begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}$ | $\begin{aligned} & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \end{aligned}$ |  |  | 500 500 500 500 |  |  |  |  |  | $\begin{aligned} & 33 / 1 \\ & 39 / 1 \\ & 47 / 1 \\ & 56 / 1 \end{aligned}$ | $\begin{aligned} & 10 \\ & 10 \\ & 10 \\ & 10 \end{aligned}$ |
| 1N3426 <br> IN3427 <br> 1N3428 <br> IN3429 | $\begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}$ | $\left\|\begin{array}{l} z 0 \\ z 0 \\ z 0 \\ z 0 \end{array}\right\|$ |  |  | $\begin{aligned} & 500 \\ & 500 \\ & 500 \\ & 500 \end{aligned}$ |  | - |  | . |  | $\begin{array}{r} 68 / 1 \\ 82 / 1 \\ 100 / 1 \\ 120 / 1 \end{array}$ | $\begin{aligned} & 10 \\ & 10 \\ & 10 \\ & 10 \end{aligned}$ |
| 1N3430 1N3431 1N3432 1N3433 | $\begin{aligned} & \mathbf{s} \\ & s \\ & s \\ & s \end{aligned}$ | $\begin{aligned} & \mathrm{zD} \\ & \mathrm{zo} \\ & \mathrm{zD} \\ & \mathrm{zD} \end{aligned}$ |  |  | 500 500 500 500 |  |  |  |  |  | $\begin{gathered} 150 / 1 \\ 180 / 1 \\ 220 / 1 \\ 82 / 25 \end{gathered}$ | $\begin{aligned} & 10 \\ & 10 \\ & 10 \\ & 10 \end{aligned}$ |
| 1N3434 1N3435 1N3436 1N3437 | ( | $\left\|\begin{array}{l} \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \end{array}\right\|$ |  |  | 2W 2W 2W 2W |  |  |  |  |  | $\begin{aligned} & 10 / 25 \\ & 12 / 25 \\ & 15 / 25 \\ & 18 / 25 \end{aligned}$ | $\begin{aligned} & 10 \\ & 10 \\ & 10 \\ & 10 \end{aligned}$ |
| 1N3438 <br> iN3439 <br> IN3440 <br> 1N3441 | S | $\left.\begin{aligned} & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \end{aligned} \right\rvert\,$ |  |  | 2W 2W 2W 2W |  |  |  |  |  | $\begin{aligned} & 22 / 7.5 \\ & 27 / 7.5 \\ & 33 / 7.5 \\ & 39 / 7.5 \end{aligned}$ | 10 10 10 10 |
| 1N3442 <br> 1N3433 <br> 1N3444 <br> 1N3445 | $\begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}$ | $\left.\begin{aligned} & \mathrm{ZD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \end{aligned} \right\rvert\,$ |  |  | $\begin{aligned} & \mathbf{2 W} \\ & \mathbf{2 W} \\ & \mathbf{2 W} \\ & \mathbf{2 W} \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 47 / 7.5 \\ & 6.2 / 2 \\ & 6.8 / 2 \\ & 8.2 / 2 \end{aligned}$ | $\begin{aligned} & 10 \\ & 10 \\ & 10 \\ & 10 \end{aligned}$ |

## DIODE INTERCHANGEABILITY

| TYPE NUMBER | 言 |  | II replacement | $\begin{aligned} & \text { FOR } \\ & \text { NEW } \\ & \text { DESIGN } \end{aligned}$ | $\begin{gathered} P_{D} \\ (m W) \end{gathered}$ | atings <br> $\mathbf{V}_{\mathbf{R}}$ <br> (V) | $I_{0}$ (A) | $\begin{array}{ll} I_{R} & V_{R} \\ \mu_{\mathrm{A}} & /(\mathrm{V}) \end{array}$ | $\mathbf{V F}_{\mathbf{F}}$ - $\mathbf{I F}_{\mathbf{F}}$ <br> (V) $/$ (mA) | sistic <br> ${ }^{1}$ <br> ( $n$ ) | $\begin{aligned} & \mathbf{V}_{\mathbf{Z}} \mathbf{I z}^{Y} \\ & \text { (V) } /(\mathrm{mA}) \end{aligned}$ | $\begin{array}{r} \text { rot } \\ \% \end{array}$ |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| $\begin{array}{\|l\|} \hline \text { IN3446 } \\ \text { lN3447 } \\ \text { 1N3448 } \\ \text { 1N3449 } \end{array}$ | $\left\lvert\, \begin{array}{\|l} \hline \mathbf{s} \\ s \\ s \\ s \\ s \end{array}\right.$ | $\begin{aligned} & \mathrm{ZD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \end{aligned}$ |  |  | $\begin{aligned} & 2 w \\ & 2 w \\ & 2 w \\ & 2 w \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 10 / 2 \\ & 12 / 2 \\ & 15 / 2 \\ & 18 / 2 \end{aligned}$ | 10 10 10 10 |
| $\begin{aligned} & \text { 1N3450 } \\ & \text { 1N3451 } \\ & \text { 1N3452 } \\ & \text { 1N3453 } \end{aligned}$ | $\left\lvert\, \begin{aligned} & \mathrm{s} \\ & \mathrm{~s} \\ & \mathrm{~s} \\ & \mathbf{s} \end{aligned}\right.$ | $\left\|\begin{array}{l} \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \end{array}\right\|$ |  |  | $\begin{aligned} & 2 w \\ & 2 w \\ & 2 w \\ & 2 w \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 22 / 2 \\ & 27 / 2 \\ & 30 / 2 \\ & 33 / 2 \end{aligned}$ | 10 <br> 10 <br> 10 <br> 10 |
| $\begin{aligned} & \text { IN3454 } \\ & \text { IN3455 } \\ & \text { IN3456 } \\ & \text { IN3457 } \end{aligned}$ | $\left\lvert\, \begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}\right.$ | $\left\|\begin{array}{l} \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \end{array}\right\|$ |  |  | $2 w$ $2 w$ $2 w$ $2 w$ |  |  |  |  |  | $\begin{aligned} & 39 / 2 \\ & 47 / 2 \\ & 56 / 2 \\ & 68 / 2 \end{aligned}$ | 10 10 10 10 |
| 1N3458 <br> 1N3459 <br> IN3460 <br> 1N3461 | $\begin{array}{\|l} \mathbf{s} \\ \mathbf{s} \\ \mathrm{s} \\ \mathrm{~s} \end{array}$ | $\left\|\begin{array}{l} \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \end{array}\right\|$ |  |  | $\begin{aligned} & 2 w \\ & 2 w \\ & 2 w \\ & 2 w \end{aligned}$ |  |  |  |  |  | $\begin{array}{r} 82 / 2 \\ 100 / 2 \\ 120 / 2 \\ 150 / 2 \end{array}$ | 10 10 10 10 |
| 1N3462 <br> IN3463 <br> IN3464 <br> 1N3465 | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \\ & \mathbf{s} \end{aligned}\right.$ | $\left\|\begin{array}{l} \mathrm{ZD} \\ \mathrm{ZD} \\ \mathrm{RE} \\ \mathrm{SD} \end{array}\right\|$ |  | TID33 | $\begin{aligned} & 2 W \\ & 2 W \end{aligned}$ | $\begin{array}{r} 12 \mathrm{~K} \\ 60 \end{array}$ | . 1 | $\begin{aligned} & .2 / 12 K \\ & 20 / 45 \end{aligned}$ | $\begin{gathered} 24 / 60 \\ 1 / 200 \end{gathered}$ |  | 180/2 | 10 10 |
| 1N3466 <br> 1N3467 <br> 1N3468 <br> 1N3469 |  | $\begin{aligned} & \text { SD } \\ & \text { SD } \\ & \text { SD } \\ & \text { SD } \end{aligned}$ |  | TID33 <br> 1N4446 <br> 1N4446 <br> 1N4608 |  | 40 18 18 35 |  | $\begin{aligned} & 15 / 30 \\ & 15 / 15 \\ & 60 / 15 \\ & 15 / 35 \end{aligned}$ | $\begin{aligned} & 1 / 200 \\ & .5 / 20 \\ & .5 / 20 \\ & 1 / 600 \end{aligned}$ | 2 |  |  |
| 1N3470 <br> 1N3471 <br> 1N3473 <br> 1N3474 | $\left\lvert\, \begin{aligned} & \mathbf{G} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}\right.$ | $\left\|\begin{array}{l} \mathrm{SD} \\ \mathrm{SD} \\ \mathrm{RE} \\ \mathrm{RE} \end{array}\right\|$ |  | IN4608 1N4148 1N4003 1N4004 |  | $\begin{array}{r} 35 \\ 40 \\ 200 \\ 400 \end{array}$ | $\begin{aligned} & .75 \\ & .75 \end{aligned}$ | $\begin{gathered} 30 / 35 \\ 20 \mathrm{~N} / 40 \\ 500 / 200 \\ 500 / 400 \end{gathered}$ | $\begin{gathered} 1 / 800 \\ 1 / 10 \\ 1.4 / 750 \\ 1.4 / 750 \end{gathered}$ | 2 |  |  |
| 1N3475 <br> 1N3476 <br> 1N3477 <br> 1N3477A | $\left\lvert\, \begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}\right.$ | $\left.\begin{aligned} & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \end{aligned} \right\rvert\,$ |  | $\begin{aligned} & \text { 1N4005 } \\ & \text { iN4006 } \end{aligned}$ | $\begin{aligned} & 250 \\ & 250 \end{aligned}$ | $\begin{aligned} & 600 \\ & 800 \end{aligned}$ | .75 .5 | $\begin{aligned} & 500 / 600 \\ & 500 / 800 \end{aligned}$ | $\begin{aligned} & 1.4 / 750 \\ & 1.4 / 500 \end{aligned}$ |  | $\begin{aligned} & 2.2 / 5 \\ & 2.2 / 5 \end{aligned}$ | 10 5 |
| 1N3478 <br> 1N3479 <br> 1N3480 <br> 1N3483 | $\begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{c} \end{aligned}$ | $\left\|\begin{array}{l} \text { sD } \\ \text { sD } \\ \text { SD } \\ \text { SD } \end{array}\right\|$ |  | IN4003 <br> iN4004 <br> 1N4005 <br> iN4305 |  | $\begin{array}{r} 200 \\ 400 \\ 600 \\ 8 \end{array}$ |  | $\begin{aligned} & 10 / 200 \\ & 10 / 400 \\ & 10 / 800 \\ & 30 / 8 \end{aligned}$ | $\begin{aligned} & 1 / 500 \\ & 1 / 500 \\ & 1 / 500 \\ & .6 / 10 \end{aligned}$ |  |  |  |
| 1N3484 <br> 1N3485 <br> 1N3486 <br> 1N3487 | $\begin{aligned} & \mathbf{o} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}$ | $\left\|\begin{array}{l} \mathrm{SD} \\ \mathrm{SD} \\ \mathrm{RE} \\ \mathrm{RE} \end{array}\right\|$ |  | 1N4305 1N4938 1N4007 |  | $\begin{array}{r} 75 \\ 175 \\ 1 \mathrm{~K} \\ 1.2 \mathrm{~K} \end{array}$ | . 4 | $\begin{aligned} & 4 / 10 \\ & 25 \mathrm{~N} / 150 \\ & 50 / 1 \mathrm{~K} \\ & 50 / \end{aligned}$ | $\begin{gathered} .45 / 10 \\ 1 / 10 \\ 2 / 400 \\ 2 / 400 \end{gathered}$ | 50 |  |  |


| TYPEnumber |  | \% | $\underset{\text { Rerlacemant }}{\boldsymbol{\pi}}$ | $\begin{aligned} & \text { FOR } \\ & \text { NEW } \\ & \text { DESICN } \end{aligned}$ | ratings |  |  | Chazactiskistics |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  | $\begin{gathered} P_{D} \\ (\mathrm{~mW}) \end{gathered}$ | $\mathbf{V}_{\mathrm{R}}$ <br> (V) | (A) | $\begin{array}{ll} \mathbf{V}_{\mathrm{R}} & \bullet \mathrm{~V}_{\mathrm{R}} \\ \mu \mathrm{~A} & /(\mathrm{V}) \end{array}$ | $\begin{array}{ccc} \mathbf{v}_{\mathbf{F}} & \mathbf{q} \\ \text { (V) } & 1(\mathrm{~mA}) \end{array}$ | $\begin{gathered} t_{\pi} \\ (n s) \end{gathered}$ | $\begin{array}{llc} \mathbf{v}_{\mathbf{z}} & \bullet & \mathbf{z} \\ \text { (v) } & / \text { (ma) } \end{array}$ | $\begin{aligned} & \text { rot } \\ & \text { \% } \end{aligned}$ |
| 1N3491 <br> 1N3492 <br> 1N3493 <br> 1N3494 | $\begin{aligned} & \mathbf{s} \\ & s \\ & s \\ & s \\ & s \end{aligned}$ | $\left.\begin{aligned} & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \end{aligned} \right\rvert\,$ |  |  |  | $\begin{array}{r} 50 \\ 100 \\ 200 \\ 300 \end{array}$ | $\begin{aligned} & 18 \\ & 18 \\ & 18 \\ & 18 \end{aligned}$ | $\begin{aligned} & 1 \mathrm{M} / \\ & 1 \mathrm{M} / \\ & 1 \mathrm{M} / \\ & 1 \mathrm{M} / \end{aligned}$ | $\begin{aligned} & 1.71 \\ & 1.71 \\ & 1.71 \\ & 1.71 \end{aligned}$ |  |  |  |
| 1N3495 <br> 1N3496 <br> 1N3497 <br> 1N3498 | $\begin{aligned} & \mathrm{s} \\ & \mathbf{s} \\ & \mathrm{~s} \\ & \mathrm{~s} \end{aligned}$ | $\begin{array}{l\|} \mathbf{R E} \\ R D \\ R D \\ R D \\ R D \end{array}$ |  |  | $\begin{aligned} & 250 \\ & 250 \\ & 250 \end{aligned}$ | 400 | 18 | 1M/ | 1.71 |  | $\begin{aligned} & 6.2 / 7.5 \\ & 6.2 / 7.5 \\ & 6.2 / 7.5 \end{aligned}$ |  |
| 1N3499 <br> 1N3500 <br> IN3501 <br> 1N3502 | $\begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}$ | $\left\|\begin{array}{l} R D \\ R D \\ R D \\ R D \end{array}\right\|$ |  |  | $\begin{aligned} & 250 \\ & 250 \\ & 250 \\ & 250 \end{aligned}$ |  |  |  |  |  | $\begin{array}{r} 6.2 / 7.5 \\ 6.2 / 7.5 \\ 6.35 / 7.5 \\ 6.35 / 7.5 \end{array}$ |  |
| IN3503 IN3504 IN3504A 1N3506 | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\left\|\begin{array}{l} R D \\ R D \\ R D \\ \mathrm{RD} \end{array}\right\|$ | 1N3506 |  | $\begin{aligned} & 250 \\ & 250 \\ & 250 \\ & 400 \end{aligned}$ |  |  |  |  |  | $\begin{gathered} 6.35 / 7.5 \\ 6.35 / 7.5 \\ 6.35 / 7.5 \\ 3.3 / 20 \end{gathered}$ | 5 |
| iN3507 1 N3508 iN3509 iN3510 | $\begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}$ | $\left\|\begin{array}{l} \mathrm{zD} \\ \mathrm{ZD} \\ \mathrm{zD} \\ \mathrm{zD} \end{array}\right\|$ | iN3507 <br> 1N3508 <br> iN3509 <br> IN3510 |  | $\begin{aligned} & 400 \\ & 400 \\ & 400 \\ & 400 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 3.6 / 20 \\ & 3.9 / 20 \\ & 4.3 / 20 \\ & 4.7 / 20 \end{aligned}$ | 5 5 5 5 |
| 1N3511 <br> IN3512 <br> IN3513 <br> iN3514 | $\begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}$ | $\left\|\begin{array}{l} \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{ZD} \end{array}\right\|$ | 1N3511 <br> 1N3512 <br> in3513 <br> 1N3514 |  | $\begin{aligned} & 400 \\ & 400 \\ & 400 \\ & 400 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 5.1 / 20 \\ & 5.6 / 20 \\ & 6.2 / 20 \\ & 6.8 / 20 \end{aligned}$ | 5 5 5 5 |
| 1 N3515 <br> IN3516 <br> IN3517 <br> IN3518 | $\begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}$ | $\left\|\begin{array}{l} \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \end{array}\right\|$ | 1N3515 <br> 1N3516 <br> 1N3517 <br> 1N3518 |  | $\begin{aligned} & 400 \\ & 400 \\ & 400 \\ & 400 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 7.5 / 10 \\ & 8.2 / 10 \\ & 9.1 / 10 \\ & 10 / 10 \end{aligned}$ | 5 5 5 5 |
| IN3519 <br> IN3520 <br> IN3521 <br> IN3522 | $\begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}$ | $\left\|\begin{array}{l} \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \end{array}\right\|$ | IN3519 <br> IN3520 <br> IN3521 <br> iN3522 |  | $\begin{aligned} & 400 \\ & 400 \\ & 400 \\ & 400 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 11 / 10 \\ & 12 / 10 \\ & 13 / 10 \\ & 15 / 5 \end{aligned}$ | 5 5 5 5 |
| $\begin{aligned} & \text { IN3523 } \\ & \text { 1N3524 } \\ & \text { IN3525 } \\ & \text { IN3526 } \end{aligned}$ | $\begin{array}{\|l} \hline s \\ s \\ s \\ s \end{array}$ | $\left\|\begin{array}{l} \mathrm{ZD} \\ \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \end{array}\right\|$ | $\begin{aligned} & \text { 1N3523 } \\ & \text { 1N3524 } \\ & \text { 1N3525 } \\ & \text { iN3526 } \end{aligned}$ |  | $\begin{aligned} & 400 \\ & 400 \\ & 400 \\ & 400 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 16 / 5 \\ & 18 / 5 \\ & 20 / 5 \\ & 22 / 5 \end{aligned}$ | 5 5 5 5 |
| IN3527 1N3528 iN3529 iN3530 | $\begin{aligned} & \mathrm{s} \\ & \mathrm{~s} \\ & \mathrm{~s} \\ & \mathrm{~s} \end{aligned}$ | $\left\|\begin{array}{l} \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \end{array}\right\|$ | $\begin{aligned} & \text { 1N3527 } \\ & \text { 1N3528 } \\ & \text { IN3529 } \\ & \text { IN3530 } \end{aligned}$ |  | $\begin{aligned} & 400 \\ & 400 \\ & 400 \\ & 400 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 24 / 5 \\ & 27 / 4 \\ & 30 / 4 \\ & 33 / 3 \end{aligned}$ | 5 5 5 5 |

## DIODE INTERCHANGEABILITY

| TYPE NUMBER |  |  | TI REPLACEMENT | $\begin{aligned} & \text { FOR } \\ & \text { NEW } \\ & \text { DESIGN } \end{aligned}$ | $\begin{aligned} & P_{D} \\ & (\mathrm{~mW}) \end{aligned}$ | TINGS <br> $\mathbf{V}_{\mathbf{R}}$ <br> (V) |  | $\begin{array}{ll} \mathbf{I}_{\mathbf{R}} & \mathbf{V}_{\mathbf{R}} \\ \mu \mathbf{A} & /(\mathrm{V}) \end{array}$ | $\mathbf{V F}_{\mathrm{F}}$ - $\mathrm{I}_{\mathrm{F}}$ <br> (V) $/$ (mA) |  | $\mathbf{V Z}_{\mathbf{Z}} \quad \mathbf{z}$ <br> (V) $/$ (mA) | $\begin{gathered} \text { TOL } \\ \% \end{gathered}$ |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 1N3531 <br> 1N3532 <br> 1N3533 <br> 1N3534 | $\begin{aligned} & \mathrm{s} \\ & \mathrm{~s} \\ & \mathrm{~s} \\ & \mathrm{~s} \end{aligned}$ | $\begin{aligned} & \mathrm{ZD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \end{aligned}$ |  |  | $\begin{aligned} & 400 \\ & 400 \\ & 400 \\ & 400 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 36 / 3 \\ & 39 / 3 \\ & 43 / 2 \\ & 47 / 2 \end{aligned}$ | 5 5 5 5 |
| $\begin{aligned} & \text { IN3535 } \\ & \text { IN3536 } \\ & \text { iN3537 } \\ & \text { iN3538 } \end{aligned}$ | $\begin{aligned} & \mathbf{s} \\ & \mathbf{S} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}$ | $\begin{aligned} & \mathrm{SD} \\ & \mathrm{SD} \\ & \mathrm{ZD} \\ & \mathrm{SD} \end{aligned}$ |  |  | IW | $\begin{array}{r} 200 \\ 70 \\ 150 \end{array}$ |  | $\begin{gathered} 1 / 150 \\ 25 \mathrm{~N} / 60 \\ 2 / 150 \end{gathered}$ | $\begin{aligned} & .55 / 1 \\ & .62 / 1 \\ & 2.3 / 2.5 \end{aligned}$ |  | 12/25 | 10 |
| IN3544 <br> 1N3545 <br> 1N3546 <br> 1N3547 | $\begin{aligned} & \mathrm{s} \\ & \mathrm{~s} \\ & \mathrm{~s} \\ & \mathrm{~s} \end{aligned}$ | RE <br> RE <br> RE <br> RE |  | 1N4002 1N4003 1 N4004 IN4004 |  | $\begin{aligned} & 100 \\ & 200 \\ & 300 \\ & 400 \end{aligned}$ | $\begin{aligned} & .6 \\ & .6 \\ & .6 \\ & .6 \end{aligned}$ | $\begin{aligned} & .2 / 100 \\ & .2 / 200 \\ & .2 / 300 \\ & .2 / 400 \end{aligned}$ | $\begin{aligned} & 1.5 / 500 \\ & 1.5 / 500 \\ & 1.5 / 500 \\ & 1.5 / 500 \end{aligned}$ |  |  |  |
| 1N3548 <br> 1N3549 <br> 1N3550 <br> 1N3553 | $\begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}$ | $\begin{aligned} & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{SD} \\ & \mathrm{RD} \end{aligned}$ |  |  | 250 | $\begin{aligned} & 500 \\ & 600 \\ & 180 \end{aligned}$ | $.6$ | $\begin{array}{r} .2 / 500 \\ .2 / 600 \\ 200 / 180 \end{array}$ | 1.5/500 <br> 1.5/500 <br> 1/50 | 10 | 6.3/7.5 | 3 |
| 1N3558 1N3559 1N3563 1N3564 | $\begin{aligned} & \mathbf{S} \\ & \mathbf{G} \\ & \mathbf{S} \\ & \mathbf{G} \end{aligned}$ | $\begin{aligned} & \mathrm{ZD} \\ & \mathrm{SD} \\ & \mathrm{RE} \\ & \mathrm{SD} \end{aligned}$ |  | IN751A <br> 1N4007 1N4448 |  | 24 1 K 15 | . 4 |  | $\begin{gathered} 1 / 200 \\ 1.2 / 400 \\ 1 / 40 \end{gathered}$ |  | 10.3/15 | 3 |
| 1N3565 <br> 1N3566 <br> 1N3567 <br> 1N3568 | $\begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}$ | $\begin{aligned} & \text { SD } \\ & R E \\ & S D \\ & S D \end{aligned}$ |  | $\begin{aligned} & \text { 1N4448 } \\ & \text { 1N4449 } \end{aligned}$ |  | 6 800 75 80 | 1 | $\begin{aligned} & 25 M / \\ & 500 / \\ & .05 / 50 \\ & 1 / 50 \end{aligned}$ | $\begin{gathered} 2 / 2 A \\ 2.2 / 1 \\ 1 / 100 \\ 1 / 20 \end{gathered}$ | 2 |  |  |
| $\begin{aligned} & \text { 1N3569 } \\ & \text { 1N3570 } \\ & \text { 1N3571 } \\ & \text { 1N3572 } \end{aligned}$ | $\begin{aligned} & \mathbf{S} \\ & \mathbf{S} \\ & \mathbf{S} \\ & \mathbf{S} \end{aligned}$ | RE <br> RE <br> RE <br> RE | . |  |  | $\begin{aligned} & 100 \\ & 200 \\ & 300 \\ & 400 \end{aligned}$ | $\begin{aligned} & 3.5 \\ & 3.5 \\ & 3.5 \\ & 3.5 \end{aligned}$ | $\begin{aligned} & 400 / \\ & 400 / \\ & 400 / \\ & 400 / \end{aligned}$ | $\begin{aligned} & 1.3 / \\ & 1.3 / \\ & 1.3 / \\ & 1.3 / \end{aligned}$ |  |  |  |
| 1N3573 1N3574 1N3575 1N3576 | $\begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}$ | $\begin{aligned} & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{SD} \\ & \mathrm{SD} \end{aligned}$ |  | $\begin{array}{\|l\|l\|} \text { IN483 } \\ \text { IN484 } \end{array}$ |  | $\begin{array}{r} 500 \\ 600 \\ 60 \\ 125 \end{array}$ | $\begin{aligned} & 3.5 \\ & 3.5 \end{aligned}$ | $\begin{aligned} & 400 / \\ & 400 / \\ & .7 \mathrm{~N} / 50 \\ & .7 \mathrm{~N} / 125 \end{aligned}$ | $\begin{aligned} & 1.3 / \\ & 1.3 / \\ & .74 / 1 \\ & .74 / 1 \end{aligned}$ |  |  |  |
| 1N3575 <br> 1N3578 <br> 1N3579 <br> 1N3580 | $\begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}$ | $\begin{aligned} & \text { SD } \\ & \text { SD } \\ & \text { SD } \\ & \text { RD } \end{aligned}$ |  |  | 750 | $\begin{aligned} & 175 \\ & 225 \\ & 275 \end{aligned}$ |  | $\begin{aligned} & .7 N / 175 \\ & .7 N / 225 \\ & .7 N / 275 \end{aligned}$ | $\begin{aligned} & .74 / 1 \\ & .74 / 1 \\ & .74 / 1 \end{aligned}$ |  | 11.7/7.5 |  |
| 1N3580A <br> 1N35808 <br> 1N3581 <br> 1N3581A | $\begin{aligned} & \mathbf{s} \\ & \mathbf{S} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}$ | $\begin{aligned} & R D \\ & R D \\ & R D \\ & R D \\ & R D \end{aligned}$ |  |  | $\begin{aligned} & 750 \\ & 750 \\ & 750 \\ & 750 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 11.7 / 7.5 \\ & 11.7 / 7.5 \\ & 11.7 / 7.5 \\ & 11.7 / 7.5 \end{aligned}$ |  |

## DIODE INTERCHANGEABILITY

| TYPE NUMBER |  |  | Tinticement | $\begin{aligned} & \text { FOR } \\ & \text { NEW } \\ & \text { DESICN } \end{aligned}$ | $\begin{gathered} P_{\mathrm{D}} \\ (\mathrm{mw}) \end{gathered}$ | $\begin{aligned} & \text { nNGS } \\ & \mathbf{v}_{\mathbf{R}} \\ & \text { (v) } \end{aligned}$ | (A) | $\begin{array}{ll} L_{R} & \bullet V_{\mathbf{R}} \\ \mu_{\mathrm{A}} & /(\mathrm{V}) \end{array}$ | $\begin{array}{cc}  & \text { CHARACTE } \\ \mathbf{v}_{\mathbf{F}} & \bullet \mathbf{l} \\ \text { (v) } & / \text { (mA) } \end{array}$ | vistics <br> ${ }^{1} \mathrm{~m}$ <br> (ns) | $\begin{array}{lll} \mathbf{v}_{\mathbf{z}} & \bullet & \mathbf{z} \\ \text { (v) } & /(\mathrm{ma}) \end{array}$ | $\begin{gathered} 701 \\ \% \end{gathered}$ |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 1N35818 <br> 1N3582 <br> 1N3582A <br> 1N3582B | s | $\left.\begin{array}{l\|} \mathbf{R D} \\ R D \\ R D \\ R D \end{array} \right\rvert\,$ |  |  | $\begin{aligned} & 750 \\ & 750 \\ & 750 \\ & 750 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 11.7 / 7.5 \\ & 11.7 / 7.5 \\ & 11.7 / 7.5 \\ & 11.7 / 7.5 \end{aligned}$ |  |
| 1N3583 <br> 1N3583A <br> 1N35838 <br> 1N3584 | $\begin{aligned} & \mathrm{s} \\ & \mathrm{~s} \\ & \mathrm{~s} \\ & \mathrm{~s} \end{aligned}$ | $\left.\begin{array}{\|l\|} \mathrm{RD} \\ \mathrm{RD} \\ \mathrm{RD} \\ \mathrm{RD} \end{array} \right\rvert\,$ |  |  | $\begin{aligned} & 750 \\ & 750 \\ & 750 \\ & 750 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 11.7 / 7.5 \\ & 11.7 / 7.5 \\ & 11.7 / 7.5 \\ & 11.7 / 7.5 \end{aligned}$ |  |
| 1N3584A <br> IN3584B <br> 1N3585 <br> 1N3586 | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\left\|\begin{array}{l} R D \\ R D \\ R E \\ R E \end{array}\right\|$ |  |  | $\begin{aligned} & 750 \\ & 750 \end{aligned}$ | $\begin{array}{r} 50 \\ 100 \end{array}$ | $\begin{aligned} & 400 \\ & 400 \end{aligned}$ | $\begin{aligned} & 25 \mathrm{M} / \\ & 25 \mathrm{M} / \end{aligned}$ | $\begin{aligned} & 1.2 / \\ & 1.2 / \end{aligned}$ |  | $\begin{aligned} & 11.7 / 7.5 \\ & 11.7 / 7.5 \end{aligned}$ |  |
| $\begin{array}{\|l} \text { 1N3587 } \\ \text { 1N3588 } \\ \text { 1N3589 } \\ \text { 1N3590 } \end{array}$ | $\begin{aligned} & \mathrm{s} \\ & \mathrm{~s} \\ & \mathrm{~s} \\ & \mathrm{~s} \end{aligned}$ | $\left\|\begin{array}{l} \mathrm{RE} \\ \mathrm{RE} \\ \mathrm{RE} \\ \mathrm{RE} \end{array}\right\|$ |  |  |  | $\begin{aligned} & 200 \\ & 300 \\ & 400 \\ & 500 \end{aligned}$ | $\begin{aligned} & 400 \\ & 400 \\ & 400 \\ & 400 \end{aligned}$ | $\begin{aligned} & 25 \mathrm{M} / \\ & 25 \mathrm{M} / \\ & 25 \mathrm{M} / \\ & 25 \mathrm{M} / \end{aligned}$ | $\begin{aligned} & 1.21 \\ & 1.2 / \\ & 1.21 \\ & 1.2 / \end{aligned}$ |  |  |  |
| 1N3591 <br> 1N3592 <br> 1N3593 <br> IN3594 | $\begin{aligned} & \mathrm{s} \\ & \mathrm{G} \\ & \mathrm{~s} \\ & \mathrm{~s} \end{aligned}$ | $\left\|\begin{array}{l} R E \\ \mathrm{SD} \\ \mathrm{SD} \\ \mathrm{SD} \end{array}\right\|$ |  | 1N4305 1N4531 iN4532 |  | 600 30 40 60 | 400 | 25M/ $\begin{array}{r} 4 / 20 \\ 25 N / 40 \\ .1 / 50 \end{array}$ | $\begin{aligned} & 1.2 / \\ & .35 / 2 \\ & 1 / 10 \\ & 1 / 50 \end{aligned}$ | $\begin{array}{r} 70 \\ 6 \end{array}$ |  |  |
| 1N3595 <br> 1N3596 <br> 1N3597 <br> 1N3598 | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\left\|\begin{array}{l} S D \\ S D \\ S D \\ S D \end{array}\right\|$ |  | IN485 1N4449 1N4938 1N4152 |  | $\begin{array}{r} 125 \\ 20 \\ 150 \\ 75 \end{array}$ |  | $\begin{gathered} 1 N / 125 \\ .1 / 20 \\ .1 / 150 \\ .1 / 50 \end{gathered}$ | $\begin{aligned} & 1 / 200 \\ & 1 / 30 \\ & 1.2 / 400 \\ & .85 / 10 \end{aligned}$ | 4 300 4 |  |  |
| 1N3599 1N3600 1N3601 1N3602 | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\begin{aligned} & \left\|\begin{array}{l} \text { SD } \\ \text { SD } \\ \text { SD } \\ \text { SD } \end{array}\right\| \end{aligned}$ |  | 1N4938 <br> 1N4150 <br> 1N4149 <br> 1N4151 |  | 200 50 100 75 |  | $\begin{aligned} & .1 / 150 \\ & .1 / 50 \\ & .1 / 75 \\ & .1 / 50 \end{aligned}$ | $1 / 100$ $1 / 200$ $1 / 10$ $1 / 20$ | 50 4 5 5 |  |  |
| 1N3603 IN3604 in3605 1N3606 | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\left\|\begin{array}{l} \text { SD } \\ \text { SD } \\ \text { SD } \\ \text { SD } \end{array}\right\|$ |  | 1N4151 <br> 1N4151 <br> 1N4152 <br> 1N4153 |  | 50 75 40 75 |  | $\begin{array}{r} .1 / 30 \\ .05 / 50 \\ .05 / 30 \\ .05 / 50 \end{array}$ | $1 / 30$ $1 / 50$ $.55 / .1$ $.55 / 1$ | 5 4 4 4 |  |  |
| 1N3607 <br> 1N3608 <br> IN3609 <br> IN3611 | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\left\|\begin{array}{l} \mathrm{SD} \\ \mathrm{SD} \\ \mathrm{SD} \\ \mathrm{SD} \end{array}\right\|$ |  | 1N4151 <br> 1N4152 <br> 1N4153 |  | 75 40 75 200 | 2 | $\begin{aligned} & .05 / 50 \\ & .05 / 30 \\ & .05 / 50 \\ & 10 / \end{aligned}$ | $\begin{gathered} 1 / 50 \\ .55 / .1 \\ .55 / .1 \\ 1 / 750 \end{gathered}$ | 4 4 4 |  |  |
| 1N3612 <br> 1N3613 <br> 1N3614 <br> IN3625 | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\left.\begin{aligned} & \text { SD } \\ & \text { SD } \\ & \text { SD } \\ & \text { SD } \end{aligned} \right\rvert\,$ |  | 1N4938 |  | $\begin{aligned} & 400 \\ & 600 \\ & 800 \\ & 225 \end{aligned}$ | 2 2 2 | $\begin{aligned} & 10 / \\ & 10 / \\ & 10 / \\ & .5 / 200 \end{aligned}$ | $\begin{aligned} & 1 / 750 \\ & 1 / 750 \\ & 1 / 750 \\ & 1 / 40 \end{aligned}$ | 500 |  |  |


| TYPE NUMBER | $\frac{\overrightarrow{3}}{\frac{1}{2}}$ | $\begin{aligned} & \frac{8}{2} \\ & \frac{2}{8} \\ & 8 \\ & 8 \\ & 8 \\ & 8 \end{aligned}$ | II | FOR <br> NEW <br> DESICN | Ratines |  |  | CHARACTERISTICS |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  | $\begin{gathered} P_{D} \\ (\mathrm{~mW}) \end{gathered}$ | $\mathbf{V}_{\mathbf{R}}$ (V) | I <br> (A) | $\begin{array}{ll} \mathbf{L}_{\mathbf{R}} & \bullet \mathbf{V}_{\mathbf{R}} \\ \mu_{\mathbf{A}} & /(\mathbf{V}) \end{array}$ | $V_{F} \cdot \boldsymbol{F}$ <br> (V) $/(\mathrm{mA})$ | $\begin{aligned} & \text { in } \\ & \text { (ns) } \end{aligned}$ | $\begin{array}{llc} \mathbf{V}_{\mathbf{Z}} & 0 & \mathbf{l} \mathbf{l} \\ & & \vdots \\ (\mathbf{V}) & / & (\mathrm{mA}) \end{array}$ | rol |
| 1N3626 <br> 1N3629 <br> IN3630 <br> 1N3631 | $\begin{aligned} & G \\ & \mathbf{S} \\ & \mathbf{S} \\ & \mathbf{S} \end{aligned}$ | SD <br> RE <br> RE <br> RE |  | $\begin{aligned} & 1 \mathrm{~N} 4002 \\ & \text { 1N4003 } \\ & \text { 1N4004 } \end{aligned}$ |  | 50 100 200 300 | $\begin{aligned} & .75 \\ & .75 \\ & .75 \end{aligned}$ | $\begin{aligned} & \hline 1 M / \\ & 10 / 70 \\ & 10 / 140 \\ & 10 / 210 \end{aligned}$ | $\begin{aligned} & .5 / 10 \\ & 1 / 750 \\ & 1 / 750 \\ & 1 / 750 \end{aligned}$ |  |  |  |
| IN3632 <br> IN3633 <br> 1N3634 <br> IN3635 | $\begin{aligned} & \mathrm{s} \\ & \mathrm{~S} \\ & \mathrm{~s} \\ & \mathrm{~s} \end{aligned}$ | $\begin{aligned} & R E \\ & R E \\ & R E \\ & R E \end{aligned}$ |  | 1N4004 IN4005 iN4005 IN4006 |  | 400 <br> 500 <br> 600 <br> 700 | $\begin{aligned} & .75 \\ & .75 \\ & .75 \\ & .75 \end{aligned}$ | $\begin{aligned} & 10 / 280 \\ & 10 / 350 \\ & 10 / 420 \\ & 10 / 490 \end{aligned}$ | $\begin{aligned} & 1 / 750 \\ & 1 / 750 \\ & 1 / 750 \\ & 1 / 750 \end{aligned}$ |  |  |  |
| 1N3636 1N3637 <br> 1N3638 <br> 1N3639 | $\begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}$ | $\begin{aligned} & R E \\ & R E \\ & R E \\ & R E \end{aligned}$ |  | 1N4006 <br> 1 N4007 <br> 1N4007 <br> 1N4003 |  | 800 <br> 900 <br> 1K <br> 200 | $\begin{aligned} & .75 \\ & .75 \\ & .75 \\ & .75 \end{aligned}$ | $\begin{array}{r} 10 / 560 \\ 10 / 630 \\ 10 / 700 \\ 200 / 200 \end{array}$ | $\begin{array}{r} 1 / 750 \\ 1 / 750 \\ 1 / 750 \\ 1.2 / 750 \end{array}$ |  |  |  |
| 1N3640 <br> 1N3641 <br> 1N3642 <br> iN3643 | S | $\begin{aligned} & \mathrm{RE} \\ & \mathbf{R E} \\ & R E \\ & R \mathrm{SO} \\ & \hline \end{aligned}$ |  |  |  | $\begin{array}{r} 400 \\ 600 \\ 800 \\ 1 K \end{array}$ | $\begin{aligned} & .75 \\ & .75 \\ & .75 \end{aligned}$ | $\begin{gathered} 200 / 400 \\ 200 / 600 \\ 200 / 800 \\ 5 / \end{gathered}$ | $\begin{array}{r} 1.2 / 750 \\ 1.2 / 750 \\ 1.2 / 750 \\ 5 / 250 \end{array}$ |  | : |  |
| 1N3644 <br> 1N3645 <br> 1N3646 <br> 1N3647 | $\begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}$ | $\begin{array}{\|l\|} \hline \text { SD } \\ \text { SD } \\ \text { SD } \\ \text { SD } \end{array}$ |  |  |  | $\begin{array}{r} 1.5 K \\ 1 K \\ 2.5 K \\ 3 K \end{array}$ |  | $\begin{aligned} & 5 / \\ & 5 / \\ & 5 / \\ & 5 / \end{aligned}$ | $\begin{aligned} & 5 / 250 \\ & 5 / 250 \\ & 5 / 250 \\ & 5 / 250 \end{aligned}$ |  |  |  |
| 1N3648 1N3649 <br> 1N3650 <br> 1N3653 | S | $\begin{aligned} & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{SD} \end{aligned}$ |  |  |  | 10 K 800 1 K 100 | $\begin{array}{r} .35 \\ 1 \\ 1 \end{array}$ | $\begin{gathered} 500 / \\ 5 / \\ 5 / \\ 25 N / 75 \end{gathered}$ | $\begin{aligned} & 23 / \\ & 1.1 / 1 \\ & 1.1 / 1 \\ & 1 / 400 \end{aligned}$ | 4 |  |  |
| 1N3654 1N3656 1N3657 1N3658 | $\begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}$ | $\begin{aligned} & \text { SD } \\ & \text { SD } \\ & S D \\ & S D \end{aligned}$ |  | IN4003 IN4004 IN4005 |  | 100 200 400 600 | 1 .1 1 | $\begin{aligned} & 25 N / 75 \\ & 10 / 200 \\ & 10 / 400 \\ & 10 / 600 \end{aligned}$ | $\begin{gathered} 1 / 50 \\ 1.2 / 500 \\ 1.2 / 500 \\ 1.2 / 500 \end{gathered}$ | 4 |  |  |
| 1N3666 <br> 1N3666M <br> 1N3667 <br> 1N3668 | $\begin{aligned} & G \\ & G \\ & S \\ & S \end{aligned}$ | $\begin{aligned} & \text { SD } \\ & \text { SD } \\ & R E \\ & S D \end{aligned}$ |  | 1N4305 iN4607 <br> IN4305 |  | 80 80 500 30 | 1.5 | $\begin{gathered} 10 / 20 \\ 150 / 20 \\ 1 \mathrm{M} / \\ .1 / 15 \end{gathered}$ | $\begin{aligned} & .4 / 5 \\ & 1 / 200 \\ & 1.2 / \\ & 1 / 5 \end{aligned}$ | $\begin{aligned} & 300 \\ & 150 \end{aligned}$ |  |  |
| IN3669 <br> IN3675 <br> IN3675A <br> IN3675B | $\begin{aligned} & 5 \\ & 5 \\ & 5 \\ & 5 \end{aligned}$ | $\begin{aligned} & \mathrm{sD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \end{aligned}$ |  | 1N4607 <br> 1N4736 <br> 1N4736 <br> 1N4736A | $\begin{aligned} & 750 \\ & 750 \\ & 750 \end{aligned}$ | 70 | .4 | .25/ | 1.1/400 | 200 | 6.8/19 6.8/19 6.8/19 | $\begin{array}{r} 20 \\ 10 \\ 5 \end{array}$ |
| 1N3676 <br> 1N3676A <br> 1N36768 <br> 1N3677 | $\begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}$ | $\left\|\begin{array}{l} \mathrm{ZD} \\ \mathrm{ZD} \\ \mathrm{ZD} \\ \mathrm{ZD} \end{array}\right\|$ |  | 1N4737 <br> 1N4737 <br> 1N4737A <br> 1N4738 | $\begin{aligned} & 750 \\ & 750 \\ & 750 \\ & 750 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 7.5 / 17 \\ & 7.5 / 17 \\ & 7.5 / 17 \\ & 8.2 / 15 \end{aligned}$ | $\begin{array}{r} 20 \\ 10 \\ 5 \\ 20 \end{array}$ |


| TY险 NUMEER | $\begin{aligned} & \frac{3}{2} \\ & \frac{\text { N }}{2} \\ & 3 \end{aligned}$ | $\begin{aligned} & \frac{8}{6} \\ & \frac{8}{2} \\ & \frac{3}{7} \\ & \frac{3}{3} \end{aligned}$ | TI | $\begin{aligned} & \text { FOR } \\ & \text { NEW } \\ & \text { DESIGN } \end{aligned}$ | Ratines |  |  | CHARACTERISTICS |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  | $\begin{gathered} P_{\mathbf{D}} \\ (\mathrm{mW}) \end{gathered}$ | $\mathbf{V}_{\mathbf{R}}$ <br> (V) | I <br> (A) | $\begin{array}{ll} \mathbf{I}_{\mathbf{R}} & \mathbf{V}_{\mathbf{R}} \\ \mu_{\mathrm{A}} & /(\mathbf{V}) \end{array}$ | $\begin{array}{ll} V_{F} & I_{F} \\ (V) & /(\mathrm{mA}) \end{array}$ | $t_{r r}$ <br> (ns) | $\begin{array}{llc} V_{Z} & \mathrm{Z} \\ (\mathrm{~V}) & /(\mathrm{mA}) \end{array}$ | $\begin{aligned} & \text { TOL } \\ & \% \end{aligned}$ |
| $\begin{aligned} & \text { 1N3677A } \\ & \text { 1N3677B } \\ & \text { 1N3678 } \\ & \text { 1N3678A } \end{aligned}$ | $\begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}$ | $\begin{aligned} & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \end{aligned}$ |  | IN4738 <br> 1N4738A <br> 1N4739 <br> 1N4739 | $\begin{aligned} & 750 \\ & 750 \\ & 750 \\ & 750 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 8.2 / 15 \\ & 8.2 / 15 \\ & 9.1 / 14 \\ & 9.1 / 14 \end{aligned}$ | $\begin{array}{r} 10 \\ 5 \\ 20 \\ 10 \end{array}$ |
| $\begin{aligned} & \text { 1N36788 } \\ & \text { 1N3679 } \\ & \text { 1N3679A } \\ & \text { iN3679B } \end{aligned}$ | $\begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}$ | $\left\|\begin{array}{l} \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \end{array}\right\|$ |  | 1N4739A <br> 1N4740 <br> 1N4740 <br> IN4740A | $\begin{aligned} & 750 \\ & 750 \\ & 750 \\ & 750 \end{aligned}$ |  |  |  |  |  | $\begin{gathered} 9.1 / 14 \\ 10 / 13 \\ 10 / 13 \\ 10 / 13 \end{gathered}$ | $\begin{array}{r} 5 \\ 20 \\ 10 \\ 5 \end{array}$ |
| $\begin{aligned} & \text { 1N3680 } \\ & \text { 1 N3680A } \\ & \text { IN36808 } \\ & \text { 1N3681 } \end{aligned}$ | $\left\lvert\, \begin{aligned} & \mathbf{s} \\ & \mathbf{S} \\ & \mathbf{S} \\ & \mathbf{s} \end{aligned}\right.$ | $\left\|\begin{array}{l} \mathrm{ZD} \\ \mathrm{ZD} \\ \mathrm{ZD} \\ \mathrm{ZD} \end{array}\right\|$ |  | IN4741 <br> 1N4741 <br> 1N4741A <br> 1N4742 | $\begin{aligned} & 750 \\ & 750 \\ & 750 \\ & 750 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 11 / 12 \\ & 11 / 12 \\ & 11 / 12 \\ & 12 / 11 \end{aligned}$ | $\begin{array}{r} 20 \\ 10 \\ 5 \\ 20 \end{array}$ |
| $\begin{aligned} & \text { 1N3681A } \\ & \text { 1N3681B } \\ & \text { 1N3682 } \\ & \text { 1N3682A } \end{aligned}$ | $\begin{aligned} & \mathbf{S} \\ & \mathbf{S} \\ & \mathbf{S} \\ & \mathbf{s} \end{aligned}$ | $\begin{aligned} & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \end{aligned}$ |  | 1N4742 <br> 1N4742A <br> 1N4743 <br> 1N4743 | $\begin{aligned} & 750 \\ & 750 \\ & 750 \\ & 750 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 12 / 11 \\ & 12 / 11 \\ & 13 / 9.5 \\ & 13 / 9.5 \end{aligned}$ | $\begin{array}{r} 10 \\ 5 \\ 20 \\ 10 \end{array}$ |
| $\begin{aligned} & \text { IN3682B } \\ & \text { IN3683 } \\ & \text { IN3683A } \\ & \text { 1N3683B } \end{aligned}$ | $\left\lvert\, \begin{aligned} & 5 \\ & 5 \\ & 5 \\ & 5 \end{aligned}\right.$ | $\left\|\begin{array}{l} \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \end{array}\right\|$ |  | IN4743A <br> 1N4744 <br> 1N4744 <br> 1N4744A | $\begin{aligned} & 750 \\ & 750 \\ & 750 \\ & 750 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 13 / 9.5 \\ & 15 / 8.5 \\ & 15 / 8.5 \\ & 15 / 8.5 \end{aligned}$ | $\begin{array}{r} 5 \\ 20 \\ 10 \\ 5 \end{array}$ |
| $\begin{aligned} & \text { 1N3684 } \\ & \text { 1N3684A } \\ & \text { 1N3684B } \\ & \text { 1N3685 } \end{aligned}$ | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\left\lvert\, \begin{aligned} & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \end{aligned}\right.$ |  | $\begin{aligned} & \text { 1N4745 } \\ & 1 N 4745 \\ & \text { 1N4745A } \\ & \text { 1N4746 } \end{aligned}$ | $\begin{aligned} & 750 \\ & 750 \\ & 750 \\ & 750 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 16 / 7.8 \\ & 16 / 7.8 \\ & 16 / 7.8 \\ & 18 / 7 \end{aligned}$ | $\begin{array}{r} 20 \\ 10 \\ 5 \\ 20 \end{array}$ |
| $\begin{aligned} & \text { IN3685A } \\ & \text { IN3685B } \\ & \text { IN3686 } \\ & \text { IN3686A } \end{aligned}$ | $\begin{aligned} & \mathbf{S} \\ & \mathbf{S} \\ & \mathbf{S} \\ & \mathbf{S} \end{aligned}$ | $\begin{aligned} & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \end{aligned}$ |  | $\begin{array}{\|l} \text { IN4746 } \\ \text { IN4746A } \\ \text { IN4747 } \\ \text { IN4747 } \end{array}$ | $\begin{aligned} & 750 \\ & 750 \\ & 750 \\ & 750 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 18 / 7 \\ & 18 / 7 \\ & 20 / 6.2 \\ & 20 / 6.2 \end{aligned}$ | $\begin{array}{r} 10 \\ 5 \\ 20 \\ 10 \end{array}$ |
| $\begin{array}{\|l\|} \hline 1 N 3686 B \\ 1 N 3687 \\ 1 N 3687 A \\ 1 N 3687 B \end{array}$ | $\left\lvert\, \begin{aligned} & \mathbf{S} \\ & \mathbf{S} \\ & \mathbf{S} \\ & \mathbf{S} \end{aligned}\right.$ | $\begin{aligned} & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \end{aligned}$ |  | $\begin{aligned} & \text { IN4747A } \\ & \text { IN4748 } \\ & \text { IN4748 } \\ & \text { IN4748A } \end{aligned}$ | $\begin{aligned} & 750 \\ & 750 \\ & 750 \\ & 750 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 20 / 6.2 \\ & 22 / 5.6 \\ & 22 / 5.6 \\ & 22 / 5.6 \end{aligned}$ | $\begin{array}{r} 5 \\ 20 \\ 10 \\ 5 \end{array}$ |
| $\begin{aligned} & \text { 1N3688 } \\ & \text { 1N3688A } \\ & \text { 1N36888 } \\ & \text { 1N3689 } \end{aligned}$ | $\begin{aligned} & \mathrm{s} \\ & \mathrm{~s} \\ & \mathrm{~s} \\ & \mathrm{~s} \end{aligned}$ | $\begin{aligned} & \mathrm{ZD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \end{aligned}$ |  | 1N4749 <br> 1N4749 <br> JN4749A <br> 1N4750 | $\begin{aligned} & 750 \\ & 750 \\ & 750 \\ & 750 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 24 / 5.2 \\ & 24 / 5.2 \\ & 24 / 5.2 \\ & 27 / 4.6 \end{aligned}$ | $\begin{array}{r} 20 \\ 10 \\ 5 \\ 20 \end{array}$ |
| $\begin{aligned} & \text { 1N3689A } \\ & \text { 1N36898 } \\ & \text { 1N3690 } \\ & \text { IN3690A } \end{aligned}$ | $\left\lvert\, \begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}\right.$ | $\left.\begin{aligned} & \mathrm{ZD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \end{aligned} \right\rvert\,$ |  | $\begin{array}{\|l} \text { IN4750 } \\ \text { 1N4750A } \\ \text { 1N4751 } \\ \text { IN4751 } \end{array}$ | $\begin{aligned} & 750 \\ & 750 \\ & 750 \\ & 750 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 27 / 4.6 \\ & 27 / 4.6 \\ & 30 / 4.2 \\ & 30 / 4.2 \end{aligned}$ | $\begin{array}{r} 10 \\ 5 \\ 20 \\ 10 \end{array}$ |

## DIODE INTERCHANGEABILITY

| TYPE NUMBER |  | 3833333 | $\begin{gathered} \text { TI } \\ \text { REPLACEMENT } \end{gathered}$ |  | Rathes |  |  | CHARACTERISTICS |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  | $\begin{aligned} & P_{D} \\ & (\mathrm{~mW}) \end{aligned}$ | $\mathbf{V}_{\mathbf{R}}$ <br> (V) | 1 <br> (A) | $\begin{array}{ll} \mathbf{I}_{\mathbf{R}} & \mathbf{V}_{\mathbf{R}} \\ \mu_{\mathbf{A}} & /(\mathbf{V}) \end{array}$ | $\begin{array}{ll} \mathbf{V}_{\mathbf{F}} & \mathbf{I F}_{\mathbf{F}} \\ (\mathbf{V}) & /(\mathrm{mA}) \end{array}$ | $\begin{aligned} & t_{\mathrm{rr}} \\ & (\mathrm{~ns}) \end{aligned}$ | $\begin{array}{ll} \mathbf{V}_{\mathbf{Z}} & \cdot \mathbf{I} \\ (\mathbf{V}) & /(\mathrm{mA}) \end{array}$ | TOL <br> * |
| $\begin{aligned} & \text { 1N36908 } \\ & \text { 1N3691 } \\ & \text { 1N3691A } \\ & \text { 1N3691B } \end{aligned}$ | $\begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}$ | $\begin{aligned} & \mathrm{ZD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \end{aligned}$ |  | IN4751A <br> 1N4752 <br> 1N4752 <br> 1N4752A | $\begin{aligned} & 750 \\ & 750 \\ & 750 \\ & 750 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 30 / 4.2 \\ & 33 / 3.8 \\ & 33 / 3.8 \\ & 33 / 3.8 \end{aligned}$ | 5 20 10 5 |
| $\begin{aligned} & \text { 1N3692 } \\ & \text { 1N3692A } \\ & \text { 1N3692B } \\ & \text { 1N3693 } \end{aligned}$ | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\left\lvert\, \begin{aligned} & \mathrm{ZD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \end{aligned}\right.$ |  |  | $\begin{aligned} & 750 \\ & 750 \\ & 750 \\ & 750 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 36 / 3.4 \\ & 36 / 3.4 \\ & 36 / 3.4 \\ & 39 / 3.2 \end{aligned}$ | 20 10 5 20 |
| $\begin{aligned} & \text { 1N3693A } \\ & \text { 1N36938 } \\ & \text { 1N3694 } \\ & \text { 1N3694A } \end{aligned}$ | $\begin{aligned} & \mathbf{S} \\ & \mathbf{S} \\ & \mathbf{S} \\ & \mathbf{S} \end{aligned}$ | $\begin{aligned} & \mathrm{zD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \end{aligned}$ |  |  | $\begin{aligned} & 750 \\ & 750 \\ & 750 \\ & 750 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 39 / 3.2 \\ & 39 / 3.2 \\ & 43 / 3 \\ & 43 / 3 \end{aligned}$ | 10 5 20 10 |
| $\begin{aligned} & \text { 1N3694B } \\ & \text { 1N3695 } \\ & \text { 1N3695A } \\ & \text { 1N3695B } \end{aligned}$ | $\begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & 5 \\ & 5 \end{aligned}$ | $\begin{aligned} & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \end{aligned}$ |  |  | $\begin{aligned} & 750 \\ & 750 \\ & 750 \\ & 750 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 43 / 3 \\ & 47 / 2.7 \\ & 47 / 2.7 \\ & 47 / 2.7 \end{aligned}$ | 5 20 10 5 |
| $\begin{aligned} & \text { 1N3696 } \\ & \text { 1N3696A } \\ & \text { 1N3696B } \\ & \text { 1N3697 } \end{aligned}$ | $\left\lvert\, \begin{aligned} & 5 \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\begin{aligned} & \mathrm{ZD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \end{aligned}$ |  |  | $\begin{aligned} & 750 \\ & 750 \\ & 750 \\ & 750 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 51 / 2.5 \\ & 51 / 2.5 \\ & 51 / 2.5 \\ & 56 / 2.2 \end{aligned}$ | $\begin{array}{r} 20 \\ 10 \\ 5 \\ 20 \end{array}$ |
| 1N3697A <br> 1N3697B <br> 1N3698 <br> IN3698A | $\left\lvert\, \begin{aligned} & 5 \\ & 5 \\ & 5 \\ & 5 \end{aligned}\right.$ | $\left\|\begin{array}{l} \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \end{array}\right\|$ |  |  | $\begin{aligned} & 750 \\ & 750 \\ & 750 \\ & 750 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 56 / 2.2 \\ & 56 / 2.2 \\ & 62 / 2 \\ & 62 / 2 \end{aligned}$ | 10 5 20 10 |
| 1N36988 <br> 1N3699 <br> 1N3699A <br> 1N36998 | $\begin{aligned} & \mathrm{s} \\ & \mathrm{~s} \\ & \mathrm{~s} \\ & \mathrm{~s} \end{aligned}$ | $\left\|\begin{array}{l} \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{ZD} \end{array}\right\|$ |  |  | $\begin{aligned} & 750 \\ & 750 \\ & 750 \\ & 750 \end{aligned}$ |  |  |  |  |  | 62/2 <br> 68/1.8 <br> 68/1.8 <br> 68/1.8 | 5 20 10 5 |
| $\begin{aligned} & \text { IN3700 } \\ & \text { IN3700A } \\ & \text { 1N3700B } \\ & \text { IN3701 } \end{aligned}$ | $\begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{S} \\ & \mathbf{s} \end{aligned}$ | $\left\lvert\, \begin{aligned} & \mathrm{ZD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \end{aligned}\right.$ |  |  | $\begin{aligned} & 750 \\ & 750 \\ & 750 \\ & 750 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 75 / 1.7 \\ & 75 / 1.7 \\ & 75 / 1.7 \\ & 82 / 1.5 \end{aligned}$ | 20 10 5 20 |
| $\begin{aligned} & \text { 1N3701A } \\ & \text { 1N3701B } \\ & \text { 1N3702 } \\ & \text { 1N3702A } \end{aligned}$ | S | $\begin{aligned} & \mathrm{zD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \end{aligned}$ |  |  | $\begin{aligned} & 750 \\ & 750 \\ & 750 \\ & 750 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 82 / 1.5 \\ & 82 / 1.5 \\ & 91 / 1.4 \\ & 91 / 1.4 \end{aligned}$ | 10 5 20 10 |
| 1N3702B 1N3703 1N3703A 1N3703B | $\begin{aligned} & 5 \\ & 5 \\ & 5 \\ & 5 \end{aligned}$ | $\begin{aligned} & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \end{aligned}$ |  |  | $\begin{aligned} & 750 \\ & 750 \\ & 750 \\ & 750 \end{aligned}$ |  |  |  |  |  | $\begin{array}{r} 91 / 1.4 \\ 100 / 1.3 \\ 100 / 1.3 \\ 100 / 1.3 \end{array}$ | $\begin{array}{r} 5 \\ 20 \\ 10 \\ 5 \end{array}$ |


| TYPE MUMAER |  | $\begin{gathered} \frac{7}{6} \\ \frac{3}{3} \\ \frac{6}{6} \\ 3 \\ 3 \end{gathered}$ |  |  | $\begin{gathered} \mathbf{P}_{\mathbf{D}} \\ (\mathrm{mW}) \end{gathered}$ | mines <br> $\mathbf{V}_{\mathbf{R}}$ <br> (V) | 1 <br> (A) | $\begin{array}{ll} \mathbf{l}_{\mathrm{R}} & \bullet \mathbf{V}_{\mathrm{R}} \\ \mu_{\mathrm{A}} & /(\mathrm{V}) \end{array}$ | $V_{F}$ - If <br> (V) $/$ (mA) | ISTICS $\begin{aligned} & t_{\pi} \\ & \text { (ns) } \end{aligned}$ | $\mathbf{V}_{\mathbf{z}}-\mathbf{l}_{\mathbf{z}}$ <br> (V) $/$ (mA) | TOL <br> * |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| IN3704 IN3704A IN37048 IN3705 | $\begin{aligned} & 5 \\ & 5 \\ & 5 \\ & 5 \end{aligned}$ | $\begin{aligned} & z D \\ & z D \\ & z D \\ & z 0 \end{aligned}$ |  |  | $\begin{aligned} & 750 \\ & 750 \\ & 750 \\ & 750 \end{aligned}$ |  |  |  |  |  | 110/1.1 <br> 110/1.1 <br> 110/1.1 <br> 120/1.0 | $\begin{array}{r} 20 \\ 10 \\ 5 \\ 20 \end{array}$ |
| 1N3705A <br> 1N37058 <br> IN3706 <br> IN3706A | $\left\lvert\, \begin{aligned} & 5 \\ & 5 \\ & 5 \\ & 5 \end{aligned}\right.$ | $\left\|\begin{array}{l} \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \end{array}\right\|$ |  |  | $\begin{aligned} & 750 \\ & 750 \\ & 750 \\ & 750 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 120 / 1.0 \\ & 120 / 1.0 \\ & 130 / .95 \\ & 130 / .95 \end{aligned}$ | $\begin{array}{r} 10 \\ 5 \\ 20 \\ 10 \end{array}$ |
| $\begin{aligned} & \text { 1N3706B } \\ & \text { 1N3707 } \\ & \text { 1N3707A } \\ & \text { 1N3707B } \end{aligned}$ | $\begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}$ | $\begin{aligned} & 20 \\ & 20 \\ & 20 \\ & 20 \end{aligned}$ |  |  | $\begin{aligned} & 750 \\ & 750 \\ & 750 \\ & 750 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 130 / .95 \\ & 150 / .85 \\ & 150 / .85 \\ & 150 / .85 \end{aligned}$ | 5 20 10 5 |
| 1N3708 <br> 1N3708A <br> 1N37088 <br> 1N3709 | $\left\lvert\, \begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}\right.$ | $\left\|\begin{array}{l} \mathrm{ZD} \\ \mathrm{ZD} \\ \mathrm{ZD} \\ \mathrm{ZD} \end{array}\right\|$ |  |  | $\begin{aligned} & 750 \\ & 750 \\ & 750 \\ & 750 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 160 / .8 \\ & 160 / .8 \\ & 160 / .8 \\ & 180 / .68 \end{aligned}$ | $\begin{array}{r} 20 \\ 10 \\ 5 \\ 20 \end{array}$ |
| $\begin{aligned} & \text { IN3709A } \\ & \text { IN37098 } \\ & \text { IN3710 } \\ & \text { 1N3710A } \end{aligned}$ | $\left\lvert\, \begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}\right.$ | $\left\lvert\, \begin{aligned} & \mathrm{ZD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \end{aligned}\right.$ |  |  | $\begin{aligned} & 750 \\ & 750 \\ & 750 \\ & 750 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 180 / .68 \\ & 180 / .68 \\ & 200 / .65 \\ & 200 / .65 \end{aligned}$ | $\begin{array}{r} 10 \\ 5 \\ 20 \\ 10 \end{array}$ |
| $\begin{array}{\|l} \text { 1N37108 } \\ \text { 1N3711 } \\ \text { 1N3722 } \\ \text { 1N3723 } \end{array}$ | $\left\lvert\, \begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}\right.$ | $\begin{aligned} & \mathrm{ZD} \\ & \mathrm{RE} \\ & \mathrm{SD} \\ & \mathrm{RE} \end{aligned}$ |  | $\left\{\begin{array}{l} \text { 1N4531 } \\ \text { 1N4007 } \end{array}\right.$ | 750 | $\begin{aligned} & 6 K \\ & 50 \\ & 1 K \end{aligned}$ | $\begin{aligned} & .15 \\ & .75 \end{aligned}$ | 25/ <br> . $1 / 30$ <br> 5/1K | $\begin{aligned} & 11 / \\ & 1 / 20 \\ & 2.2 / 750 \end{aligned}$ | 10 | 200/. 65 | 5 |
| $\begin{aligned} & \text { IN3724 } \\ & \text { iN3725 } \\ & \text { iN3726 } \\ & \text { IN3727 } \end{aligned}$ | $\left\lvert\, \begin{aligned} & 5 \\ & s \\ & 5 \\ & 5 \end{aligned}\right.$ | $\begin{aligned} & R E \\ & R E \\ & R E \\ & R E \\ & R E \end{aligned}$ |  |  |  | $\begin{aligned} & 1.2 K \\ & 1.4 K \\ & 1.8 K \\ & 1.8 K \end{aligned}$ | $\begin{aligned} & .75 \\ & .75 \\ & .75 \\ & .75 \end{aligned}$ | $\begin{aligned} & 5 / \\ & 5 / \\ & 5 / \\ & 5 / \end{aligned}$ | $\begin{aligned} & 2.2 / \\ & 2.2 \prime \\ & 2.2 \prime \\ & 2.2 / \end{aligned}$ |  |  |  |
| $\begin{aligned} & \text { 1N3728 } \\ & \text { 1N3729 } \\ & \text { 1N3730 } \\ & \text { 1N3731 } \end{aligned}$ | $\begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{S} \\ & \mathbf{s} \end{aligned}$ | $\begin{aligned} & \text { SD } \\ & \text { SD } \\ & \text { SD } \\ & \text { SD } \end{aligned}$ |  | 1N648 <br> IN648 <br> 1N4608 <br> 1N4153 |  | 550 600 80 80 |  | $\begin{gathered} .1 / 400 \\ .1 / 500 \\ .1 / 60 \\ 5 / 80 \end{gathered}$ | $\begin{aligned} & 1.2 / 400 \\ & 1 / 5 \\ & 1 / 750 \\ & 1 / 100 \end{aligned}$ | 500 30 3 |  |  |
| $\begin{aligned} & \text { 1N3732 } \\ & \text { 1N3748 } \\ & \text { 1N3749 } \\ & \text { 1N3750 } \end{aligned}$ | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\begin{aligned} & \mathrm{ZD} \\ & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \end{aligned}$ |  | 1N4733A <br> 1N4003 <br> iN4004 <br> 1N4005 | 1W | $\begin{aligned} & 200 \\ & 400 \\ & 600 \end{aligned}$ | $\begin{aligned} & .5 \\ & .5 \\ & .5 \end{aligned}$ | 5/200 <br> 5/400 <br> 5/600 |  |  | $5.1 / 40$ | 5 |
| $\begin{array}{\|l\|} \text { 1N3751 } \\ \text { 1N3752 } \\ \text { 1N3753 } \\ \text { 1N3754 } \end{array}$ | $\begin{aligned} & \mathbf{S} \\ & \mathbf{S} \\ & \mathbf{G} \\ & \mathbf{S} \end{aligned}$ | $\left\|\begin{array}{l} R E \\ R E \\ S D \\ R E \end{array}\right\|$ |  | $\begin{aligned} & \text { IN4006 } \\ & \text { iN4007 } \\ & \text { iN4148 } \\ & \text { IN4002 } \end{aligned}$ |  | $\begin{array}{r} 800 \\ 1 K \\ 55 \\ 100 \end{array}$ | $\begin{array}{r} .5 \\ .5 \\ .15 \end{array}$ | $\begin{gathered} 5 / 800 \\ 5 / 1 K \\ 5 / 55 \\ 300 / 100 \end{gathered}$ | $\begin{array}{r} 1.5 / 500 \\ 1.5 / 500 \\ 1 / 150 \\ 1.2 / 150 \end{array}$ |  |  |  |

## DIODE INTERCHANGEABILITY

| TYPE NUMBER |  | 3 0 0 3 3 3 3 | $\begin{gathered} \text { TI } \\ \text { REPLACEMENT } \end{gathered}$ | FOR NEW DESIGN | $\begin{gathered} \mathbf{P D} \\ (\mathrm{mW}) \end{gathered}$ | ATINGS <br> $\mathbf{V}_{\mathbf{R}}$ <br> (V) | I <br> (A) | $\begin{array}{ll} \mathbf{I}_{\mathbf{R}} & \mathbf{V}_{\mathbf{R}} \\ \mu \mathbf{A} & / \mathbf{V}) \end{array}$ | CHARACT <br> $\mathbf{V}_{F}$. $\mathbf{I F}_{F}$ <br> (V) $/$ (mA) | $\begin{aligned} & \text { ERISTIC } \\ & \text { trr } \\ & \text { (ns) } \end{aligned}$ | $\mathbf{V}_{\mathbf{Z}}$ © $\mathbf{I z}$ <br> (V) $/$ (mA) | $\begin{aligned} & \mathrm{TOL} \\ & \% \end{aligned}$ |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| $\begin{aligned} & \text { 1N3755 } \\ & \text { 1N3756 } \\ & \text { 1N3757 } \\ & \text { 1N3758 } \end{aligned}$ | $\begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}$ | $\begin{aligned} & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \end{aligned}$ |  | 1N4003 1N4004 1 N4003 IN4004 |  | 200 400 200 400 | .15 .15 1 1 | $\begin{array}{r} 300 / 200 \\ 300 / 400 \\ 5 / 200 \\ 5 / 400 \end{array}$ | $\begin{gathered} 1.2 / 150 \\ 1.2 / 150 \\ 1 / 1 \mathrm{~A} \\ 1 / 1 \mathrm{~A} \end{gathered}$ |  |  | . |
| $\begin{aligned} & \text { 1N3759 } \\ & \text { 1N3760 } \\ & \text { 1N3761 } \\ & \text { 1N3762 } \end{aligned}$ | $\begin{aligned} & 5 \\ & 5 \\ & 5 \\ & 5 \end{aligned}$ | $\begin{aligned} & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \end{aligned}$ |  |  |  | 600 800 $1 K$ 5.3 K | 1 1 1 .065 | $\begin{aligned} & 5 / 600 \\ & 5 / 800 \\ & 5 / 1 K \\ & 5 / \end{aligned}$ | $\begin{aligned} & 1 / 1 A \\ & 1 / 1 A \\ & 1 / 1 A \\ & 12 / \end{aligned}$ |  |  |  |
| $\begin{aligned} & \text { 1N3763 } \\ & \text { 1N3764 } \\ & \text { 1N3769 } \\ & \text { 1N3773 } \end{aligned}$ | $\begin{aligned} & S \\ & S \\ & G \\ & G \end{aligned}$ | $\left\|\begin{array}{l} R D \\ R E \\ \mathrm{SD} \\ \mathrm{SD} \end{array}\right\|$ |  | 1N4305 <br> 1N4305 | 1.5W | $3 K$ 90 25 | . 2 | $\begin{aligned} & 100 / \\ & 5 / 5 \\ & 4 / 3 \end{aligned}$ | 6.51 $\begin{aligned} & .5 / 25 \\ & .35 / 2 \end{aligned}$ | 40 | 20/10 | 5 |
| 1N3774 <br> 1N3775 <br> 1N3777 <br> 1N3779 | $\left\lvert\, \begin{aligned} & S \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\begin{aligned} & \mathrm{ZD} \\ & R E \\ & S D \\ & R D \end{aligned}$ |  | 1N4148 | $\begin{aligned} & 340 \\ & 400 \end{aligned}$ | $1.5 K$ 40 | 3.3 | $\begin{array}{r} 100 \% \\ .1 / \end{array}$ | $\begin{aligned} & 2.2 / \\ & 1.1 / 10 \end{aligned}$ | 4 | $\begin{aligned} & 1.15 / 10 \\ & 6.5 / 7.5 \end{aligned}$ | 2 |
| 1N3780 <br> 1N3781 <br> 1N3782 <br> 1N3783 | $\begin{aligned} & \mathrm{s} \\ & \mathrm{~S} \\ & \mathrm{~S} \\ & \mathrm{~S} \end{aligned}$ | $\begin{aligned} & R D \\ & R D \\ & R D \\ & R D \end{aligned}$ |  |  | $\begin{aligned} & 400 \\ & 400 \\ & 400 \\ & 400 \end{aligned}$ |  |  |  | - |  | $\begin{aligned} & 6.5 / 7.5 \\ & 6.5 / 7.5 \\ & 6.5 / 7.5 \\ & 6.5 / 7.5 \end{aligned}$ |  |
| $\begin{array}{\|l} \text { IN3784 } \\ \text { 1N3785 } \\ \text { 1N3785A } \\ \text { IN3785B } \end{array}$ | $\begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}$ | $\begin{aligned} & R D \\ & \mathrm{ZD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \end{aligned}$ |  | $\begin{aligned} & \text { IN4736 } \\ & \text { IN4736 } \\ & \text { 1N4736A } \end{aligned}$ | $\begin{array}{r} 400 \\ 1.5 \mathrm{~W} \\ 1.5 \mathrm{~W} \\ 1.5 \mathrm{~W} \end{array}$ |  |  |  |  |  | $\begin{aligned} & 6.5 / 7.5 \\ & 6.8 / 55 \\ & 6.8 / 55 \\ & 6.8 / 55 \end{aligned}$ | 20 10 5 |
| $\begin{aligned} & \text { 1N3786 } \\ & \text { 1N3786A } \\ & \text { 1N3786B } \\ & \text { 1N3787 } \end{aligned}$ | $\left\lvert\, \begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}\right.$ | $\left\|\begin{array}{l} \mathrm{ZD} \\ \mathrm{ZD} \\ \mathrm{ZD} \\ \mathrm{ZD} \end{array}\right\|$ |  | $\begin{array}{\|l} \text { 1N4737 } \\ \text { 1N4737 } \\ \text { 1N4737A } \\ \text { 1N4738 } \end{array}$ | 1.5W <br> 1.5W <br> 1.5W <br> 1.5W |  |  |  |  |  | $\begin{aligned} & 7.5 / 50 \\ & 7.5 / 50 \\ & 7.5 / 50 \\ & 8.2 / 46 \end{aligned}$ | $\begin{array}{r} 20 \\ 10 \\ 5 \\ 20 \end{array}$ |
| 1N3787A <br> 1N3787B <br> 1N3788 <br> 1N3788A | $\begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}$ | $\begin{aligned} & \mathrm{ZD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \end{aligned}$ |  | IN4738 <br> 1N4738A <br> 1N4739 <br> 1N4739 | $\begin{aligned} & 1.5 \mathrm{~W} \\ & 1.5 \mathrm{~W} \\ & 1.5 \mathrm{~W} \\ & 1.5 \mathrm{~W} \end{aligned}$ |  |  |  |  |  | 8.2/46 <br> 8.2/46 <br> $9.1 / 41$ <br> $9.1 / 41$ | $\begin{array}{r} 10 \\ 5 \\ 20 \\ 10 \end{array}$ |
| 1N3788B <br> 1N3789 <br> 1N3789A <br> 1N3789B | $\left\lvert\, \begin{aligned} & 5 \\ & 5 \\ & 5 \\ & s \end{aligned}\right.$ | $\left\|\begin{array}{l} \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \end{array}\right\|$ |  | 1N4739A <br> 1N4740 <br> 1N4740 <br> 1N4740A | $\begin{aligned} & 1.5 \mathrm{~W} \\ & 1.5 \mathrm{~W} \\ & 1.5 \mathrm{~W} \\ & 1.5 \mathrm{~W} \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 9.1 / 41 \\ & 10 / 37 \\ & 10 / 37 \\ & 10 / 37 \end{aligned}$ | 5 20 10 5 |
| 1N3790 <br> 1N3790A <br> iN37908 <br> 1N3791 | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\begin{aligned} & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \end{aligned}$ |  | IN4741 <br> IN4741 <br> 1N4741A <br> iN4742 | $\begin{aligned} & 1.5 \mathrm{~W} \\ & 1.5 \mathrm{~W} \\ & 1.5 \mathrm{~W} \\ & 1.5 \mathrm{~W} \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 11 / 34 \\ & 11 / 34 \\ & 11 / 34 \\ & 12 / 31 \end{aligned}$ | $\begin{array}{r} 20 \\ 10 \\ 5 \\ 20 \end{array}$ |


| TYFE NOMOR |  | $\begin{aligned} & 8 \\ & 0 \\ & 3 \\ & 3 \\ & 3 \\ & 8 \end{aligned}$ | TI |  | Ratives |  |  | CHARACTERISTICS |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  | $\begin{gathered} \mathbf{P} \\ (\mathrm{mW}) \end{gathered}$ | $V_{\text {R }}$ <br> (v) | (A) | $\begin{array}{ll} L_{R} & \bullet V_{R} \\ \mu \mathrm{~A} & /(\mathrm{V}) \end{array}$ | $\begin{array}{ccc} \mathbf{V}_{F} & -F^{\prime} \\ (\mathrm{V}) & /(\mathrm{mal}) \end{array}$ | $\begin{aligned} & \text { irr } \\ & \text { (ns) } \end{aligned}$ | $\begin{array}{ll} \mathbf{V}_{\mathbf{z}} & \mathbf{L z} \\ (\mathrm{V}) & / \mathrm{mA}) \end{array}$ | $\begin{gathered} \text { TOL } \\ \text { \% } \end{gathered}$ |
| 1N3791A <br> 1N37918 <br> 1N3792 <br> IN3792A | $\text { } \begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}$ | $\left\|\begin{array}{l} z 0 \\ z 0 \\ z 0 \\ z 0 \end{array}\right\|$ |  | 1N4742 <br> 1N4742A <br> 1N4743 <br> 1N4743 | $\begin{aligned} & 1.5 \mathrm{~W} \\ & 1.5 \mathrm{~W} \\ & 1.5 \mathrm{~W} \\ & 1.5 \mathrm{~W} \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 12 / 31 \\ & 12 / 31 \\ & 13 / 29 \\ & 13 / 29 \end{aligned}$ | $\begin{array}{r} 10 \\ 5 \\ 20 \\ 10 \end{array}$ |
| $\begin{aligned} & \text { IN3792B } \\ & \text { IN3793 } \\ & \text { IN3793A } \\ & \text { IN3793A } \end{aligned}$ | $\begin{aligned} & \mathbf{s} \\ & \mathbf{5} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}$ | $\begin{aligned} & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \end{aligned}$ |  | $\begin{aligned} & \text { 1N4743A } \\ & \text { 1N4744 } \\ & \text { 1NA74A } \\ & \text { 1N474AA } \end{aligned}$ | $\begin{aligned} & 1.5 \mathrm{~W} \\ & 1.5 \mathrm{~W} \\ & 1.5 \mathrm{~W} \\ & 1.5 \mathrm{~W} \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 13 / 29 \\ & 15 / 25 \\ & 15 / 25 \\ & 15 / 25 \end{aligned}$ | $\begin{array}{r} 5 \\ 20 \\ 10 \\ 5 \end{array}$ |
| $\begin{aligned} & \text { 1N3794 } \\ & \text { 1N3794A } \\ & \text { 1N37948 } \\ & \text { 1N3795 } \end{aligned}$ | $\begin{aligned} & \mathrm{s} \\ & \mathrm{~s} \\ & \mathrm{~s} \\ & \mathrm{~s} \end{aligned}$ | $\begin{aligned} & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \end{aligned}$ |  | $\begin{aligned} & \text { IN4745 } \\ & \text { INA745 } \\ & \text { IN4745A } \\ & \text { INA7AS } \end{aligned}$ | $\begin{aligned} & 1.5 \mathrm{~W} \\ & 1.5 \mathrm{~W} \\ & 1.5 \mathrm{~W} \\ & 1.5 \mathrm{~W} \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 16 / 23 \\ & 16 / 23 \\ & 16 / 23 \\ & 18 / 21 \end{aligned}$ | $\begin{array}{r} 20 \\ 10 \\ 5 \\ 20 \end{array}$ |
| 1N3795A <br> iN37958 <br> 1N3796 <br> 1N37964 | $\begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}$ | $\left.\begin{aligned} & \mathbf{z 0} \\ & \mathbf{z 0} \\ & \mathbf{z 0} \\ & \mathbf{z 0} \end{aligned} \right\rvert\,$ |  | 1N4746 IN4746A 1N4747 1N4747 | $\begin{aligned} & 1.5 \mathrm{~W} \\ & 1.5 \mathrm{~W} \\ & 1.5 \mathrm{~W} \\ & 1.5 \mathrm{~W} \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 18 / 21 \\ & 18 / 21 \\ & 20 / 19 \\ & 20 / 19 \end{aligned}$ | $\begin{array}{r} 10 \\ 5 \\ 20 \\ 10 \end{array}$ |
| $\begin{aligned} & \text { IN37968 } \\ & \text { IN3797 } \\ & \text { 1N3797A } \\ & \text { IN3797 } \end{aligned}$ | $\left\lvert\, \begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}\right.$ | $\begin{aligned} & 20 \\ & 20 \\ & 20 \\ & 20 \end{aligned}$ |  | 1N4747A iN4748 INM748 INAT48A | $\begin{aligned} & 1.5 \mathrm{~W} \\ & 1.5 \mathrm{w} \\ & 1.5 \mathrm{~W} \\ & 1.5 \mathrm{w} \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 20 / 19 \\ & 22 / 17 \\ & 22 / 17 \\ & 22 / 17 \end{aligned}$ | $\begin{array}{r} 5 \\ 20 \\ 10 \\ 5 \end{array}$ |
| $\begin{aligned} & \text { 1N3798 } \\ & \text { 1N3798A } \\ & \text { 1N37988 } \\ & \text { 1N3799 } \end{aligned}$ | $\left\lvert\, \begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}\right.$ | $\begin{aligned} & z 0 \\ & z 0 \\ & z 0 \\ & z 0 \end{aligned}$ |  | 1N4749 <br> IN4749 <br> INA749A <br> 1N4750 | $\begin{aligned} & 1.5 \mathrm{~W} \\ & 1.5 \mathrm{w} \\ & 1.5 \mathrm{w} \\ & 1.5 \mathrm{w} \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 24 / 16 \\ & 24 / 16 \\ & 24 / 16 \\ & 27 / 14 \end{aligned}$ | 20 10 5 20 |
| 1N3799A <br> 1N37998 <br> 1N3800 <br> iN3se0n |  | $\left\lvert\, \begin{aligned} & z 0 \\ & z 0 \\ & z 0 \\ & z 0 \end{aligned}\right.$ |  | 1N4750 <br> 1N4750A <br> 1N4751 <br> 1N4751 | $\begin{aligned} & 1.5 \mathrm{~W} \\ & 1.5 \mathrm{~W} \\ & 1.5 \mathrm{~W} \\ & 1.5 \mathrm{~W} \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 27 / 14 \\ & 27 / 14 \\ & 30 / 12 \\ & 30 / 12 \end{aligned}$ | 10 5 20 10 |
| $\begin{aligned} & \text { IN38000 } \\ & \text { IN3s01 } \\ & \text { IN3801A } \\ & \text { IN38018 } \end{aligned}$ | $\left\lvert\, \begin{aligned} & 5 \\ & 5 \\ & 5 \\ & 5 \end{aligned}\right.$ | $\left\|\begin{array}{l} z 0 \\ z 0 \\ z 0 \\ z 0 \end{array}\right\|$ |  | 1N4751A <br> 1N4752 <br> 1N4752 <br> IN4752A | $\begin{aligned} & 1.5 \mathrm{~W} \\ & 1.5 \mathrm{~W} \\ & 1.5 \mathrm{~W} \\ & 1.5 \mathrm{~W} \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 30 / 12 \\ & 33 / 11 \\ & 33 / 11 \\ & 33 / 11 \end{aligned}$ | 5 20 10 5 |
| 1N3t02 <br> 1N3802A <br> 1N3602: <br> 1N3603 | S S S S | $\begin{aligned} & z 0 \\ & z 0 \\ & z 0 \\ & z 0 \end{aligned}$ |  | . | $\begin{aligned} & 1.5 \mathrm{~W} \\ & 1.5 \mathrm{~W} \\ & 1.5 \mathrm{~W} \\ & 1.5 \mathrm{~W} \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 36 / 10 \\ & 36 / 10 \\ & 36 / 10 \\ & 39 / 10 \end{aligned}$ | 20 10 5 20 |
| $\begin{aligned} & \text { 1N3803A } \\ & \text { 1N38038 } \\ & \text { 1N3804 } \\ & \text { IN3804A } \end{aligned}$ | $\begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}$ | $\begin{aligned} & 20 \\ & 20 \\ & 20 \\ & 20 \end{aligned}$ |  |  | $\begin{aligned} & 1.5 \mathrm{~W} \\ & 1.5 \mathrm{~W} \\ & 1.5 \mathrm{w} \\ & 1.5 \mathrm{~W} \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 39 / 10 \\ & 39 / 10 \\ & 43 / 9 \\ & 43 / 9 \end{aligned}$ | $\begin{array}{r} 10 \\ 5 \\ 20 \\ 10 \end{array}$ |

## DIODE INTERCHANGEABILITY

| $\begin{gathered} \text { TYPE } \\ \text { number } \end{gathered}$ |  | $\begin{array}{\|c} \hline \frac{7}{5} \\ \frac{5}{4} \\ \frac{2}{4} \\ 0 \\ 0 \end{array}$ | $\left\|\begin{array}{c} \text { n } \\ \text { REPLACEMENT } \end{array}\right\|$ | $\begin{gathered} \text { FOR } \\ \text { NEWW } \\ \text { DESHCN } \end{gathered}$ | $\begin{gathered} \text { PD } \\ (\mathrm{mw}) \end{gathered}$ | $\begin{gathered} \mathbf{V}_{\mathbf{R}} \\ \text { (V) } \end{gathered}$ | (A) | $\begin{array}{ll} I_{R} & V_{R} \\ \mu A & (V) \end{array}$ | $\begin{array}{cc} \mathbf{v}_{\mathbf{F}} & \mathbf{l}_{\mathbf{F}} \\ \text { (V) } & 1 \text { (mA) } \end{array}$ | ERISTIC <br> In <br> (ms) | $\begin{array}{ccc} \mathbf{v}_{\mathbf{z}} & \cdot & \mathbf{z} \\ (\mathrm{V}) & /(\mathrm{mA}) \end{array}$ | $\begin{gathered} \mathrm{TOL} \\ \% \end{gathered}$ |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| $\begin{aligned} & \text { IN380AB } \\ & \text { 1N3805 } \\ & \text { 1N3805A } \\ & \text { 1N3805B } \end{aligned}$ | $\left\lvert\, \begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}\right.$ | $\left\|\begin{array}{l} \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \end{array}\right\|$ |  |  | $\begin{aligned} & 1.5 \mathrm{~W} \\ & 1.5 \mathrm{~W} \\ & 1.5 \mathrm{~W} \\ & 1.5 \mathrm{~W} \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 43 / 9 \\ & 47 / 8 \\ & 47 / 8 \\ & 47 / 8 \end{aligned}$ | 5 20 10 5 |
| 1N3806 <br> 1N3806A <br> iN38068 <br> 1N3807 | $\begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}$ | $\left\|\begin{array}{l} \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \end{array}\right\|$ |  |  | $\begin{aligned} & 1.5 \mathrm{~W} \\ & 1.5 \mathrm{~W} \\ & 1.5 \mathrm{~W} \\ & 1.5 \mathrm{~W} \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 51 / 7.4 \\ & 51 / 7.4 \\ & 51 / 7.4 \\ & 56 / 6.7 \end{aligned}$ | 20 10 5 20 |
| in3807A <br> iN3807B <br> IN3808 <br> iN3808A | $\begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}$ | $\left\|\begin{array}{l} \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \end{array}\right\|$ |  |  | $\begin{aligned} & 1.5 \mathrm{~W} \\ & 1.5 \mathrm{~W} \\ & 1.5 \mathrm{~W} \\ & 1.5 \mathrm{~W} \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 56 / 6.7 \\ & 56 / 6.7 \\ & 6226 \\ & 62 / 6 \end{aligned}$ | 10 5 20 10 |
| 1N3808B 1N3809 <br> IN3809A 1N38098 | $\begin{array}{\|l} \mathrm{s} \\ \mathrm{~s} \\ \mathrm{~s} \\ \mathrm{~s} \end{array}$ | $\left\|\begin{array}{l} \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \end{array}\right\|$ |  |  | $\begin{aligned} & 1.5 \mathrm{~W} \\ & 1.5 \mathrm{~W} \\ & 1.5 \mathrm{~W} \\ & 1.5 \mathrm{~W} \end{aligned}$ |  |  |  |  |  | 62/6 <br> 68/5.5 <br> 68/5.5 <br> 68/5.5 | 5 20 10 5 |
| 1N3810 <br> 1N3810A <br> in38108 <br> 1N3811 | $\begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}$ | $\left\|\begin{array}{l} \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \end{array}\right\|$ |  |  | $\begin{aligned} & 1.5 \mathrm{~W} \\ & 1.5 \mathrm{~W} \\ & 1.5 \mathrm{~W} \\ & 1.5 \mathrm{~W} \end{aligned}$ |  |  |  |  |  | 75/5 <br> 75/5 <br> 75/5 <br> 82/4.5 | 20 10 5 20 |
| 1N3811A <br> 1N38118 <br> iN3812 <br> 1N3812A |  | $\left\|\begin{array}{l} \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \end{array}\right\|$ |  |  | $\begin{aligned} & 1.5 \mathrm{~W} \\ & 1.5 \mathrm{~W} \\ & 1.5 \mathrm{~W} \\ & 1.5 \mathrm{~W} \end{aligned}$ |  |  |  |  |  | 82/4.5 82/4.5 91/4.1 91/4.1 | 10 5 20 10 |
| 1N38128 1N3813 1N3813A 1N38138 | $\begin{aligned} & \mathrm{s} \\ & \mathrm{~s} \\ & \mathrm{~s} \\ & \mathrm{~s} \end{aligned}$ | $\left\|\begin{array}{l} \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \end{array}\right\|$ |  |  | $\begin{aligned} & 1.5 \mathrm{~W} \\ & 1.5 \mathrm{~W} \\ & 1.5 \mathrm{~W} \\ & 1.5 \mathrm{~W} \end{aligned}$ |  |  |  |  |  | $\begin{array}{r} 91 / 4.1 \\ 100 / 3.7 \\ 100 / 3.7 \\ 100 / 3.7 \end{array}$ | 5 20 10 5 |
| 1N3814 <br> 1N3814A <br> 1N3814B <br> 1N3815 | s | $\left\|\begin{array}{l} \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \end{array}\right\|$ |  |  | $\begin{aligned} & 1.5 \mathrm{~W} \\ & 1.5 \mathrm{~W} \\ & 1.5 \mathrm{~W} \\ & 1.5 \mathrm{~W} \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 110 / 3.4 \\ & 110 / 3.4 \\ & 110 / 3.4 \\ & 120 / 3.1 \end{aligned}$ | 20 10 5 20 |
|  | $\begin{aligned} & s \\ & s \\ & s \\ & s \\ & s \end{aligned}$ | $\left.\begin{aligned} & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \end{aligned} \right\rvert\,$ |  |  | $\begin{aligned} & 1.5 \mathrm{w} \\ & 1.5 \mathrm{w} \\ & 1.5 \mathrm{w} \\ & 1.5 \mathrm{w} \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 120 / 3.1 \\ & 120 / 3.1 \\ & 130 / 2.9 \\ & 130 / 2.9 \end{aligned}$ | 10 5 20 10 |
| 1N3816B <br> 1N3817 <br> 1N3817A <br> IN3817: | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\left\|\begin{array}{l} \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \end{array}\right\|$ |  |  | $\begin{aligned} & 1.5 \mathrm{~W} \\ & 1.5 \mathrm{~W} \\ & 1.5 \mathrm{~W} \\ & 1.5 \mathrm{~W} \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 130 / 2.9 \\ & 150 / 2.5 \\ & 150 / 2.5 \\ & 150 / 2.5 \end{aligned}$ | $\begin{array}{r} 5 \\ 20 \\ 10 \\ 5 \end{array}$ |

## DIODE INTERCHANGEABILITY

| TYPEnumaen |  | $\underline{8}$ | $\underset{\text { RELACEMENT }}{\text { II }}$ | $\begin{gathered} \text { FOR } \\ \text { NEW } \\ \text { DESICN } \end{gathered}$ | Ratings |  |  | Characteristics |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  | $\begin{gathered} P_{D} \\ (m W) \end{gathered}$ | $\begin{aligned} & \mathbf{v}_{\mathbf{R}} \\ & (\mathbf{v}) \end{aligned}$ | (A) | $\begin{array}{ll} l_{R} & V_{R} \\ \mu_{\mathrm{A}} & /(\mathrm{V}) \end{array}$ | $\begin{array}{cc} \mathbf{v}_{F} & e \mathrm{q} \\ (\mathrm{v}) & /(\mathrm{mA}) \end{array}$ | ${ }^{\prime}$ <br> (ms) | $\mathbf{v}_{\mathbf{z}}$ - $\mathbf{z}$ <br> (V) $/$ (mA) | $\begin{gathered} \text { rou } \\ \% \end{gathered}$ |
| 1N3818 <br> IN3818A 1N3818B 1N3819 | $\left\lvert\, \begin{aligned} & \mathrm{s} \\ & \mathrm{~s} \\ & \mathrm{~s} \\ & \mathrm{~s} \end{aligned}\right.$ | zD <br> zD <br> zD <br> zD |  |  | $\begin{aligned} & 1.5 \mathrm{~W} \\ & 1.5 \mathrm{~W} \\ & 1.5 \mathrm{~W} \\ & 1.5 \mathrm{~W} \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 160 / 2.3 \\ & 160 / 2.3 \\ & 160 / 2.3 \\ & 180 / 2.1 \end{aligned}$ | 20 10 5 20 |
| iN3819A in3819B 1N3820 in3820A | $\left\lvert\, \begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}\right.$ | $\left\|\begin{array}{l} \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \end{array}\right\|$ |  |  | 1.5W <br> 1.5W <br> 1.5W <br> 1.5 W |  |  |  |  |  | $\begin{aligned} & 180 / 2.1 \\ & 180 / 2.1 \\ & 200 / 1.9 \\ & 200 / 1.9 \end{aligned}$ | 10 5 20 10 |
| 1N3820e <br> 1N3821 <br> in3821A <br> 1N3822 | $\begin{aligned} & \mathrm{s} \\ & \mathrm{~s} \\ & \mathrm{~s} \\ & \mathrm{~s} \end{aligned}$ | $\left\|\begin{array}{l} \mathrm{ZD} \\ \mathrm{ZD} \\ \mathrm{ZD} \\ \mathrm{ZD} \end{array}\right\|$ |  | 1N4728 <br> 1N4728A <br> 1N4729 | $\begin{aligned} & 1.5 \mathrm{w} \\ & 1 \mathrm{w} \\ & 1 \mathrm{w} \\ & 1 \mathrm{w} \end{aligned}$ |  |  |  |  |  | $\begin{array}{r} 200 / 1.9 \\ 3.3 / 76 \\ 3.3 / 76 \\ 3.6 / 69 \end{array}$ | 5 10 5 10 |
| 1N3822A 1N3823 1N3823A iN3824 | $\begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}$ | $\left\|\begin{array}{l} \mathrm{ZD} \\ \mathrm{ZD} \\ \mathrm{ZD} \\ \mathrm{ZD} \end{array}\right\|$ |  | 1N4729A 1 N4730 1N4730A iN4731 | iw <br> iw <br> 1w <br> iw |  |  |  |  |  | $\begin{aligned} & 3.6 / 69 \\ & 3.9 / 64 \\ & 3.9 / 64 \\ & 4.3 / 58 \end{aligned}$ | 5 10 5 10 |
|  | $\left\lvert\, \begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}\right.$ | $\left\|\begin{array}{l} \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \end{array}\right\|$ |  |  | $\begin{aligned} & 1 W \\ & 1 w \\ & 1 w \\ & 1 w \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 4.3 / 58 \\ & 4.7 / 53 \\ & 4.7 / 53 \\ & 5.1 / 49 \end{aligned}$ | 5 10 5 10 |
|  | $\begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}$ | $\left\|\begin{array}{l} \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \end{array}\right\|$ |  | INA733A iN4734 iNAT34A IN4735 | iw <br> 1w <br> 1w <br> IW |  |  |  |  |  | $\begin{aligned} & 5.1 / 49 \\ & 5.6 / 45 \\ & 5.6 / 45 \\ & 6.2 / 41 \end{aligned}$ | 5 10 5 10 |
|  | $\begin{aligned} & \mathrm{s} \\ & \mathrm{~s} \\ & \mathrm{~s} \\ & \mathrm{~s} \end{aligned}$ | $\left\|\begin{array}{l} \mathrm{ZD} \\ \mathrm{ZD} \\ \mathrm{ZD} \\ \mathrm{ZD} \end{array}\right\|$ |  |  | $\begin{aligned} & \text { iw } \\ & \text { iw } \\ & \text { iw } \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 6.2 / 41 \\ & 6.8 / 37 \\ & 6.8 / 37 \\ & 7.5 / 34 \end{aligned}$ | 5 10 5 10 |
| IN3830A IN3864 iN3865 iN3866 | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\left\|\begin{array}{l} \mathrm{ZD} \\ \mathrm{SD} \\ \mathrm{SD} \\ \mathrm{RE} \end{array}\right\|$ |  | $\begin{aligned} & \text { 1N4737A } \\ & \text { 1N458 } \\ & \text { iN4148 } \\ & \text { IN4003 } \end{aligned}$ | Iw | $\begin{array}{r} 125 \\ 80 \\ 200 \end{array}$ | 1 | $\begin{aligned} & 1 N / 125 \\ & 15 / 50 \\ & .01 / 200 \end{aligned}$ | $\begin{aligned} & 1.5 / 200 \\ & 1 / 100 \\ & 1.1 / 1 \mathrm{~A} \end{aligned}$ | $\begin{aligned} & 900 \\ & 500 \end{aligned}$ | 7.5/34 | 5 |
| $\begin{array}{\|l\|l\|} \text { IN } 3867 \\ \text { 1N3868 } \\ \text { 1N3869 } \\ \text { IN3870 } \end{array}$ | $\left\lvert\, \begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}\right.$ | $\begin{aligned} & \mathrm{RE} \\ & \mathbf{R E} \\ & \mathbf{R E} \\ & \mathbf{R E} \\ & \mathbf{R E} \end{aligned}$ |  | $\begin{aligned} & \text { 1N4004 } \\ & \text { iN4005 } \\ & \text { IN4007 } \end{aligned}$ |  | $\begin{array}{r} 400 \\ 600 \\ 1 K \\ 1.5 K \end{array}$ | $\begin{aligned} & 1 \\ & 1 \\ & .5 \\ & .5 \end{aligned}$ | .01/400 <br> .01/600 <br> 10/1K <br> 10/1.5K | 1.1/1A <br> 1.1/1A 3/500 3/500 |  |  |  |
| $\begin{aligned} & \text { 1N3871 } \\ & \text { 1N3887 } \\ & \text { 1N3873 } \\ & \text { 1N3894 } \end{aligned}$ | $\left\lvert\, \begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}\right.$ | $\begin{aligned} & \text { RE } \\ & \text { SD } \\ & \text { SD } \\ & \text { SD } \end{aligned}$ |  | $\left\lvert\, \begin{aligned} & \text { TID33 } \\ & \text { TiD33 } \\ & \text { in647 } \end{aligned}\right.$ |  | $\begin{array}{r} 2.5 \mathrm{~K} \\ 90 \\ 50 \\ 400 \end{array}$ | . 25 | $\begin{aligned} & 10 / 2.5 K \\ & .1 / 75 \\ & .1 / 50 \\ & .2 / 400 \end{aligned}$ | $\begin{array}{r} 6 / 250 \\ 1 / 150 \\ .95 / 150 \\ 1 / 400 \end{array}$ | 15 4 |  |  |

## DIODE INTERCHANGEABILITY

| TYPE number | E |  | $\begin{gathered} \text { n } \\ \text { RERLACEMENT } \end{gathered}$ | $\begin{gathered} \text { FOR } \\ \text { NEW } \\ \text { DESICN } \end{gathered}$ | PD (mW) | atincs <br> $\mathbf{V}_{\mathbf{R}}$ <br> (V) | (A) | $\begin{array}{cc} \mathbf{L}_{\mathbf{R}} & \mathbf{V}_{\mathbf{R}} \\ \mu_{\mathrm{A}} & /(\mathbf{V}) \end{array}$ | $\begin{array}{cc} \mathbf{v}_{\mathbf{F}} & \mathbf{l}_{\mathbf{F}} \\ \text { (V) } & 1 \text { (ma) } \end{array}$ |  | $\begin{array}{ccc} \mathbf{v}_{\mathbf{z}} & \mathbf{z} \\ (\mathrm{V}) & /(\mathrm{mA}) \end{array}$ | TOA * |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| $\begin{array}{\|l\|} \hline \text { 1N3895 } \\ \text { 1N3896 } \\ \text { 1N3697 } \\ \text { 1N3898 } \end{array}$ | $\begin{array}{\|l} \mathbf{s} \\ \mathbf{s} \\ \mathbf{s} \\ \mathbf{s} \end{array}$ | $\left.\begin{aligned} & \mathrm{sD} \\ & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \end{aligned} \right\rvert\,$ |  | 1N647 | $\begin{aligned} & 250 \\ & 250 \\ & 250 \end{aligned}$ | 350 |  | .5/350 | 1/200 |  | $\begin{array}{r} .77 / 50 \\ 1.5 / 30 \\ 2 / 20 \end{array}$ | 5 5 5 |
| $\begin{array}{\|l\|} \text { 1N3929 } \\ \text { 1N3930 } \\ \text { 1N3931 } \\ \text { 1N3932 } \\ \hline \end{array}$ | $\begin{aligned} & \mathrm{s} \\ & \mathrm{~s} \\ & \mathrm{~s} \\ & \mathrm{~s} \end{aligned}$ | $\left.\begin{array}{\|l\|l\|} \text { SD } \\ \text { SD } \\ \text { SD } \\ \text { SD } \end{array} \right\rvert\,$ |  |  |  | 1 K 1.5 K 2K 1.5 K |  | $\begin{aligned} & 10 / \\ & 10 / \\ & 101 \\ & 10 \prime \end{aligned}$ | $\begin{aligned} & 2 / 1 A \\ & 2 / 1 A \\ & 2 / 1 A \\ & 2 / 1 A \end{aligned}$ |  |  |  |
| $\begin{aligned} & \text { 1N3933 } \\ & \text { 1N3934 } \\ & \text { 1N3938 } \\ & \text { 1N3939 } \end{aligned}$ | $\begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}$ | $\begin{array}{\|l\|} \mathbf{S D} \\ \mathbf{R E} \\ \mathbf{R E} \\ \mathbf{R E} \\ \mathbf{R E} \end{array}$ |  |  |  | $3 K$ $1.2 K$ 200 400 | 1 2 2 | $\begin{array}{r} 10 / \\ 400 / \\ 400 / \\ 200 / \end{array}$ | $\begin{aligned} & 2 / 11 \mathrm{~A} \\ & 2.5 / \\ & 1.1 / \\ & 1.1 / \end{aligned}$ |  |  |  |
| $\begin{aligned} & \text { 1N3940 } \\ & \text { 1N3941 } \\ & \text { 1N3942 } \\ & \text { 1N3943 } \end{aligned}$ | $\begin{aligned} & \mathrm{s} \\ & \mathrm{~s} \\ & \mathrm{~s} \\ & \mathrm{~s} \end{aligned}$ | $\begin{array}{\|l\|} \mathbf{R E} \\ \mathbf{R E} \\ \mathbf{R E} \\ \mathrm{SD} \end{array}$ |  | IN4001 |  | $\begin{array}{r} 600 \\ 800 \\ 1 K \\ 3 \end{array}$ | $\begin{array}{r} 2 \\ 2 \\ 2 \\ .75 \end{array}$ | $\begin{aligned} & 200 / \\ & 200 / \\ & 200 / \\ & 10 / 1 \end{aligned}$ | $\begin{aligned} & 1.1 / \\ & 1.5 / \\ & 1.5 / \\ & 3.5 / 300 \end{aligned}$ |  |  |  |
| $\begin{aligned} & \text { 1N3944 } \\ & \text { 1N3950 } \\ & \text { 1N3951 } \\ & \text { 1N3952 } \end{aligned}$ | $\begin{aligned} & \mathbf{G} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}$ | $\left\|\begin{array}{l} \mathrm{SD} \\ \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{sD} \end{array}\right\|$ |  | IN4305 <br> iN4938 | $\begin{aligned} & 1.5 \mathrm{~W} \\ & 1.5 \mathrm{~W} \end{aligned}$ | 15 <br> 150 |  | 2.5/1.5 <br> 25N/130 | .75/10 <br> .74/10 | 12 | $\begin{aligned} & 20 / 19 \\ & 25 / 15 \end{aligned}$ | 5 |
| $\begin{aligned} & \text { 1N3953 } \\ & \text { 1N3954 } \\ & \text { 1N3956 } \\ & \text { 1N3957 } \end{aligned}$ | $\begin{aligned} & \mathbf{G} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}$ | $\begin{array}{\|l\|} \hline \text { SD } \\ \text { SD } \\ \text { SD } \\ \text { SD } \end{array}$ |  | 1N4148 <br> 1N4150 <br> 1N4305 |  | 40 50 40 1 K | 4 | $\begin{aligned} & 50 / 40 \\ & .1 / 50 \\ & .05 / 40 \\ & 10 / \end{aligned}$ | $\begin{gathered} .5 / 35 \\ 1 / 200 \\ .55 .1 \\ 1 / \end{gathered}$ | 300 4 2 |  |  |
| IN3958 IN3958C IN3959 1N3959C | $\begin{aligned} & \mathrm{s} \\ & \mathrm{~s} \\ & \mathrm{~s} \\ & \mathrm{~s} \end{aligned}$ | $\begin{aligned} & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathbf{R E} \end{aligned}$ |  |  |  | $\begin{aligned} & 100 \\ & 100 \\ & 200 \\ & 200 \end{aligned}$ | $\begin{aligned} & 3.5 \\ & 3.5 \\ & 3.5 \\ & 3.5 \end{aligned}$ | $\begin{aligned} & 400 / \\ & 400 / \\ & 400 / \\ & 400 / \end{aligned}$ | $\begin{aligned} & 1.3 / \\ & 1.3 / \\ & 1.3 / \\ & 1.3 / \end{aligned}$ | 30 10 30 10 |  |  |
| 1N3960 <br> 1N3960C <br> 1N3961 <br> IN3961C | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\begin{aligned} & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \end{aligned}$ |  |  |  | $\begin{aligned} & 300 \\ & 300 \\ & 400 \\ & 400 \end{aligned}$ | $\begin{aligned} & 3.5 \\ & 3.5 \\ & 3.5 \\ & 3.5 \end{aligned}$ | $\begin{aligned} & 400 / \\ & 400 / \\ & 400 / \\ & 400 \% \end{aligned}$ | $\begin{aligned} & 1.3 / \\ & 1.3 / \\ & 1.3 \prime \\ & 1.3 / \end{aligned}$ | 30 10 30 10 |  |  |
| 1N3962 1N3962C 1N3963 IN3963C | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\begin{aligned} & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \end{aligned}$ |  |  |  | $\begin{aligned} & 500 \\ & 500 \\ & 600 \\ & 600 \end{aligned}$ | $\begin{aligned} & 3.5 \\ & 3.5 \\ & 3.5 \\ & 3.5 \end{aligned}$ | 4001 400/ 400/ 400/ | $\begin{aligned} & 1.3 / \\ & 1.3 / \\ & 1.3 / \\ & 1.3 / \end{aligned}$ | 30 10 30 10 |  |  |
| IN3981 <br> IN3982 <br> 1N3983 <br> 1N3987 | $\begin{aligned} & s \\ & s \\ & s \\ & s \\ & s \end{aligned}$ | $\begin{aligned} & S D \\ & S D \\ & S D \\ & S D \\ & R E \end{aligned}$ |  |  |  | $\begin{aligned} & 200 \\ & 400 \\ & 000 \\ & 700 \end{aligned}$ | $\begin{aligned} & 4 \\ & 4 \\ & 4 \\ & 6 \end{aligned}$ | $\begin{aligned} & 10 / 200 \\ & 10 / 400 \\ & 10 / 800 \\ & 900 / \end{aligned}$ | $\begin{aligned} & 1 / 900 \\ & 1 / 900 \\ & 1 / 900 \\ & 1.41 \end{aligned}$ |  |  |  |

## DIODE INTERCHANGEABILITY

| TYPE MUMBER |  |  | II | $\begin{aligned} & \text { FOR } \\ & \text { NEW } \\ & \text { DESTON } \end{aligned}$ | RATINOS |  |  | CHARACTERISTICS |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  | $\begin{gathered} \mathrm{PD}_{\mathrm{D}} \\ (\mathrm{~mW}) \end{gathered}$ | $\mathbf{V}_{\mathbf{R}}$ <br> (V) | I <br> (A) | $\begin{array}{ll} \mathbf{L}_{\mathbf{R}} & \mathbf{V}_{\mathbf{R}} \\ \mu_{\mathbf{A}} & / \mathbf{V}) \end{array}$ | $\begin{aligned} & \mathbf{V}_{F} \quad \mathbf{I}_{\mathbf{F}} \\ & \text { (V) } \quad /(\mathrm{mA}) \end{aligned}$ | $\begin{aligned} & i \pi \\ & (n s) \end{aligned}$ | $\begin{array}{lll} V_{z} & 1 z \\ (V) & /(\mathrm{mA}) \end{array}$ | TOL \% |
| 1N3988 <br> 1N3989 <br> 1N3990 <br> IN3991 | $\begin{aligned} & \text { S } \\ & 5 \\ & s \\ & G \end{aligned}$ | $\begin{aligned} & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{SD} \end{aligned}$ |  | 1N4305 |  | 800 900 $1 K$ 35 | 6 6 6 | $\begin{aligned} & 800 / \\ & 700 \% \\ & 600 / \\ & 1 \mathrm{M} / 10 \end{aligned}$ | 1.4/ <br> $1.4 /$ <br> $1.4 /$ <br> .55/30 |  |  |  |
| IN3992 <br> 1N4001 <br> 1N4002 <br> IN4003 | $\begin{aligned} & 5 \\ & 5 \\ & 5 \\ & 5 \end{aligned}$ | $\begin{aligned} & \mathrm{SD} \\ & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \end{aligned}$ |  |  |  | $4 K$ 50 100 200 | 1 1 1 | $\begin{aligned} & 5 / 4 K \\ & 10 / 50 \\ & 10 / 100 \\ & 10 / 200 \end{aligned}$ | $\begin{aligned} & 5 / 250 \\ & 1.1 / 1 \\ & 1.1 / 1 \\ & 1.1 / 1 \end{aligned}$ |  |  |  |
| IN4004 <br> IN4005 <br> IN4006 <br> 1N4007 | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\begin{array}{\|c\|c\|c} \hline \mathbf{R E} \\ \hline \mathbf{R E} \\ \mathbf{R E} \\ \mathbf{R E} \\ \mathbf{R E} \end{array}$ | IN4004 1N4005 1N4006 IN4007 |  |  | 400 600 800 $1 K$ | 1 1 1 | $\begin{aligned} & 10 / 400 \\ & 10 / 600 \\ & 10 / 800 \\ & 10 / 1 K \end{aligned}$ | $\begin{aligned} & 1.1 / 1 \\ & 1.1 / 1 \\ & 1.1 / 1 \\ & 1.1 / 1 \end{aligned}$ |  |  |  |
| IN4008 iN4009 1 N4010 IN4011 | $\begin{aligned} & G \\ & S \\ & S \\ & S \end{aligned}$ | $\begin{aligned} & \text { SD } \\ & \text { SD } \\ & R D \\ & R E \end{aligned}$ |  | 1N4305 1N4154 <br> 1N4007 | 400 | $\begin{aligned} & 12 \\ & 25 \\ & \text { 1K } \end{aligned}$ | . 5 | $\begin{aligned} & 100 / 10 \\ & 100 / 25 \\ & \\ & 200 / 1 K \end{aligned}$ | $\begin{gathered} .5 / 10 \\ 1 / 30 \\ \\ 1.1 / 500 \end{gathered}$ | 70 | 6.2/7.5 | 5 |
| 1N4043 <br> 1N4057 <br> 1N4057A <br> 1N4058 | $\left\lvert\, \begin{aligned} & \mathbf{S} \\ & \mathrm{S} \\ & \mathrm{~S} \\ & \mathrm{~S} \end{aligned}\right.$ | $\begin{aligned} & R D \\ & R D \\ & R D \\ & R D \end{aligned}$ |  | 1N4154 | 1.5W 1.5W 1.5 W | 25 |  | .1/25 | 1/30 | 2 | 12.4/10 <br> 12.4/10 <br> $14.6 / 10$ |  |
| 1N4058A <br> 1N4059 <br> 1N4059A <br> 1N4060 | $\begin{aligned} & \mathbf{s} \\ & 5 \\ & 5 \\ & \mathbf{S} \end{aligned}$ | $\begin{aligned} & R D \\ & R D \\ & R D \\ & R D \end{aligned}$ |  |  | $\begin{aligned} & 1.5 \mathrm{~W} \\ & 1.5 \mathrm{~W} \\ & 1.5 \mathrm{~W} \\ & 1.5 \mathrm{~W} \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 14.6 / 10 \\ & 16.8 / 10 \\ & 16.8 / 10 \\ & 18.5 / 10 \end{aligned}$ |  |
| 1N4060A <br> 1N4061 <br> IN4061A <br> 1N4062 | $\begin{aligned} & \mathbf{s} \\ & s \\ & s \\ & s \end{aligned}$ | $\begin{aligned} & R D \\ & R D \\ & R D \\ & R D \end{aligned}$ |  |  | $\begin{aligned} & 1.5 \mathrm{~W} \\ & 1.5 \mathrm{~W} \\ & 1.5 \mathrm{~W} \\ & 1.5 \mathrm{~W} \end{aligned}$ |  |  |  |  |  | $\begin{array}{r} 18.5 / 10 \\ 21 / 10 \\ 21 / 10 \\ 23 / 10 \end{array}$ |  |
| 1N4062A <br> 1N4063 <br> 1N4063A <br> 1N4064 | $\left\lvert\, \begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}\right.$ | $\begin{aligned} & \mathrm{RD} \\ & R D \\ & R D \\ & R D \end{aligned}$ |  |  | $\begin{aligned} & 1.5 \mathrm{~W} \\ & 1.5 \mathrm{~W} \\ & 1.5 \mathrm{~W} \\ & 1.5 \mathrm{~W} \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 23 / 10 \\ & 27 / 10 \\ & 27 / 10 \\ & 30 / 10 \end{aligned}$ |  |
| 1N4064A <br> 1N4065 <br> 1N4065A <br> IN4066 | $\begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}$ | $\begin{aligned} & R D \\ & R D \\ & R D \\ & R D \end{aligned}$ |  |  | $\begin{aligned} & 1.5 \mathrm{~W} \\ & 1.5 \mathrm{~W} \\ & 1.5 \mathrm{~W} \\ & 1.5 \mathrm{~W} \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 30 / 10 \\ & 33 / 10 \\ & 33 / 10 \\ & 37 / 7.5 \end{aligned}$ |  |
| IN4066A <br> IN4067 <br> 1N4067A <br> 1N4068 | $\begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}$ | $\begin{aligned} & R D \\ & R D \\ & R D \\ & R D \\ & R D \end{aligned}$ |  |  | $\begin{aligned} & 1.5 \mathrm{~W} \\ & 1.5 \mathrm{~W} \\ & 1.5 \mathrm{~W} \\ & 1.5 \mathrm{~W} \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 37 / 7.5 \\ & 43 / 7.5 \\ & 43 / 7.5 \\ & 47 / 7.5 \end{aligned}$ |  |

## DIODE INTERCHANGEABILITY

| TYPE NUMBER |  |  | TI |  | Ratines |  |  | Charactertstics |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  | $P_{D}$ $(\mathrm{mW})$ | $\mathbf{V}_{\mathbf{R}}$ <br> (V) | 1 <br> (A) | $\begin{array}{ll} \mathbf{I}_{\mathbf{R}} & \bullet \mathbf{V}_{\mathbf{R}} \\ \mu_{\mathbf{A}} & /(\mathbf{V}) \end{array}$ | $\begin{array}{ccc} V_{F} & \mathbf{I F}_{f} \\ \text { (V) } & 1 \text { (ma) } \end{array}$ | $\begin{aligned} & i_{r r} \\ & (\mathrm{n}) \end{aligned}$ | $\begin{array}{ll} \mathbf{V}_{\mathbf{Z}} & \mathbf{Z} \\ (\mathbf{V}) & / \mathrm{mA}) \end{array}$ | $\begin{gathered} \text { TOL } \\ \% \end{gathered}$ |
| 1N4068A 1N4069 <br> 1N4069A <br> 1N4070 | $\begin{aligned} & \hline \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}$ | $\begin{array}{\|l\|} \mathrm{RD} \\ \mathrm{RD} \\ \mathrm{RD} \\ \mathrm{RD} \\ \hline \end{array}$ |  |  | $\begin{array}{r} 1.5 W \\ 2 W \\ 2 W \\ 2 W \end{array}$ |  |  |  |  |  | $\begin{aligned} & 47 / 7.5 \\ & 51 / 7.5 \\ & 51 / 7.5 \\ & 56 / 7.5 \end{aligned}$ |  |
| 1N4070A iN4071 <br> IN4071A <br> 1N4072 | $\begin{aligned} & \mathrm{s} \\ & \mathrm{~s} \\ & \mathrm{~s} \\ & \mathbf{s} \end{aligned}$ | $\begin{aligned} & R D \\ & R D \\ & R D \\ & R D \\ & R D \end{aligned}$ |  |  | 2W 2W 2W 2W |  |  |  |  |  | $\begin{aligned} & 56 / 7.5 \\ & 62 / 7.5 \\ & 62 / 7.5 \\ & 68 / 5 \end{aligned}$ |  |
| $\begin{aligned} & \text { 1N4072A } \\ & \text { IN4073 } \\ & \text { IN4073A } \\ & \text { IN4074 } \end{aligned}$ | $\left\lvert\, \begin{aligned} & 5 \\ & 5 \\ & 5 \\ & 5 \end{aligned}\right.$ | $\begin{aligned} & R D \\ & R D \\ & R D \\ & R D \end{aligned}$ |  |  | $\begin{aligned} & 2 W \\ & 2 W \\ & 2 W \\ & 2 W \end{aligned}$ |  |  |  | . |  | $\begin{aligned} & 68 / 5 \\ & 75 / 5 \\ & 75 / 5 \\ & 82 / 5 \end{aligned}$ |  |
| IN4074A <br> 1N4075 <br> iN4075A <br> 1N4076 | s | $\begin{aligned} & R D \\ & R D \\ & R D \\ & R D \end{aligned}$ |  |  | $\begin{aligned} & 2 W \\ & 2 W \\ & 2 W \\ & 2 W \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 82 / 5 \\ & 87 / 5 \\ & 87 / 5 \\ & 91 / 5 \end{aligned}$ |  |
| 1N4076A <br> 1N4077 <br> 1N4077A <br> 1N4078 | $\begin{aligned} & \mathbf{s} \\ & s \\ & s \\ & s \end{aligned}$ | $\begin{aligned} & R D \\ & R D \\ & R D \\ & R D \\ & R D \end{aligned}$ |  |  | $\begin{aligned} & 2 W \\ & 2 W \\ & 2 W \\ & 2 W \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 91 / 5 \\ & 100 / 5 \\ & 100 / 5 \\ & 105 / 2.5 \end{aligned}$ |  |
| 1N4078A <br> 1N4079 <br> 1N4079A <br> IN4080 | $\begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}$ | $\begin{aligned} & R D \\ & R D \\ & R D \\ & R D \\ & R D \end{aligned}$ |  |  | $\begin{aligned} & 2 w \\ & 2 w \\ & 2 w \\ & 2 w \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 105 / 2.5 \\ & 110 / 2.5 \\ & 110 / 2.5 \\ & 120 / 2.5 \end{aligned}$ |  |
| 1N4080A IN4086 1N4087 iN4088 | $\begin{aligned} & s \\ & s \\ & s \\ & G \end{aligned}$ | $\begin{aligned} & \text { RD } \\ & \text { SD } \\ & \text { SD } \\ & \text { SD } \end{aligned}$ |  | $\begin{array}{\|l} \text { TID33 } \\ \text { TID33 } \\ \text { IN4148 } \end{array}$ | 2W | 70 50 30 |  | $\begin{array}{r} .25 / 70 \\ .09 / 50 \\ 200 / 20 \end{array}$ | $\begin{gathered} 1 / 200 \\ .98 / 30 \\ 1 / 100 \end{gathered}$ | 200 | 120/2.5 |  |
| 1N4089 1N4092 IN4093 IN4094 | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | RE <br> SD <br> SD <br> RD |  | - | 1W | $\begin{array}{r} 400 \\ 50 \end{array}$ | 1.1 | $\begin{gathered} 200 / \\ 1 / \\ 1 \mathrm{M} / \end{gathered}$ | $\begin{aligned} & 1.2 / \\ & 1 / 5 \\ & 1 / 5 \end{aligned}$ |  | 9.6/10 |  |
| IN4095 1N4099 1N4100 IN4101 | $\begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}$ | $\left\|\begin{array}{l} \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \end{array}\right\|$ | 1N4099 <br> INA100 <br> 1N4101 | 1N751 | $\begin{aligned} & 275 \\ & 250 \\ & 250 \\ & 250 \end{aligned}$ |  |  |  |  |  | $\begin{gathered} 5 / 5 \\ 6.8 / .25 \\ 7.5 / .25 \\ 8.2 / .25 \end{gathered}$ | 10 5 5 5 |
| 1N4102 1N4103 1N4104 1N4105 | $\begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}$ | $\begin{array}{\|c\|c} \mathrm{ZD} & 1 \\ \mathrm{ZD} & 1 \\ \mathrm{ZD} & 1 \\ \mathrm{ZD} & 1 \end{array}$ | IN4102 <br> IN4103 <br> IN4104 <br> 1NA105 |  | $\begin{aligned} & 250 \\ & 250 \\ & 250 \\ & 250 \end{aligned}$ |  |  |  |  |  | $\begin{array}{r} 8.7 / .25 \\ 9.1 / .25 \\ 10 / .25 \\ 11 / .25 \end{array}$ | 5 5 5 5 |


| TYP NDMETE |  | $\begin{aligned} & \frac{3}{6} \\ & \frac{3}{3} \\ & 3 \\ & 3 \\ & 8 \end{aligned}$ | $\frac{\text { TI }}{\text { REPLACEMENT }}$ | FORNEWDESNO | ratinos |  |  | CMARACTERISTICS |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  |  | $\begin{aligned} & V_{R} \\ & (V) \end{aligned}$ | I <br> (A) | $\begin{array}{ll} \mathbf{V}_{\mathbf{R}} & \mathbf{V}_{\mathbf{R}} \\ \mu \mathrm{A} & / \mathbf{V}) \end{array}$ | $\mathbf{V}_{\mathrm{F}}$ <br> (V) |  | (ms) | $\mathbf{v}_{\mathbf{z}}$ • $\mathbf{z}$ <br> (V) $/$ (ma) | $\begin{gathered} \text { rot } \\ \times \end{gathered}$ |
| IN4106 <br> 1N4107 <br> INA108 <br> 1N4100 | $\begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}$ | $\left\|\begin{array}{\|c\|} z D \\ z D \\ z D \\ z D \end{array}\right\|$ | 1N4106 |  | $\begin{aligned} & 250 \\ & 250 \\ & 250 \\ & 250 \end{aligned}$ |  |  |  |  |  |  | $\begin{aligned} & 12 / .25 \\ & 13 / .25 \\ & 14 / .25 \\ & 15 / .25 \end{aligned}$ | 5 5 5 5 |
| 1NA110 <br> 1N4111 <br> 1N4112 <br> INA113 | $\left\lvert\, \begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}\right.$ | $\begin{aligned} & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \end{aligned}$ |  |  | $\begin{aligned} & 250 \\ & 250 \\ & 250 \\ & 250 \end{aligned}$ |  |  |  |  |  |  | $\begin{aligned} & 16 / .25 \\ & 17 / .25 \\ & 18 / .25 \\ & 19 / .25 \end{aligned}$ | 5 5 5 5 |
| INA114 <br> INAIIS <br> 1N4116 <br> iN4117 | $\begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}$ | $\left\lvert\, \begin{aligned} & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \end{aligned}\right.$ |  |  | $\begin{aligned} & 250 \\ & 250 \\ & 250 \\ & 250 \end{aligned}$ |  |  |  |  |  |  | $\begin{aligned} & 20 / .25 \\ & 22 / .25 \\ & 24 / .25 \\ & 25 / .25 \end{aligned}$ | 5 5 5 5 |
| 1NA118 <br> 1N4119 <br> IN4120 <br> INAI21 | $\left\lvert\, \begin{aligned} & 5 \\ & s \\ & s \\ & 5 \end{aligned}\right.$ | $\left\lvert\, \begin{aligned} & \mathrm{zD} \\ & \mathrm{zo} \\ & \mathrm{zD} \\ & \mathrm{zo} \end{aligned}\right.$ |  |  | $\begin{aligned} & 250 \\ & 250 \\ & 250 \\ & 250 \end{aligned}$ |  |  |  |  |  |  | $\begin{aligned} & 27 / .25 \\ & 28 / .25 \\ & 30 / .25 \\ & 33 / .25 \end{aligned}$ | 5 5 5 5 |
| $\begin{aligned} & \text { INA122 } \\ & \text { 1NA123 } \\ & \text { INA124 } \\ & \text { INA125 } \end{aligned}$ | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\begin{aligned} & \mathrm{ZD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \end{aligned}$ | . |  | $\begin{aligned} & 250 \\ & 250 \\ & 250 \\ & 250 \end{aligned}$ | - |  |  |  |  |  | $\begin{aligned} & 36 / .25 \\ & 39 / .25 \\ & 43 / .25 \\ & 47 / .25 \end{aligned}$ | 5 5 5 5 |
| 1N4126 <br> 1N4127 <br> 1N4128 <br> 1N4129 | $\begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}$ | $\left\|\begin{array}{l} \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \end{array}\right\|$ |  |  | $\begin{aligned} & 250 \\ & 250 \\ & 250 \\ & 250 \end{aligned}$ |  |  |  |  |  |  | $\begin{aligned} & 51 / .25 \\ & 56 / .25 \\ & 60 / .25 \\ & 62 / .25 \end{aligned}$ | 5 5 5 5 |
| 1N4130 <br> 1N4131 <br> 1N4132 <br> IN4133 | $\begin{aligned} & 5 \\ & s \\ & s \\ & s \end{aligned}$ | $\left.\begin{aligned} & z 0 \\ & z 0 \\ & z 0 \\ & z 0 \end{aligned} \right\rvert\,$ |  |  | $\begin{aligned} & 250 \\ & 250 \\ & 250 \\ & 250 \end{aligned}$ |  |  |  |  |  |  | $\begin{aligned} & 68 / .25 \\ & 75 / .25 \\ & 82 / .25 \\ & 87 / .25 \end{aligned}$ | 5 5 5 5 |
| 1N4134 <br> 1N4135 <br> iN4139 <br> IN4140 | $\left\lvert\, \begin{aligned} & 5 \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\begin{aligned} & Z D \\ & Z D \\ & R E \\ & R E \end{aligned}$ |  |  | $\begin{aligned} & 250 \\ & 250 \end{aligned}$ | $\begin{array}{r} 50 \\ 100 \end{array}$ | $\begin{aligned} & 3 \\ & 3 \end{aligned}$ | $\begin{aligned} & 100 / \\ & 100 / \end{aligned}$ |  | $\begin{aligned} & 1 / \\ & 1 / \end{aligned}$ |  | $\begin{array}{r} 91 / .25 \\ 100 / .25 \end{array}$ | 5 5 |
| 1N4141 <br> 1N4142 <br> 1N4143 <br> 1N4144 | $\left\lvert\, \begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}\right.$ | $\left.\begin{aligned} & R E \\ & R E \\ & R E \\ & R E \\ & R E \end{aligned} \right\rvert\,$ |  |  |  | $\begin{aligned} & 200 \\ & 400 \\ & 600 \\ & 800 \end{aligned}$ | 3 3 3 3 | $\begin{aligned} & 100 / \\ & 100 / \\ & 100 / \\ & 100 / \end{aligned}$ |  | $\begin{aligned} & 1 / \\ & 1 / \\ & 1 / \\ & 1 / \end{aligned}$ |  |  |  |
| 1N4145 <br> 1N4146 <br> INA147 <br> IN4148 | $\left\lvert\, \begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}\right.$ | $\begin{aligned} & R E \\ & R E \\ & S D \\ & S D \\ & S D \end{aligned}$ | IN4147 <br> IN4148 |  |  | $\begin{aligned} & 1 K \\ & 2 K \\ & 30 \\ & 75 \end{aligned}$ | 3 | $\begin{aligned} & 100 / \\ & 100 / \\ & .1 / 30 \\ & 25 N / 20 \end{aligned}$ |  | $\begin{aligned} & 1 / \\ & 1 / \\ & 1 / 30 \\ & 1 / 10 \end{aligned}$ | 10 |  |  |


| TYPE NUMBER |  |  | II | $\begin{aligned} & \text { FOR } \\ & \text { NEW } \\ & \text { DESIGN } \end{aligned}$ | $\begin{gathered} P_{D} \\ (\mathrm{~mW}) \end{gathered}$ | tinges <br> $\mathbf{V}_{\mathrm{R}}$ <br> (V) | I <br> (A) | $\begin{array}{ll} \mathbf{I}_{\mathbf{R}} & \mathbf{V}_{\mathbf{R}} \\ \mu \mathbf{A} & / \mathbf{V}) \end{array}$ | $\mathbf{V}_{\mathbf{F}} \oplus \mathbf{I}_{\mathbf{F}}$ <br> (V) $/(\mathrm{mA})$ |  | $\mathbf{v}_{\mathbf{z}} \cdot \mathbf{I z}_{\mathbf{z}}$ <br> (V) / (mA) | $\left\lvert\, \begin{gathered} \mathrm{TOL} \\ \% \end{gathered}\right.$ |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 1N4149 <br> 1N4150 <br> 1N4151 <br> 1N4152 | $\begin{aligned} & 5 \\ & 5 \\ & 5 \\ & 5 \end{aligned}$ | $\left\lvert\, \begin{aligned} & S D \\ & S D \\ & S D \\ & S D \end{aligned}\right.$ | IN4149 <br> 1N4150 <br> IN4151 <br> IN4152 |  |  | 75 50 75 40 |  | $\begin{array}{r} 25 N / 20 \\ .1 / 50 \\ 50 N / 50 \\ 50 N / 30 \end{array}$ | $\begin{gathered} 1 / 10 \\ 1 / 200 \\ 1 / 50 \\ .88 / 20 \end{gathered}$ | 4 6 2 2 |  |  |
| IN4153 <br> 1N4154 <br> 1N4155 <br> 1N4158 | $\begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}$ | $\begin{aligned} & \text { SD } \\ & \text { SD } \\ & \text { SD } \\ & \text { ZD } \end{aligned}$ | IN4153 IN4154 | $\begin{aligned} & \text { 1N647 } \\ & \text { 1N4736 } \end{aligned}$ | 1W | 75 35 400 |  | $\begin{gathered} 50 N / 50 \\ .1 / 25 \\ .1 / 400 \end{gathered}$ | $\begin{aligned} & .88 / 20 \\ & 1 / 300 \\ & 1 / 100 \end{aligned}$ | $\begin{array}{r} 2 \\ 4 \\ 104 \end{array}$ | 6.8/37 | 20 |
| 1N4158A <br> 1N4158B <br> 1N4159 <br> 1N4159A | $\begin{aligned} & \mathrm{s} \\ & \mathrm{~S} \\ & \mathrm{~s} \\ & \mathrm{~s} \end{aligned}$ | $\begin{aligned} & \mathrm{ZD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \end{aligned}$ |  | 1N4736 <br> 1N4736A <br> 1 N4737 <br> 1N4737 | $\begin{aligned} & 1 \mathrm{w} \\ & \text { iw } \\ & \text { iw } \\ & \text { iw } \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 6.8 / 37 \\ & 6.8 / 37 \\ & 7.5 / 34 \\ & 7.5 / 34 \end{aligned}$ | $\begin{array}{r} 10 \\ 5 \\ 20 \\ 10 \end{array}$ |
| 1N41598 <br> 1N4160 <br> INA160A <br> 1N41608 | $\begin{aligned} & \mathbf{s} \\ & \mathbf{S} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}$ | $\begin{aligned} & \mathrm{ZD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \end{aligned}$ |  | 1N4737A 1N4738 1N4738 1N4738A | $\begin{aligned} & 1 w \\ & 1 w \\ & 1 w \\ & 1 w \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 7.5 / 34 \\ & 8.2 / 31 \\ & 8.2 / 31 \\ & 8.2 / 31 \end{aligned}$ | $\begin{array}{r} 5 \\ 20 \\ 10 \\ 5 \end{array}$ |
| 1N4161 <br> 1N4161A <br> 1N4161B <br> 1N4162 | $\begin{aligned} & \mathbf{s} \\ & \mathbf{S} \\ & \mathbf{S} \\ & \mathbf{s} \end{aligned}$ | $\begin{aligned} & \mathrm{ZD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \end{aligned}$ |  | $\begin{aligned} & \text { 1N4739 } \\ & \text { 1N4739 } \\ & \text { 1N4739A } \\ & \text { 1N4740 } \end{aligned}$ | $\begin{aligned} & 1 w \\ & 1 w \\ & 1 w \\ & \text { iw } \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 9.1 / 28 \\ & 9.1 / 28 \\ & 9.1 / 28 \\ & 10 / 25 \end{aligned}$ | $\begin{array}{r} 20 \\ 10 \\ 5 \\ 20 \end{array}$ |
| 1N4162A <br> 1N4162B <br> IN4163 <br> IN4163A | $\begin{aligned} & \mathbf{s} \\ & \mathbf{S} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}$ | $\begin{aligned} & \mathrm{ZD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \end{aligned}$ |  | $\begin{aligned} & \text { 1N4740 } \\ & \text { 1N4740A } \\ & \text { 1N4741 } \\ & \text { 1N4741 } \end{aligned}$ | $\begin{aligned} & \text { iw } \\ & \text { iw } \\ & \text { iw } \\ & \text { iw } \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 10 / 25 \\ & 10 / 25 \\ & 11 / 23 \\ & 11 / 23 \end{aligned}$ | $\begin{array}{r} 10 \\ 5 \\ 20 \\ 10 \end{array}$ |
| 1N41638 <br> 1N4164 <br> 1N4164A <br> IN416AB | $\begin{aligned} & \mathbf{s} \\ & \mathbf{S} \\ & \mathbf{S} \\ & \mathbf{s} \end{aligned}$ | $\begin{aligned} & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \end{aligned}$ |  | $\begin{aligned} & \text { IN4741A } \\ & \text { IN4742 } \\ & \text { IN4742 } \\ & \text { IN4742A } \end{aligned}$ | 1W <br> 1W <br> 1W <br> IW |  |  |  |  |  | $\begin{aligned} & 11 / 23 \\ & 12 / 21 \\ & 12 / 21 \\ & 12 / 21 \end{aligned}$ | $\begin{array}{r} 5 \\ 20 \\ 10 \\ 5 \end{array}$ |
| 1N4165 <br> IN4165A <br> 1NA165B <br> 1N4166 | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\left\lvert\, \begin{aligned} & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \end{aligned}\right.$ | . | 1N4743 <br> 1N4743 <br> 1N4743A <br> 1N4744 | $\begin{aligned} & \text { iw } \\ & 1 W \\ & 1 W \\ & 1 W \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 13 / 19 \\ & 13 / 19 \\ & 13 / 19 \\ & 15 / 17 \end{aligned}$ | $\begin{array}{r} 20 \\ 10 \\ 5 \\ 20 \end{array}$ |
| 1N4166A <br> 1N4166B <br> IN4167 <br> 1NA167A | $\begin{aligned} & \mathbf{s} \\ & \mathbf{S} \\ & \mathbf{S} \\ & \mathbf{s} \end{aligned}$ | $\left\|\begin{array}{l} \mathrm{ZD} \\ \mathrm{ZD} \\ \mathrm{ZD} \\ \mathrm{ZD} \end{array}\right\|$ |  | 1N4744 <br> 1N4744A <br> 1N4745 <br> 1N4745 | $\begin{aligned} & 1 \mathrm{w} \\ & \mathrm{iW} \\ & \mathrm{iw} \\ & \mathrm{iw} \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 15 / 17 \\ & 15 / 17 \\ & 16 / 16 \\ & 16 / 16 \end{aligned}$ | $\begin{array}{r} 10 \\ 5 \\ 20 \\ 10 \end{array}$ |
| 1N4167B <br> 1N4168 <br> 1N4168A <br> 1N41688 | $\begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}$ | $\left\lvert\, \begin{aligned} & \mathrm{ZD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \end{aligned}\right.$ |  | IN4745A <br> iN4746 <br> 1N4746 <br> 1N4746A | $\begin{aligned} & \text { iw } \\ & \text { iw } \\ & \text { iw } \\ & \text { iw } \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 16 / 16 \\ & 18 / 14 \\ & 18 / 14 \\ & 18 / 14 \end{aligned}$ | $\begin{array}{r} 5 \\ 20 \\ 10 \\ 5 \end{array}$ |


| TYPE Mumber | 3333 |  | REHACEMENT |  | ratines |  |  | CHARACTERISTICS |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  | $\left\|\begin{array}{c} \mathbf{P}_{\mathrm{D}} \\ (\mathrm{~mW}) \end{array}\right\|$ | $\mathbf{V}_{\mathbf{R}}$ <br> (V) | I <br> (A) | $\begin{array}{lll} \mathbf{L}_{\mathrm{R}} & \mathbf{V}_{\mathrm{R}} \\ \mu \mathrm{~A} & / \mathbf{V}) \end{array}$ | $\begin{array}{cc} \mathbf{V}_{\mathrm{F}} & \mathrm{l}_{\mathrm{F}} \\ \text { (V) } & / \mathrm{mA}) \end{array}$ | $\begin{aligned} & \text { trr } \\ & \text { (ns) } \end{aligned}$ | $\begin{array}{llc} \mathbf{V}_{\mathbf{z}} & \mathbf{l} \mathbf{z} \\ (\mathrm{V}) & 1 & (\mathrm{ma}) \end{array}$ | TOL \% |
| 1N4169 <br> 1N4169A <br> 1N41698 <br> iN4170 | $\left\lvert\, \begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{S} \\ & \mathbf{s} \end{aligned}\right.$ | $\left\|\begin{array}{l} \mathrm{ZD} \\ \mathrm{ZD} \\ \mathrm{ZD} \\ \mathrm{ZD} \end{array}\right\|$ |  | $\begin{aligned} & \text { IN4747 } \\ & \text { 1N4747 } \\ & \text { IN4747A } \\ & \text { 1N4748 } \end{aligned}$ | $\begin{aligned} & 1 w \\ & \text { iw } \\ & \text { iw } \\ & \text { iw } \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 20 / 13 \\ & 20 / 13 \\ & 20 / 13 \\ & 22 / 12 \end{aligned}$ | $\begin{array}{r} 20 \\ 10 \\ 5 \\ 20 \end{array}$ |
| 1N4170A <br> 1N4170B <br> 1N4171 <br> IN4171A | $\begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}$ | $\begin{aligned} & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \end{aligned}$ |  | 1N4748 <br> 1N4748A <br> 1N4749 <br> 1N4749 | $\begin{aligned} & \text { iw } \\ & \text { iw } \\ & \text { iw } \\ & \text { iw } \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 22 / 12 \\ & 22 / 12 \\ & 24 / 11 \\ & 24 / 11 \end{aligned}$ | $\begin{array}{r} 10 \\ 5 \\ 20 \\ 10 \end{array}$ |
| $\begin{aligned} & \text { 1N4171B } \\ & \text { 1N4172 } \\ & \text { 1N4172A } \\ & \text { 1N4172B } \end{aligned}$ | $\begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}$ | $\left\|\begin{array}{l} \mathrm{ZD} \\ \mathrm{ZD} \\ \mathrm{ZD} \\ \mathrm{ZD} \end{array}\right\|$ |  | 1N4749A <br> 1N4750 <br> 1N4750 <br> INA750A | $\begin{aligned} & \text { iw } \\ & \text { iw } \\ & \text { iw } \\ & \text { iw } \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 24 / 11 \\ & 27 / 9.5 \\ & 27 / 9.5 \\ & 27 / 9.5 \end{aligned}$ | $\begin{array}{r} 5 \\ 20 \\ 10 \\ 5 \end{array}$ |
| 1N4173 <br> 1N4173A <br> 1N41738 <br> 1N4174 | $\begin{aligned} & \mathbf{s} \\ & \mathbf{S} \\ & \mathbf{S} \\ & \mathbf{S} \end{aligned}$ | $\begin{aligned} & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \end{aligned}$ |  | 1N4751 <br> 1N4751 <br> 1N4751A <br> 1N4752 | $\begin{aligned} & \text { iw } \\ & \text { iw } \\ & \text { iw } \\ & \text { iw } \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 30 / 8.5 \\ & 30 / 8.5 \\ & 30 / 8.5 \\ & 33 / 7.5 \end{aligned}$ | $\begin{array}{r} 20 \\ 10 \\ 5 \\ 20 \end{array}$ |
| INA174A <br> 1N4174B <br> iN4175 <br> 1N4175A | $\begin{aligned} & \mathbf{S} \\ & \mathbf{S} \\ & \mathbf{S} \\ & \mathbf{s} \end{aligned}$ | $\left\|\begin{array}{l} \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \end{array}\right\|$ |  | 1N4752 IN4752A | $\begin{aligned} & \text { iw } \\ & \text { iw } \\ & \text { iw } \\ & \text { iw } \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 33 / 7.5 \\ & 33 / 7.5 \\ & 36 / 7 \\ & 36 / 7 \end{aligned}$ | $\begin{array}{r} 10 \\ 5 \\ 20 \\ 10 \end{array}$ |
| 1N41758 <br> IN4176 <br> 1N4176A <br> IN4176B | $\begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}$ | $\begin{aligned} & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{ZD} \\ & \mathrm{zD} \end{aligned}$ |  |  | $\begin{aligned} & \text { iw } \\ & \text { iw } \\ & \text { iw } \\ & \text { iw } \end{aligned}$ | - |  |  |  |  | $\begin{aligned} & 36 / 7 \\ & 39 / 6.5 \\ & 39 / 6.5 \\ & 39 / 6.5 \end{aligned}$ | 5 20 10 5 |
| 1N4177 <br> 1NA177A <br> 1N41778 <br> 1NA178 | $\left\lvert\, \begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}\right.$ | $\begin{aligned} & \mathrm{ZD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \end{aligned}$ |  |  | $\begin{aligned} & \text { iw } \\ & \text { iw } \\ & \text { iw } \\ & \text { iw } \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 43 / 6 \\ & 43 / 6 \\ & 43 / 6 \\ & 47 / 5.5 \end{aligned}$ | 20 10 5 20 |
| 1N4178A <br> 1N41788 <br> IN4179 <br> 1N4179A | $\begin{aligned} & 5 \\ & 5 \\ & 5 \\ & 5 \end{aligned}$ | $\begin{aligned} & \mathrm{ZD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \end{aligned}$ |  |  | $\begin{aligned} & \text { iw } \\ & \text { iw } \\ & \text { iw } \\ & \text { iw } \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 47 / 5.5 \\ & 47 / 5.5 \\ & 51 / 5 \\ & 51 / 5 \end{aligned}$ | 10 5 20 10 |
| 1N4179B <br> IN4180 <br> 1N4180A <br> 1N41808 | S | $\begin{aligned} & \mathrm{ZD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \end{aligned}$ |  |  | $\begin{aligned} & \text { iw } \\ & 1 \mathbf{w} \\ & \text { iw } \\ & \text { iw } \end{aligned}$ |  |  |  | . |  | 51/5 <br> 56/4.5 <br> 56/4.5 <br> 56/4.5 | 5 20 10 5 |
| 1N4181 <br> IN4181A <br> INA181B <br> 1N4182 | S | $\begin{aligned} & \mathrm{zD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \end{aligned}$ |  |  | $\begin{aligned} & \text { iw } \\ & \text { iw } \\ & \text { iw } \\ & \text { iw } \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 62 / 4 \\ & 62 / 4 \\ & 62 / 4 \\ & 68 / 3.7 \end{aligned}$ | 20 10 5 20 |


| TYPE number |  | 完 |  | $\underset{\text { RERLACEMENT }}{\text { II }}$ | $\begin{gathered} \text { FOR } \\ \text { NEW } \\ \text { DESHON } \end{gathered}$ | $\begin{gathered} \mathrm{PD}_{\mathrm{D}} \\ (\mathrm{~mW}) \end{gathered}$ | $\begin{aligned} & \text { ratinos } \\ & \mathbf{V}_{\mathbf{R}} \\ & (\mathbf{V}) \end{aligned}$ | I <br> (A) | $\begin{array}{ll} r_{R} & V_{R} \\ \mu_{\mathrm{A}} & /(\mathrm{V}) \end{array}$ | $\begin{array}{ll} \mathbf{v}_{F} & \mathbf{l}_{F} \\ \text { (v) } & 1 \text { (mA) } \end{array}$ | IERISTIC ${ }_{(n s)}^{i_{r}}$ | $\begin{array}{lll} v_{z} & 0 & \mathbf{z} \\ (\mathrm{~V}) & 1 & (\mathrm{~mA}) \end{array}$ | $\left.\right\|_{\%} ^{10 x}$ |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | $s$ |  | z0 zD zD zD |  |  | iw <br> 1w <br> 1W <br> IW |  |  |  |  |  | $\begin{aligned} & 68 / 3.7 \\ & 68 / 3.7 \\ & 75 / 3.3 \\ & 75 / 3.3 \end{aligned}$ | 10 5 20 10 |
| 1N4183B 1N4184 in4i84A 1N4184B | ( $\begin{aligned} & \text { s } \\ & \text { s } \\ & \text { s } \\ & \text { s }\end{aligned}$ |  | $\left\|\begin{array}{l\|} \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \end{array}\right\|$ |  |  | iw iw iw iw |  |  |  |  |  | $\begin{aligned} & 75 / 3.3 \\ & 82 / 3 \\ & 82 / 3 \\ & 82 / 3 \end{aligned}$ | 5 20 10 5 |
| 1N4185 <br> 1N4185A <br> IN4185B <br> 1N4186 | $\left.\right\|_{s} ^{s}$ |  | $\begin{aligned} & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \end{aligned}$ |  |  | 1w iw iw iw |  |  |  |  |  | $\begin{array}{r} 91 / 2.8 \\ 91 / 2.8 \\ 91 / 2.8 \\ 100 / 2.5 \end{array}$ | 20 10 5 20 |
| 1N4186A 1N41868 1N4187 IN4187A | S |  |  |  |  | 1w <br> IW <br> IW <br> 1W |  |  |  |  |  | $\begin{aligned} & 100 / 2.5 \\ & 100 / 2.5 \\ & 110 / 2.3 \\ & 110 / 2.3 \end{aligned}$ | 10 5 20 10 |
| 1N41878 <br> 1N4188 <br> in4188A <br> IN4188B | ( |  |  |  |  | iw iw iw iw |  |  |  |  |  | $\begin{aligned} & 110 / 2.3 \\ & 120 / 2 \\ & 120 / 2 \\ & 120 / 2 \end{aligned}$ | 5 20 10 5 |
| INA189 <br> 1N4189A <br> 1N4189B <br> 1N4190 | S |  |  |  |  | IW IW iw 1W |  |  |  |  |  | $\begin{aligned} & 130 / 1.9 \\ & 130 / 1.9 \\ & 130 / 1.9 \\ & 150 / 1.7 \end{aligned}$ | 20 10 5 20 |
|  | S |  |  |  |  | $\begin{aligned} & 1 w \\ & 1 w \\ & 1 w \\ & 1 w \end{aligned}$ |  |  |  |  |  | 150/1.7 150/1.7 180/1.6 160/1.6 | 10 5 20 10 |
| INA191B N4192 indig2A N4192B | $\begin{aligned} & \mathbf{s} \\ & s \\ & s \\ & s \\ & s \end{aligned}$ | 2D |  |  |  | IW <br> 1w <br> 1W <br> iw |  |  |  |  |  | $\begin{aligned} & 160 / 1.6 \\ & 180 / 1.4 \\ & 180 / 1.4 \\ & 180 / 1.4 \end{aligned}$ | 5 20 10 5 |
| iN4193 <br> 1N4193A <br> IN41938 <br> in4242 | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | SD |  |  |  | $\begin{aligned} & \text { iw } \\ & i w \\ & \text { iw } \end{aligned}$ | 40 |  | .1N/ | 1/20 | 2 | $\begin{aligned} & 200 / 1.2 \\ & 200 / 1.2 \\ & 200 / 1.2 \end{aligned}$ | $\begin{array}{r} 20 \\ 10 \\ 5 \end{array}$ |
| 1N4243 <br> 1N4244 <br> 1N4245 <br> 1N4246 |  | SD SD RE RE |  |  | $\begin{aligned} & N 4003 \\ & N 4004 \end{aligned}$ |  | $\begin{array}{r} 40 \\ 10 \\ 200 \\ 400 \end{array}$ | 1 | $\begin{aligned} & .1 \mathrm{~N} / \\ & .1 / \\ & 1 / 200 \\ & 1 / 400 \end{aligned}$ | $\begin{array}{r} 1 / 10 \\ 1 / 20 \\ 1.2 / 1 \\ 1.2 / 1 \end{array}$ | $\begin{array}{r} 2 \\ .75 \end{array}$ |  |  |


| TYPENUMBER |  | $\begin{aligned} & \mathbf{z} \\ & \mathbf{0} \\ & \mathbf{5} \\ & \frac{5}{4} \\ & \frac{4}{4} \\ & \mathbf{3} \end{aligned}$ | $\begin{gathered} \text { TI } \\ \text { REPLACEMENT } \end{gathered}$ |  | RATINCS |  |  | CHARACTERISTICS |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  | $\begin{gathered} P_{D} \\ (m w) \end{gathered}$ | $V_{R}$ (V) | (A) | $\begin{array}{ll} \mathbf{m}_{\mathbf{R}} & \bullet \mathbf{v}_{\mathbf{R}} \\ \mu_{\mathbf{A}} & ,\left(v_{1}\right) \end{array}$ | $\mathbf{V F}_{\mathrm{F}}$ - $\mathbf{F}$ <br> (v) $/$ (mA) | $\begin{gathered} i_{n} \\ (n s) \end{gathered}$ | $\begin{array}{llc} \mathbf{v}_{\mathbf{z}} & \cdot \mathbf{z} \\ (\mathrm{V}) & /(\mathrm{mA}) \end{array}$ | tol * |
| 1N4247 1N4248 IN4249 1N4250 | $\begin{aligned} & \mathrm{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}$ | $\left\|\begin{array}{l} \mathrm{RE} \\ \mathrm{RE} \\ \mathrm{RE} \\ \mathrm{RE} \end{array}\right\|$ |  | IN4005 IN4006 IN4007 IN4006 |  | $\begin{gathered} 600 \\ 800 \\ 1 K \\ 800 \end{gathered}$ | 1 1 1 . | $\begin{aligned} & 1 / 600 \\ & 1 / 800 \\ & 1 / 1 K \\ & 1 / 800 \end{aligned}$ | $\begin{aligned} & 1.2 / 1 \\ & 1.2 / 1 \\ & 1.2 / 1 \\ & 1.2 / 1 \end{aligned}$ |  |  |  |
| 1N4251 1N4252 1N4253 1N4254 | $\begin{aligned} & \hline \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}$ | $\left.\begin{array}{\|l\|} \hline \mathbf{R E} \\ \mathrm{RE} \\ \mathrm{RE} \\ \mathrm{RE} \end{array} \right\rvert\,$ |  | 1N4007 |  | $\begin{array}{r} 1 K \\ 1.2 \mathrm{~K} \\ 1.5 \mathrm{~K} \\ 1.5 \mathrm{~K} \end{array}$ | $\begin{array}{r} .5 \\ .5 \\ .5 \\ .25 \end{array}$ | $\begin{aligned} & 1 / 1 \mathrm{~K} \\ & 50 \% \\ & 50 \% \\ & 50 \% \end{aligned}$ | $1.2 / 1$ <br> 4.8/ |  |  |  |
| 1N4255 iN4256 1N4295 | $\left\lvert\, \begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}\right.$ | $\begin{aligned} & R E \\ & R E \\ & R E \\ & R E \\ & R E \\ & R E \end{aligned}$ |  |  | 400 | $\begin{array}{r} 2 \mathrm{~K} \\ 2.5 \mathrm{~K} \\ 3 \mathrm{~K} \end{array}$ | $\begin{aligned} & .25 \\ & .25 \\ & .25 \end{aligned}$ | $\begin{aligned} & \mathbf{5 0 /} \\ & \mathbf{5 0 /} \\ & \mathbf{5 0 /} \end{aligned}$ | $\begin{aligned} & 4.8 / \\ & 4.81 \\ & 4.8 / \end{aligned}$ |  | 10/10 |  |
| 1N4295A 1N4296 iN4296A iN4305 | $\begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}$ | $\left\|\begin{array}{l} \mathrm{RD} \\ \mathrm{RD} \\ \mathrm{RD} \\ \mathrm{SD} \end{array}\right\|$ | 1N4305 |  | $\begin{aligned} & 400 \\ & 1 w \\ & 1 w \end{aligned}$ | 75 |  | .1/50 | .57/.25 | 2 | $\begin{aligned} & 10 / 10 \\ & 10 / 20 \\ & 10 / 20 \end{aligned}$ |  |
| $\begin{aligned} & \text { 1N4306 } \\ & \text { 1N4307 } \\ & \text { 1N4308 } \\ & \text { 1N4309 } \end{aligned}$ | $\begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}$ | SD SD SD SD |  | 1N4151 1N4151 1N4150 IN4608 |  | 75 75 100 50 |  | $\begin{array}{r} 50 \mathrm{~N} / 50 \\ 50 \mathrm{~N} / 50 \\ .1 / 75 \\ .1 / 30 \end{array}$ | $\begin{aligned} & 1 / 50 \\ & 1 / 50 \\ & 1 / 200 \\ & 1 / 400 \end{aligned}$ | 2 2 2 2 |  |  |
| $\begin{aligned} & \text { IN4310 } \\ & \text { IN4311 } \\ & \text { IN4312 } \\ & \text { IN4313 } \end{aligned}$ | $\begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}$ | $\begin{aligned} & \text { SD } \\ & \text { SD } \\ & \text { SD } \\ & \text { SD } \end{aligned}$ |  | $\begin{array}{\|l} \text { 1N4608 } \\ \text { 1N4607 } \\ \text { TID32 } \\ \text { INA151 } \end{array}$ |  | $\begin{array}{r} 75 \\ 100 \\ 150 \\ 100 \end{array}$ |  | $\begin{aligned} & .1 / 50 \\ & .1 / 75 \\ & .1 / 100 \\ & .1 / 75 \end{aligned}$ | $\begin{aligned} & 1 / 400 \\ & 1 / 300 \\ & 1 / 200 \\ & 1 / 100 \end{aligned}$ | $\left\|\begin{array}{l} 2 \\ 2 \\ 2 \\ 4 \end{array}\right\|$ |  |  |
| $\left\{\begin{array}{l} \text { IN4314 } \\ \text { 1N4315 } \\ \text { IN4316 } \\ \text { IN4317 } \end{array}\right.$ | $\begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}$ | $\begin{aligned} & \text { SD } \\ & \text { SD } \\ & \text { SD } \\ & \text { SD } \end{aligned}$ |  | 1N4150 1N4608 1N4608 1N4607 |  | $\begin{array}{r} 100 \\ 50 \\ 75 \\ 100 \end{array}$ |  | $\begin{aligned} & .1 / 75 \\ & .1 / 30 \\ & .1 / 50 \\ & .1 / 75 \end{aligned}$ | $\begin{aligned} & 1 / 200 \\ & 1 / 400 \\ & 1 / 400 \\ & 1 / 300 \end{aligned}$ | 2 2 2 2 |  |  |
| iN4318 iN4319 IN4322 IN4323 | $\begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}$ | $\begin{aligned} & \mathrm{SD} \\ & \mathrm{SD} \\ & \mathrm{SD} \\ & \mathrm{ZD} \end{aligned}$ |  | TID32 <br> 1N4151 1N4150 1N4736 | IW | $\begin{array}{r} 150 \\ 75 \\ 50 \end{array}$ |  | $\begin{aligned} & .1 / 100 \\ & .1 / 50 \\ & .1 / 50 \end{aligned}$ | $\begin{aligned} & 1 / 200 \\ & 1 / 100 \\ & 1 / 200 \end{aligned}$ | $\left.\begin{aligned} & 2 \\ & 4 \\ & 6 \end{aligned} \right\rvert\,$ | 6.8/37 | 20 |
| 1N4323A 1N4323B 1N4324 1NA32AA | S | $\begin{aligned} & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \end{aligned}$ |  | 1N4736 IN4738A 1N4737 1N4737 | $\begin{aligned} & 1 w \\ & 1 w \\ & 1 w \\ & 1 w \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 6.8 / 37 \\ & 6.8 / 37 \\ & 7.5 / 34 \\ & 7.5 / 34 \end{aligned}$ | 10 5 20 10 |
| IN4324B IN4325 IN4325A IN4325B | $\left\lvert\, \begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}\right.$ | $\left\lvert\, \begin{aligned} & \mathrm{ZD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \end{aligned}\right.$ |  | 1N4737A 1N4738 1N4738 1N4738A | $\begin{aligned} & \text { iw } \\ & \text { iw } \\ & \text { iw } \\ & \text { iw } \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 7.5 / 34 \\ & 8.2 / 31 \\ & 8.2 / 31 \\ & 8.2 / 31 \end{aligned}$ | 5 20 10 5 |

## DIODE INTERCHANGEABILITY

| TYPE MUMEER |  |  | 7 REPLACEMENT |  | $\begin{aligned} & P_{D} \\ & (\mathrm{~mW}) \end{aligned}$ | $\mathbf{V}_{\mathbf{R}}$ <br> (V) | I <br> (A) | $\begin{array}{ll} \mathbf{I}_{\mathbf{R}} & \bullet \mathbf{V}_{\mathbf{R}} \\ \mu_{\mathbf{A}} & !(\mathbf{V}) \end{array}$ | $\begin{aligned} & V_{F} \\ & (V) \end{aligned}$ | $\begin{gathered} \text { CHARACTI } \\ \text { e } \begin{array}{c} \text { IF } \\ \hline(\mathrm{mA}) \end{array} \end{gathered}$ | \% <br> (na) | $\mathbf{V}_{\mathbf{z}}$ - $\mathbf{z}$ <br> (V) $/$ (mA) |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| $\begin{array}{\|l\|} \hline \text { IN4326 } \\ \text { IN4326A } \\ \text { IN4326B } \\ \text { IN4327 } \end{array}$ | $\begin{aligned} & \mathrm{s} \\ & \mathrm{~s} \\ & \mathrm{~s} \\ & \mathrm{~s} \end{aligned}$ | ZD |  | $\begin{aligned} & \text { 1N4739 } \\ & \text { 1N4739 } \\ & \text { 1N4739A } \\ & \text { IN4740 } \end{aligned}$ | $\begin{aligned} & 16 \\ & 1 w \\ & 1 w \\ & i w \end{aligned}$ |  |  |  |  |  |  | $\begin{gathered} 9.1 / 28 \\ 9.1 / 28 \\ 9.1 / 28 \\ 10 / 25 \end{gathered}$ | 20 10 5 20 |
| $\begin{aligned} & \text { 1N4327A } \\ & \text { 1N4327B } \\ & \text { 1N4328 } \\ & \text { 1N4328A } \end{aligned}$ | $\left\lvert\, \begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{S} \\ & \mathbf{s} \end{aligned}\right.$ | $\left\|\begin{array}{l} \mathrm{zD} \\ \mathrm{ZD} \\ \mathrm{ZD} \\ \mathrm{zD} \end{array}\right\|$ |  | 1N4740 <br> 1N4740A <br> 1N4741 <br> 1N4741 | $\begin{aligned} & 16 \\ & 1 w \\ & 1 w \\ & 1 w \end{aligned}$ |  |  |  |  |  |  | $\begin{aligned} & 10 / 25 \\ & 10 / 25 \\ & 11 / 23 \\ & 11 / 23 \end{aligned}$ | $\begin{array}{r} 10 \\ 5 \\ 20 \\ 10 \end{array}$ |
| $\begin{aligned} & \text { 1N4328B } \\ & \text { 1N4329 } \\ & \text { 1N4329A } \\ & \text { 1N4329B } \end{aligned}$ | $\begin{aligned} & \mathrm{s} \\ & \mathbf{s} \\ & \mathrm{~s} \\ & \mathbf{s} \end{aligned}$ | $\begin{aligned} & \mathbf{Z D} \\ & \mathbf{Z D} \\ & \mathbf{Z D} \\ & \mathbf{Z D} \end{aligned}$ |  | $\begin{aligned} & \text { IN4741A } \\ & \text { IN4742 } \\ & \text { IN4742 } \\ & \text { 1N4742A } \end{aligned}$ | $\begin{aligned} & i w \\ & i w \\ & i w \\ & i w \end{aligned}$ |  |  |  |  |  |  | $\begin{aligned} & 11 / 23 \\ & 12 / 21 \\ & 12 / 21 \\ & 12 / 21 \end{aligned}$ | $\begin{array}{r} 5 \\ 20 \\ 10 \\ 5 \end{array}$ |
| $\begin{aligned} & \text { IN4330 } \\ & \text { IN4330A } \\ & \text { IN4330B } \\ & \text { IN4331 } \end{aligned}$ | $\begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}$ | $\begin{aligned} & \mathrm{ZD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \end{aligned}$ |  | $\begin{aligned} & \text { 1N4743 } \\ & \text { 1N4743 } \\ & \text { IN4743A } \\ & \text { 1N47A4 } \end{aligned}$ | $\begin{aligned} & 1 w \\ & 1 w \\ & 1 w \\ & i w \end{aligned}$ |  |  |  |  |  |  | $\begin{aligned} & 13 / 19 \\ & 13 / 19 \\ & 13 / 19 \\ & 15 / 17 \end{aligned}$ | $\begin{array}{r} 20 \\ 10 \\ 5 \\ 20 \end{array}$ |
| IN4331A <br> 1N43318 <br> IN4332 <br> 1N4332A | $\left\lvert\, \begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{S} \end{aligned}\right.$ | $\begin{aligned} & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{ZD} \\ & \mathrm{zD} \end{aligned}$ |  | 1N4744 <br> 1N4744A <br> 1N4745 <br> 1N4745 | $\begin{aligned} & \text { iw } \\ & \text { iw } \\ & \text { iw } \\ & \text { iw } \end{aligned}$ |  |  |  |  |  |  | $\begin{aligned} & 15 / 17 \\ & 15 / 17 \\ & 16 / 16 \\ & 16 / 16 \end{aligned}$ | $\begin{array}{r} 10 \\ 5 \\ 20 \\ 10 \end{array}$ |
| IN4332B <br> IN4333 <br> IN4333A <br> 1N4333B | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\begin{aligned} & \mathrm{ZD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \end{aligned}$ |  | $\begin{aligned} & \text { 1N4745A } \\ & \text { 1N4746 } \\ & \text { 1N4746 } \\ & \text { 1N4746A } \end{aligned}$ | $\begin{aligned} & \text { iw } \\ & \text { iw } \\ & \text { iw } \\ & \text { iw } \end{aligned}$ |  |  |  |  |  |  | $\begin{aligned} & 16 / 16 \\ & 18 / 14 \\ & 18 / 14 \\ & 18 / 14 \end{aligned}$ | 5 20 10 5 |
| 1N4334 <br> IN4334A <br> 1N4334B <br> 1N4335 | $\begin{aligned} & s \\ & s \\ & s \\ & s \\ & s \end{aligned}$ | $\left\lvert\, \begin{aligned} & \mathrm{ZD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \end{aligned}\right.$ |  | 1N4747 <br> 1N4747 <br> IN4747A <br> 1N4748 | $\begin{aligned} & \text { iw } \\ & \text { iw } \\ & \text { iw } \\ & \text { iw } \end{aligned}$ |  |  |  |  |  |  | $\begin{aligned} & 20 / 13 \\ & 20 / 13 \\ & 20 / 13 \\ & 22 / 12 \end{aligned}$ | 20 10 5 20 |
| 1N4335A <br> 1N43358 <br> 1N4336 <br> 1N4336A | $\begin{aligned} & \mathbf{s} \\ & \mathbf{S} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}$ | $\begin{aligned} & \mathrm{zD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \end{aligned}$ |  | 1N4748 <br> 1N4748A <br> 1N4749 <br> 1N4749 | $\begin{aligned} & \text { iw } \\ & \text { iw } \\ & \text { iw } \\ & \text { iw } \end{aligned}$ |  |  |  |  |  |  | $\begin{aligned} & 22 / 12 \\ & 22 / 12 \\ & 24 / 11 \\ & 24 / 11 \end{aligned}$ | 10 5 20 10 |
| 1N43368 <br> 1N4337 <br> 1N4337A <br> 1N4337B | $\begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}$ | $\begin{aligned} & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \end{aligned}$ |  | 1N4749A <br> 1N4750 <br> IN4750 <br> 1N4750A | $\begin{aligned} & 1 w \\ & 1 w \\ & 1 w \\ & i w \end{aligned}$ |  |  |  |  |  |  | $\begin{aligned} & 24 / 11 \\ & 27 / 9.5 \\ & 27 / 9.5 \\ & 27 / 9.5 \end{aligned}$ | 5 20 10 5 |
| 1N4338 <br> 1N4338A <br> 1N4338B <br> IN4339 | $\begin{aligned} & 5 \\ & 5 \\ & 5 \\ & 5 \end{aligned}$ | $\begin{aligned} & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \end{aligned}$ |  | 1N4751 <br> 1N4751 <br> 1N4751A <br> 1N4752 | $\begin{aligned} & 1 W \\ & 1 w \\ & 1 W \\ & 1 W \end{aligned}$ |  |  |  |  |  |  | $\begin{aligned} & 30 / 8.5 \\ & 30 / 8.5 \\ & 30 / 8.5 \\ & 33 / 7.5 \end{aligned}$ | $\begin{array}{r} 20 \\ 10 \\ 5 \\ 20 \end{array}$ |


| TYPE Number |  | $\begin{aligned} & \frac{3}{6} \\ & \frac{3}{3} \\ & \frac{3}{2} \\ & \frac{1}{5} \\ & 3 \\ & 3 \end{aligned}$ | REPLACEMENT | $\begin{aligned} & \text { FOR } \\ & \text { NEW } \\ & \text { DESMCN } \end{aligned}$ | ratinos |  |  | Characteristics |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  | $\left\lvert\, \begin{gathered} \mathbf{P D}_{\mathrm{D}} \\ (\mathrm{~mW}) \end{gathered}\right.$ | $\mathbf{V}_{\mathbf{R}}$ <br> (V) | I <br> (A) | $\begin{array}{ll} \mathbf{R} & \mathbf{V}_{\mathbf{R}} \\ \mu \mathrm{A} & / \mathbf{V}) \end{array}$ | $\begin{array}{cc} \mathbf{V}_{\mathrm{F}} & \mathbf{l}_{\mathrm{F}} \\ (\mathrm{~V}) & /(\mathrm{mA}) \end{array}$ | ${ }^{1} \pi$ <br> (ns) | $\mathbf{V}_{\mathbf{z}}$ - $\mathbf{I z}_{\mathbf{z}}$ <br> (V) $/$ (mA) | $\begin{gathered} \text { TOX } \\ \% \end{gathered}$ |
| 1N4339A <br> 1N43398 <br> IN4340 <br> 1N4340A | $\begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{S} \\ & \mathbf{S} \end{aligned}$ | $\begin{aligned} & \mathrm{ZD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \end{aligned}$ |  | $\begin{aligned} & \text { IN4752 } \\ & \text { INA752A } \end{aligned}$ | $\begin{aligned} & \text { iw } \\ & \text { iw } \\ & \text { iw } \\ & \text { iw } \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 33 / 7.5 \\ & 33 / 7.5 \\ & 36 / 7 \\ & 36 / 7 \end{aligned}$ | $\begin{array}{r} 10 \\ 5 \\ 20 \\ 10 \end{array}$ |
| 1N43408 <br> 1N4341 <br> IN4341A <br> 1N4341B | $\begin{aligned} & \mathbf{S} \\ & \mathbf{S} \\ & \mathbf{S} \\ & \mathbf{s} \end{aligned}$ | $\begin{aligned} & \mathrm{ZD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \end{aligned}$ |  |  | $\begin{aligned} & \text { iw } \\ & \text { iw } \\ & \text { iw } \\ & \text { iw } \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 36 / 7 \\ & 39 / 6.5 \\ & 39 / 6.5 \\ & 39 / 6.5 \end{aligned}$ | $\begin{array}{r} 5 \\ 20 \\ 10 \\ 5 \end{array}$ |
| 1N4342 <br> IN4342A <br> 1N4342B <br> 1N4343 | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\left\lvert\, \begin{aligned} & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \end{aligned}\right.$ |  |  | $\begin{aligned} & \text { iw } \\ & \text { iw } \\ & \text { iw } \\ & \text { iw } \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 43 / 6 \\ & 43 / 6 \\ & 43 / 6 \\ & 47 / 5.5 \end{aligned}$ | $\begin{array}{r} 20 \\ 10 \\ 5 \\ 20 \end{array}$ |
| 1N4343A <br> 1N4343B <br> 1N4344 <br> IN43A4A | $\left\lvert\, \begin{aligned} & \mathbf{S} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}\right.$ | $\begin{aligned} & \mathrm{ZD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \end{aligned}$ |  |  | $\begin{aligned} & 1 w \\ & 1 w \\ & 1 w \\ & i w \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 47 / 5.5 \\ & 47 / 5.5 \\ & 51 / 5 \\ & 51 / 5 \end{aligned}$ | $\begin{array}{r} 10 \\ 5 \\ 20 \\ 10 \end{array}$ |
| $\begin{aligned} & \text { IN4344B } \\ & \text { IN4345 } \\ & \text { IN4345A } \\ & \text { IN4345B } \end{aligned}$ | $\begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}$ | $\left.\begin{aligned} & z 0 \\ & z 0 \\ & z D \\ & z D \end{aligned} \right\rvert\,$ |  |  | $\begin{aligned} & \text { iw } \\ & \text { 1w } \\ & \text { iw } \\ & \text { iw } \end{aligned}$ |  |  |  |  |  | $51 / 5$ <br> 56/4.5 <br> 56/4.5 <br> 56/4.5 | $\begin{array}{r} 5 \\ 20 \\ 10 \\ 5 \end{array}$ |
| 1N4346 <br> INA346A <br> IN4346B <br> 1N4347 | $\begin{aligned} & 5 \\ & 5 \\ & 5 \\ & 5 \end{aligned}$ | $\left\|\begin{array}{l} \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \end{array}\right\|$ |  |  | $\begin{aligned} & \text { iw } \\ & \text { iw } \\ & \text { iw } \\ & \text { iw } \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 62 / 4 \\ & 62 / 4 \\ & 62 / 4 \\ & 68 / 3.7 \end{aligned}$ | $\begin{array}{r} 20 \\ 10 \\ 5 \\ 20 \end{array}$ |
| $\begin{aligned} & \text { IN4347A } \\ & \text { IN4347B } \\ & \text { 1N4348 } \\ & \text { IN4348A } \end{aligned}$ | $\begin{aligned} & s \\ & s \\ & s \\ & s \\ & s \end{aligned}$ | $\left.\begin{aligned} & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \end{aligned} \right\rvert\,$ |  |  | $\begin{aligned} & \text { IW } \\ & \text { iw } \\ & \text { iw } \\ & \text { iw } \end{aligned}$ |  |  | . |  |  | $\begin{aligned} & 68 / 3.7 \\ & 68 / 3.7 \\ & 75 / 3.3 \\ & 75 / 3.3 \end{aligned}$ | 10 5 20 10 |
| 1N43488 <br> 1N4349 <br> 1N4349A <br> 1N4349B | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\left.\begin{aligned} & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \end{aligned} \right\rvert\,$ |  |  | $\begin{aligned} & \text { iw } \\ & \text { iw } \\ & \text { iw } \\ & \text { iw } \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 75 / 3.3 \\ & 82 / 3 \\ & 82 / 3 \\ & 82 / 3 \end{aligned}$ | 5 20 10 5 |
| 1N4350 <br> IN4350A <br> 1N43508 <br> 1N4351 | $1 \begin{aligned} & 5 \\ & 5 \\ & s \\ & 5 \end{aligned}$ | $\left\|\begin{array}{l} \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \end{array}\right\|$ |  |  | $\begin{aligned} & \text { 1w } \\ & \text { 1w } \\ & \text { iw } \\ & \text { iw } \end{aligned}$ |  |  |  |  |  | $\begin{array}{r} 91 / 2.8 \\ 91 / 2.8 \\ 91 / 2.8 \\ 100 / 2.5 \end{array}$ | 20 10 5 20 |
| IN4351A <br> 1N4351B <br> 1N4352 <br> 1N4352A | $\begin{aligned} & \mathbf{S} \\ & \mathbf{s} \\ & \mathbf{S} \\ & \mathbf{s} \end{aligned}$ | $\begin{aligned} & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \end{aligned}$ |  |  | $\begin{aligned} & \text { iw } \\ & \text { iw } \\ & \text { iw } \\ & \text { iw } \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 100 / 2.5 \\ & 100 / 2.5 \\ & 110 / 2.3 \\ & 110 / 2.3 \end{aligned}$ | 10 5 20 10 |

## DIODE INTERCHANGEABILITY

| TYPE NUMEER |  |  | 7 REPACEMENT | $\begin{aligned} & \text { FOR } \\ & \text { NEW } \\ & \text { DESIGN } \end{aligned}$ | $\begin{gathered} P_{D} \\ (\mathrm{~mW}) \end{gathered}$ | atines <br> $\mathbf{V}_{\mathbf{R}}$ <br> (V) | 1 <br> (A) | $\begin{array}{lll} \mathbf{I}_{\mathbf{R}} & \mathbf{V}_{\mathbf{R}} \\ \mu \mathbf{A} & (\mathbf{V}) \end{array}$ | $\mathbf{V F}_{\mathbf{F}}$ - $\mathbf{l}_{\mathbf{F}}$ <br> (V) $/$ (mA) | IT <br> (ns) | $\mathbf{v}_{\mathbf{Z}} \in \mathbf{z}$ <br> (V) / (mA) |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| $\begin{aligned} & \text { 1N4352B } \\ & \text { 1N4353 } \\ & \text { IN4353A } \\ & \text { 1N4353B } \end{aligned}$ | S | $\begin{aligned} & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \end{aligned}$ |  |  | $\begin{aligned} & \text { iw } \\ & \text { iw } \\ & \text { iw } \\ & \text { iw } \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 110 / 2.3 \\ & 120 / 2 \\ & 120 / 2 \\ & 120 / 2 \end{aligned}$ | 5 20 10 5 |
| $\begin{aligned} & \text { IN4354 } \\ & \text { 1N4354A } \\ & \text { 1N435AB } \\ & \text { 1N4355 } \end{aligned}$ | $\begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}$ | $\left\|\begin{array}{l} \mathrm{ZD} \\ \mathrm{ZD} \\ \mathrm{ZD} \\ \mathrm{ZD} \end{array}\right\|$ |  |  | $\begin{aligned} & 1 \mathrm{w} \\ & 1 \mathrm{w} \\ & \mathrm{iw} \\ & \mathrm{iw} \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 130 / 1.9 \\ & 130 / 1.9 \\ & 130 / 1.9 \\ & 150 / 1.7 \end{aligned}$ | $\begin{array}{r} 20 \\ 10 \\ 5 \\ 20 \end{array}$ |
| $\begin{array}{\|l} \text { 1N4355A } \\ \text { 1N43558 } \\ \text { 1N4356 } \\ \text { 1N4356A } \end{array}$ | $\left\lvert\, \begin{aligned} & \mathbf{S} \\ & \mathbf{S} \\ & \mathbf{s} \\ & \mathbf{S} \end{aligned}\right.$ | $\begin{aligned} & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \end{aligned}$ |  |  | $\begin{aligned} & 1 w \\ & 1 w \\ & 1 w \\ & 1 \mathbf{w} \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 150 / 1.7 \\ & 150 / 7.7 \\ & 160 / 1.6 \\ & 160 / 1.6 \end{aligned}$ | 10 5 20 10 |
| 1N43568 <br> 1N4357 <br> IN4357A <br> 1N4357B | $\begin{aligned} & 5 \\ & s \\ & 5 \\ & 5 \end{aligned}$ | $\begin{aligned} & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \end{aligned}$ |  |  | $\begin{aligned} & \text { iw } \\ & \text { iw } \\ & \text { iw } \\ & \text { iw } \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 160 / 1.6 \\ & 180 / 1.4 \\ & 180 / 1.4 \\ & 180 / 1.4 \end{aligned}$ | 5 20 10 5 |
| 1N4358 <br> IN4358A <br> 1N43588 <br> IN4360 | S | $\left.\begin{aligned} & \mathrm{ZD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \end{aligned} \right\rvert\,$ |  |  | $\begin{aligned} & 1 W \\ & 1 W \\ & 1 W \\ & 250 \end{aligned}$ |  |  |  |  |  | $\begin{gathered} 200 / 1.2 \\ 200 / 1.2 \\ 200 / 1.2 \\ 2.4 / 10 \end{gathered}$ | 20 10 5 5 |
| 1N4361 1N4362 IN4363 iN4364 | $\begin{aligned} & 5 \\ & 5 \\ & 5 \\ & 5 \end{aligned}$ | $\begin{aligned} & R E \\ & S D \\ & S D \\ & R E \\ & R E \end{aligned}$ |  | 1N4007 <br> 1N484 <br> IN4938 <br> TID382 |  | $\begin{aligned} & 900 \\ & 100 \\ & 150 \\ & 100 \end{aligned}$ | $\begin{gathered} .5 \\ .75 \end{gathered}$ | $\begin{gathered} 500 / 900 \\ 10 N / 50 \\ .1 / 120 \\ 100 / 100 \end{gathered}$ | $\begin{array}{r} 1.3 / 500 \\ .9 / 100 \\ 1 / 200 \\ 1.5 / 750 \end{array}$ | 40 |  |  |
| IN4365 <br> 1N4366 <br> 1N4367 <br> 1N4368 | $\begin{aligned} & 5 \\ & 5 \\ & 5 \\ & 5 \end{aligned}$ | $\begin{aligned} & R E \\ & R E \\ & R E \\ & R E \\ & R E \end{aligned}$ |  | $\begin{aligned} & \text { TID383 } \\ & \text { TID384 } \\ & \text { TID384 } \\ & \text { TID385 } \end{aligned}$ |  | $\begin{array}{r} 200 \\ 300 \\ 400 \\ 500 \end{array}$ | $\begin{aligned} & .75 \\ & .75 \\ & .75 \\ & .75 \end{aligned}$ | $\begin{aligned} & 100 / 200 \\ & 100 / 300 \\ & 100 / 400 \\ & 100 / 500 \end{aligned}$ | $\begin{aligned} & 1.5 / 750 \\ & 1.5 / 750 \\ & 1.5 / 750 \\ & 1.5 / 750 \end{aligned}$ |  |  |  |
| 1N4369 <br> 1N4370 <br> 1N4370A <br> IN4371 | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\begin{aligned} & R E \\ & \mathrm{ZD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \end{aligned}$ |  | TID385 | $\begin{array}{r} 400 \\ 400 \\ 400 \end{array}$ | 600 | .75 | 100/600 | 1.5/750 |  | $\begin{aligned} & 2.4 / 20 \\ & 2.4 / 20 \\ & 2.7 / 20 \end{aligned}$ | 10 5 10 |
| 1N4371A <br> IN4372 <br> 1N4372A <br> 1N4373 | $\left\lvert\, \begin{aligned} & s \\ & 5 \\ & 5 \\ & s \end{aligned}\right.$ | $\begin{aligned} & \mathrm{zo} \\ & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{sD} \end{aligned}$ |  | 1N4531 | $\begin{array}{r} 400 \\ 400 \\ 400 \end{array}$ | 100 |  | 25N/20 | 1/10 | 4 | $\begin{aligned} & 2.7 / 20 \\ & 3.0 / 20 \\ & 3.0 / 20 \end{aligned}$ | 5 10 5 |
| 1N4374 <br> 1N4375 <br> iNa376 <br> 1N4377 | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\begin{aligned} & R E \\ & S D \\ & S D \\ & R E \end{aligned}$ |  | $\begin{aligned} & \text { 1N4 } 153 \\ & \text { TID701 } \end{aligned}$ |  | $\begin{array}{r} 1.5 K \\ 60 \\ 20 \\ 25 K \end{array}$ | $\begin{aligned} & .75 \\ & .75 \end{aligned}$ | $\begin{aligned} & 100 / \\ & 10 N / 10 \\ & .1 / 10 \\ & 100 / \end{aligned}$ | $\begin{aligned} & 1.7 / \\ & 1 / 20 \\ & 1.1 / 50 \\ & 30 / \end{aligned}$ | $\begin{array}{r} 6 \\ .75 \end{array}$ |  |  |


|  |  | \% |  |  | RATINOS |  |  | CHARACTERISTICS |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| TYFE Rumber | $\frac{8}{3}$ |  | $\begin{gathered} \text { n } \\ \text { REPLACEMENT } \end{gathered}$ | $\begin{aligned} & \text { FON } \\ & \text { NBW } \\ & \text { DESVAN } \end{aligned}$ |  | $\mathbf{V}_{\mathbf{R}}$ <br> (V) | I <br> (A) | $\begin{array}{cc} \mathbf{k}_{\mathbf{R}} & \mathbf{V}_{\mathrm{R}} \\ \mu \mathrm{~N} & /(\mathrm{V}\rangle \end{array}$ | $\begin{array}{cc} \mathbf{V}_{\mathbf{F}} & \mathbf{i f} \\ \text { (V) } & /(\mathrm{mA}) \end{array}$ | $\begin{aligned} & t r r \\ & (n s) \end{aligned}$ | $\mathbf{v}_{\mathbf{Z}} \quad \mathbf{t z}_{\mathbf{z}}$ <br> (V) $/(\mathrm{mA})$ | $\begin{gathered} \text { rox } \\ \text { \% } \end{gathered}$ |
| 1N4380 <br> 1N4381 <br> 1N4382 <br> 1N4383 | $\begin{aligned} & \mathbf{S} \\ & \mathbf{G} \\ & \mathbf{S} \\ & \mathbf{S} \end{aligned}$ | $\begin{aligned} & \text { SO } \\ & \text { SD } \\ & \text { SD } \\ & \text { RE } \end{aligned}$ |  | T1D383 |  | 50 25 55 200 | 1 | $\begin{aligned} & 50 / 50 \\ & .1 M / \\ & .1 / \\ & 275 / 200 \end{aligned}$ | $\begin{aligned} & 1.4 / 570 \\ & .35 / 2 \\ & 1 / 300 \\ & 1.3 / 1 \mathrm{~A} \end{aligned}$ | $\begin{array}{r} 1.8 \\ 100 \\ 6.5 \end{array}$ |  |  |
| IN4384 <br> 1N4385 <br> 1N4389 <br> 1N4390 | $\left\lvert\, \begin{aligned} & 5 \\ & 5 \\ & 5 \\ & 5 \end{aligned}\right.$ | $\left\|\begin{array}{l} R E \\ R E \\ S D \\ S D \end{array}\right\|$ |  | $\begin{aligned} & \text { TID384 } \\ & \text { TID385 } \\ & \text { IN4148 } \\ & \text { TID701 } \end{aligned}$ |  | $\begin{array}{r} 400 \\ 600 \\ 5 \\ 20 \end{array}$ | 1 | $\begin{gathered} 250 / 400 \\ 225 / 600 \\ 100 / 5 \\ .2 / 5 \end{gathered}$ | $\begin{gathered} 1.3 / 1 \mathrm{~A} \\ 1.3 / 1 \mathrm{~A} \\ 1 / 2 \\ 1 / 5 \end{gathered}$ | . 5 |  |  |
| 1N4391 <br> 1N4392 <br> 1N4400 <br> INH400A | $\left\lvert\, \begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}\right.$ | $\left.\begin{aligned} & S D \\ & \text { SD } \\ & \mathrm{ZD} \\ & \mathrm{ZD} \end{aligned} \right\rvert\,$ |  | $\begin{aligned} & \text { TID701 } \\ & \text { TID701 } \\ & \text { 1N4736 } \\ & \text { 1N4736 } \end{aligned}$ | $\begin{aligned} & \text { iw } \\ & \text { iw } \end{aligned}$ | 20 15 |  | $\begin{aligned} & .2 / 5 \\ & 1 / 5 \end{aligned}$ | $\begin{aligned} & 1 / 2 \\ & 1 / 2 \end{aligned}$ | . 5 | $\begin{aligned} & 6.8 / 37 \\ & 6.8 / 37 \end{aligned}$ | $\begin{aligned} & 20 \\ & 10 \end{aligned}$ |
| 1N44008 <br> 1N4401 <br> IN4401A <br> IN4401B | $\begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}$ | $\left.\begin{aligned} & z 0 \\ & z D \\ & z D \\ & z D \end{aligned} \right\rvert\,$ |  | 1N4736A 1N4737 iN4737 1N4737A | $\begin{aligned} & \text { iw } \\ & \text { iw } \\ & \text { iw } \\ & \text { iw } \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 6.8 / 37 \\ & 7.5 / 34 \\ & 7.5 / 34 \\ & 7.5 / 34 \end{aligned}$ | $\begin{array}{r} 5 \\ 20 \\ 10 \\ 5 \end{array}$ |
| $\begin{aligned} & \text { IN4402 } \\ & \text { INA } 102 \mathrm{~A} \\ & \text { INA402S } \\ & \text { IN4 } 03 \end{aligned}$ | $\begin{aligned} & 5 \\ & 5 \\ & 5 \\ & 5 \end{aligned}$ | $\left.\begin{aligned} & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \end{aligned} \right\rvert\,$ |  | 1N4738 <br> 1N4738 <br> 1N4738A <br> 1N4739 | $\begin{aligned} & \text { iw } \\ & \text { iw } \\ & \text { iw } \\ & \text { iw } \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 8.2 / 31 \\ & 8.2 / 31 \\ & 8.2 / 31 \\ & 9.1 / 28 \end{aligned}$ | $\begin{array}{r} 20 \\ 10 \\ 5 \\ 20 \end{array}$ |
| $\begin{aligned} & \text { IN4403A } \\ & \text { IN4403B } \\ & \text { IN4404 } \\ & \text { INA4O4A } \end{aligned}$ | $\begin{aligned} & s \\ & s \\ & s \\ & s \\ & s \end{aligned}$ | $\begin{aligned} & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \end{aligned}$ |  | IN4739 <br> IN4739A <br> IN4740 <br> IN4740 | $\begin{aligned} & \text { iw } \\ & \text { iw } \\ & \text { iw } \\ & \text { iw } \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 9.1 / 28 \\ & 9.1 / 28 \\ & 10 / 25 \\ & 10 / 25 \end{aligned}$ | $\begin{array}{r} 10 \\ 5 \\ 20 \\ 10 \end{array}$ |
| 1N44048 in4405 IN4405A iN4405B | $\begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}$ | $\left.\begin{aligned} & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \end{aligned} \right\rvert\,$ |  | IMA740A <br> 1N4741 <br> 1N4741 <br> INA741A | 1W 16 16 16 |  |  |  |  |  | $\begin{aligned} & 10 / 25 \\ & 11 / 23 \\ & 11 / 23 \\ & 11 / 23 \end{aligned}$ | 5 20 10 5 |
| 1N4406 <br> 1N4406A <br> 1N4068 <br> in4407 | $\begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{S} \\ & \mathbf{s} \end{aligned}$ | $\begin{aligned} & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \end{aligned}$ |  | 1N4742 <br> 1N4742 <br> IN4742A <br> 1N4743 | $\begin{aligned} & \text { iw } \\ & \text { iw } \\ & \text { iw } \\ & \text { iw } \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 12 / 21 \\ & 12 / 21 \\ & 12 / 21 \\ & 13 / 19 \end{aligned}$ | 20 10 5 20 |
| IN4407A <br> IN4407B <br> IN4408 <br> INA408A | $\left\lvert\, \begin{aligned} & 5 \\ & 5 \\ & 5 \\ & 5 \end{aligned}\right.$ | $\left\lvert\, \begin{aligned} & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \end{aligned}\right.$ |  | IN4743 <br> IN4743A <br> 1N4744 <br> IN4744 | $\begin{aligned} & 1 w \\ & 1 w \\ & 1 w \\ & 1 w \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 13 / 19 \\ & 13 / 19 \\ & 15 / 17 \\ & 15 / 17 \end{aligned}$ | 10 5 20 10 |
| IN4408B <br> 1N4409 <br> IN4410 <br> 1N4410A | $\left\lvert\, \begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}\right.$ | $\begin{aligned} & \mathrm{ZD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \end{aligned}$ |  | INA74AA <br> 1N4745 <br> 1N4746 <br> 1N4746 | $\begin{aligned} & \text { iw } \\ & \text { iw } \\ & \text { iw } \\ & \text { iw } \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 15 / 17 \\ & 16 / 19 \\ & 18 / 14 \\ & 18 / 14 \end{aligned}$ | $\begin{array}{r} 5 \\ 20 \\ 20 \\ 10 \end{array}$ |

## DIODE INTERCHANGEABILITY

| TYPE NUMBER |  |  | 11 REPLACEMENT | $\begin{aligned} & \text { FOR } \\ & \text { NEW } \\ & \text { DESICN } \end{aligned}$ | $P_{D}$ $(\mathrm{mW})$ | tinges <br> $V_{R}$ <br> (V) | I <br> (A) | $\begin{array}{ll} \mathbf{l}_{\mathbf{R}} & \mathbf{V}_{\mathbf{R}} \\ \mu \mathrm{A} & / \mathbf{V}) \end{array}$ | $\begin{aligned} & \mathbf{V}_{\mathbf{F}} \\ & (\mathbf{V}) \end{aligned}$ | $\begin{gathered} \text { CHARACTE } \\ \text { © } \begin{array}{c} \text { IF } \\ /(\mathrm{mA}) \end{array} \end{gathered}$ | $t_{r}$ <br> ( m ) | $\mathbf{v}_{\mathbf{z}} \cdot \mathbf{l}_{\mathbf{z}}$ <br> (V) $/$ (mA) |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 1N4410B <br> 1N4411 <br> 1N4411A <br> 1N441B | $\begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}$ | $\begin{aligned} & \mathrm{ZD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \end{aligned}$ |  | 1N4746A <br> 1N4747 <br> IN4747 <br> 1N4747A | $\begin{aligned} & \text { iw } \\ & \text { iw } \\ & \text { iw } \\ & \text { iw } \end{aligned}$ |  |  |  |  |  |  | $\begin{aligned} & 18 / 14 \\ & 20 / 13 \\ & 20 / 13 \\ & 20 / 13 \end{aligned}$ | 5 20 10 5 |
| 1N4412 <br> 1N4412A <br> 1N4412B <br> IN4413 | $\begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}$ | $\left\|\begin{array}{l} \mathrm{ZD} \\ \mathrm{zD} \\ \mathrm{ZD} \\ \mathrm{ZD} \end{array}\right\|$ |  | $\begin{array}{\|l} \text { 1N4748 } \\ \text { 1N4748 } \\ \text { IN4748A } \\ \text { IN4749 } \end{array}$ | $\begin{aligned} & 16 \\ & 1 w \\ & 1 w \\ & 1 \mathbf{w} \end{aligned}$ |  |  |  |  |  |  | $\begin{aligned} & 22 / 12 \\ & 22 / 12 \\ & 22 / 12 \\ & 24 / 11 \end{aligned}$ | $\begin{array}{r} 20 \\ 10 \\ 5 \\ 20 \end{array}$ |
| IN4413A <br> IN4413B <br> 1N4414 <br> INA414A | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\left\|\begin{array}{l} \mathrm{ZD} \\ \mathrm{ZD} \\ \mathrm{ZD} \\ \mathrm{ZD} \end{array}\right\|$ |  | 1N4749 <br> 1N4749A <br> 1N4750 <br> 1N4750 | $\begin{aligned} & 1 \mathrm{w} \\ & 1 \mathrm{~W} \\ & 1 \mathrm{w} \\ & 1 \mathrm{w} \end{aligned}$ |  |  |  |  |  |  | $\begin{aligned} & 24 / 11 \\ & 24 / 11 \\ & 27 / 9.5 \\ & 27 / 9.5 \end{aligned}$ | $\begin{array}{r} 10 \\ 5 \\ 20 \\ 10 \end{array}$ |
| 1N4414B <br> IN4415 <br> 1N4416 <br> 1N4416A | $\begin{aligned} & 5 \\ & 5 \\ & 5 \\ & \mathrm{~s} \end{aligned}$ | $\begin{aligned} & \mathrm{zD} \\ & \mathrm{ZD} \\ & \mathrm{zD} \\ & \mathrm{ZD} \end{aligned}$ |  | 1N4750A <br> 1N4751 <br> 1N4752 <br> iN4752 | $\begin{aligned} & \text { iw } \\ & \text { iw } \\ & \text { iw } \\ & \text { iw } \end{aligned}$ |  |  |  |  |  |  | $\begin{aligned} & 27 / 9.5 \\ & 30 / 8.5 \\ & 33 / 7.5 \\ & 33 / 7.5 \end{aligned}$ | $\begin{array}{r} 5 \\ 20 \\ 20 \\ 10 \end{array}$ |
| 1N4416B <br> 1N4417 <br> 1N4417A <br> 1N44178 | $\begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}$ | $\left\|\begin{array}{l} \mathrm{ZD} \\ \mathrm{ZD} \\ \mathrm{ZD} \\ \mathrm{ZD} \end{array}\right\|$ |  | 1N4752A | $\begin{aligned} & \text { iw } \\ & \text { iw } \\ & \text { iw } \\ & \text { iw } \end{aligned}$ |  |  |  |  |  |  | $\begin{aligned} & 33 / 7.5 \\ & 36 / 7 \\ & 36 / 7 \\ & 36 / 7 \end{aligned}$ | 5 20 10 5 |
| 1N4418 <br> IN4418A <br> 1N4418B <br> 1N4419 | $\begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}$ | $\left\|\begin{array}{l} \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \end{array}\right\|$ |  |  | $\begin{aligned} & \text { iw } \\ & \text { iw } \\ & \text { iw } \\ & \text { iw } \end{aligned}$ |  |  |  |  |  |  | $\begin{aligned} & 39 / 6.5 \\ & 39 / 6.5 \\ & 39 / 6.5 \\ & 43 / 6 \end{aligned}$ | $\begin{array}{r} 20 \\ 10 \\ 5 \\ 20 \end{array}$ |
| IN4419A <br> 1N4419B <br> 1N4420 <br> IN4420A | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\begin{aligned} & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \end{aligned}$ |  |  | $\begin{aligned} & \text { iw } \\ & \text { iw } \\ & \text { iw } \\ & \text { iw } \end{aligned}$ |  |  |  |  |  |  | $\begin{aligned} & 43 / 6 \\ & 43 / 6 \\ & 47 / 5.5 \\ & 47 / 5.5 \end{aligned}$ | $\begin{array}{r} 10 \\ 5 \\ 20 \\ 10 \end{array}$ |
| $\begin{aligned} & \text { 1N4420B } \\ & \text { 1N4421 } \\ & \text { 1N4422 } \\ & \text { 1N4422A } \end{aligned}$ | $\left\lvert\, \begin{aligned} & 5 \\ & 5 \\ & 5 \\ & s \end{aligned}\right.$ | $\left\|\begin{array}{l} \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \end{array}\right\|$ |  |  | $\begin{aligned} & \text { iw } \\ & \text { iw } \\ & \text { iw } \\ & \text { iw } \end{aligned}$ |  |  |  |  |  |  | $\begin{aligned} & 47 / 5.5 \\ & 51 / 5 \\ & 56 / 4.5 \\ & 56 / 4.5 \end{aligned}$ | $\begin{array}{r} 5 \\ 20 \\ 20 \\ 10 \end{array}$ |
| 1N4422B <br> IN4423 <br> 1N4423A <br> 1N4423B | $\begin{aligned} & \mathbf{s} \\ & s \\ & s \\ & s \end{aligned}$ | $\begin{aligned} & \mathrm{ZD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \end{aligned}$ |  |  | $\begin{aligned} & 1 W \\ & 1 W \\ & 1 W \\ & 1 W \end{aligned}$ |  |  |  |  |  |  | $\begin{aligned} & 56 / 4.5 \\ & 62 / 4 \\ & 62 / 4 \\ & 62 / 4 \end{aligned}$ | 5 20 10 5 |
| 1N4424 <br> 1N4424A <br> 1N4424B <br> 1N4425 | $\begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}$ | $\begin{aligned} & \mathrm{zo} \\ & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \end{aligned}$ |  |  | $\begin{aligned} & \text { iw } \\ & \text { iw } \\ & \text { iw } \\ & \text { iw } \end{aligned}$ |  |  |  |  |  |  | $\begin{aligned} & 68 / 3.7 \\ & 68 / 3.7 \\ & 68 / 3.7 \\ & 75 / 3.3 \end{aligned}$ | $\begin{array}{r} 20 \\ 10 \\ 5 \\ 20 \end{array}$ |


| TYFE Mumest |  | $\begin{gathered} \frac{3}{6} \\ \frac{2}{3} \\ \frac{3}{3} \\ \frac{3}{3} \end{gathered}$ | II |  | ratines |  |  | CHARACTERISTICS |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  | $\left\lvert\, \begin{gathered} \mathbf{P D}_{\mathrm{D}} \\ (\mathrm{~m} W) \end{gathered}\right.$ | $\mathbf{V}_{\mathrm{R}}$ (V) | 1 <br> (A) | $\begin{array}{lll} \mathbf{V}_{\mathbf{R}} & \bullet \mathbf{V}_{\mathrm{R}} \\ \mu \mathrm{~A} & ,(\mathrm{~V}) \end{array}$ | $\begin{array}{cc} V_{F} & \mathbf{V}_{F} \\ (\mathrm{~V}) & /(\mathrm{mA}) \end{array}$ | $\begin{gathered} t r r \\ (n s) \end{gathered}$ | $\begin{aligned} & \mathbf{V}_{\mathbf{z}} \quad \mathbf{z} \\ & (\mathrm{V}) \quad /(\mathrm{mA}) \end{aligned}$ | $\begin{aligned} & \text { for } \\ & \times \end{aligned}$ |
| 1N4423A <br> IN4425B <br> INH26 <br> IN4426A | $\left\lvert\, \begin{aligned} & 5 \\ & 5 \\ & s \\ & 5 \end{aligned}\right.$ | $\left\lvert\, \begin{aligned} & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \end{aligned}\right.$ |  |  | 1w |  |  |  |  |  | $\begin{aligned} & 75 / 3.3 \\ & 75 / 3.3 \\ & 82 / 3 \\ & 82 / 3 \end{aligned}$ | $\begin{array}{r} 10 \\ 5 \\ 20 \\ 10 \end{array}$ |
| $\begin{aligned} & \text { INA4268 } \\ & \text { INA427 } \\ & \text { INA428 } \\ & \text { IN4428A } \end{aligned}$ | $\begin{aligned} & 5 \\ & s \\ & s \\ & s \end{aligned}$ | $\begin{aligned} & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \end{aligned}$ |  |  | $\begin{aligned} & \text { iw } \\ & \text { iw } \\ & \text { iw } \\ & \text { iw } \end{aligned}$ |  |  |  |  |  | $\begin{gathered} 82 / 3 \\ 91 / 2.8 \\ 100 / 2.5 \\ 100 / 2.5 \end{gathered}$ | $\begin{array}{r} 5 \\ 20 \\ 20 \\ 10 \end{array}$ |
| 1N42888 <br> 1N4429 <br> IN4429A <br> 1N4298 | $\begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{S} \\ & \mathbf{s} \end{aligned}$ | $\left.\begin{aligned} & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \end{aligned} \right\rvert\,$ |  |  | $\begin{aligned} & \text { iw } \\ & \text { iw } \\ & \text { iw } \\ & \text { iw } \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 100 / 2.5 \\ & 110 / 2.3 \\ & 110 / 2.3 \\ & 110 / 2.3 \end{aligned}$ | 5 20 10 5 |
| IN4430 IN4430A IN44303 IN4431 | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\begin{aligned} & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \end{aligned}$ | - |  | $\begin{aligned} & \text { iw } \\ & \text { iw } \\ & \text { iw } \\ & \text { iw } \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 120 / 2 \\ & 120 / 2 \\ & 120 / 2 \\ & 130 / 1.9 \end{aligned}$ | 20 10 5 20 |
| $\begin{aligned} & \text { 1N4431A } \\ & \text { iN44318 } \\ & \text { 1N4432 } \\ & \text { INA432A } \end{aligned}$ | $\begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}$ | $\begin{aligned} & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \end{aligned}$ |  |  | $\begin{aligned} & 1 \mathbf{w} \\ & 1 \mathbf{w} \\ & 1 \mathbf{w} \\ & 1 \mathbf{w} \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 130 / 1.9 \\ & 130 / 1.9 \\ & 150 / 1.7 \\ & 150 / 1.7 \end{aligned}$ | 10 5 20 10 |
| 1N44328 <br> IN4433 <br> 1N4334 <br> INA434A | $\left\lvert\, \begin{aligned} & 5 \\ & 5 \\ & 5 \\ & 5 \end{aligned}\right.$ | $\left\|\begin{array}{l} \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \end{array}\right\|$ |  |  | $\begin{aligned} & \text { iw } \\ & \text { iw } \\ & \text { iw } \\ & \text { iw } \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 150 / 1.7 \\ & 160 / 1.6 \\ & 180 / 1.4 \\ & 180 / 1.4 \end{aligned}$ | 5 20 20 10 |
| 1N44348 <br> 1N4435 <br> IN4435A <br> 1NC435B | $\begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}$ | $\left\|\begin{array}{l} \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \end{array}\right\|$ |  |  | $\begin{aligned} & \text { iw } \\ & \text { iw } \\ & \text { iw } \\ & \text { iw } \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 180 / 1.4 \\ & 200 / 1.2 \\ & 200 / 1.2 \\ & 200 / 1.2 \end{aligned}$ | 5 20 10 5 |
| 1N4336 <br> 1N4437 <br> 1N4338 <br> IN4439 | 5 5 5 5 | $\begin{aligned} & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \end{aligned}$ |  |  |  | $\begin{aligned} & 200 \\ & 400 \\ & 600 \\ & 800 \end{aligned}$ | $\begin{aligned} & 10 \\ & 10 \\ & 10 \\ & 10 \end{aligned}$ | $1 \mathrm{M} /$ <br> 1M/ <br> 1M/ <br> 1M/ | $\begin{aligned} & 1.2 / \\ & 1.2 / \\ & 1 / \\ & 1.2 / \end{aligned}$ |  |  |  |
| 1N4440 <br> 1Na4 1 <br> 1N4442 <br> iN443 | S S S S | $\begin{array}{\|l\|} \hline R E \\ R E \\ \text { SD } \\ \text { SD } \end{array}$ |  |  |  | $1 K$ $1.5 K$ 30 50 | $\begin{array}{r} 10 \\ .025 \end{array}$ | $\begin{gathered} 1 M / \\ 1 / \\ 1 N / \\ 2 N / \end{gathered}$ | $\begin{aligned} & 1.2 / \\ & 4 / \\ & 1 / 100 \\ & 1 / 100 \end{aligned}$ | 1 .6 |  |  |
| IN444 <br> 1N445 <br> 1N4446 <br> 1N4447 | $\begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}$ | $\begin{aligned} & \text { SO } \\ & \text { SD } \\ & \text { SD } \\ & \text { SD } \end{aligned}$ | inceld <br> IN446 1N4447 | 1N4151 |  | $\begin{array}{r} 70 \\ 100 \\ 75 \\ 75 \end{array}$ |  | $50 \mathrm{~N} / 50$ <br> 50N/75 <br> $25 \mathrm{~N} / 20$ <br> 25N/20 | $\begin{aligned} & 1 / 100 \\ & 1 / 100 \\ & 1 / 20 \\ & 1 / 20 \end{aligned}$ | $\begin{aligned} & 7 \\ & 4 \\ & 4 \\ & 4 \end{aligned}$ |  |  |

## DIODE INTERCHANGEABILITY

| TYFE NUMEER |  |  | 7 REPLACEMENT | $\begin{aligned} & \text { FOR } \\ & \text { NEW } \\ & \text { DESICN } \end{aligned}$ | $P_{D}$ (mW) | tines <br> $\mathbf{V}_{\mathbf{R}}$ <br> (V) | I <br> (A) | $\begin{array}{ll} \mathbf{I}_{\mathbf{R}} & \mathbf{V}_{\mathbf{R}} \\ \mu \mathbf{A} & /(\mathbf{V}) \end{array}$ | CHARACT <br> $\mathbf{V}_{\mathbf{F}}$ • $\mathbf{I F}$ <br> (V) $/$ (mA) | RISTIC $\begin{aligned} & \text { Itr } \\ & \hline \end{aligned}$ | $\mathbf{v}_{\mathbf{z}} \cdot \mathbf{l}_{\mathbf{z}}$ <br> (V) / (mA) | TOL \% |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| IN4488 <br> 1N4449 <br> IN4451 <br> 1N4450 | $\left[\begin{array}{l} s \\ s \\ s \\ s \end{array}\right.$ | $\begin{aligned} & \text { SD } \\ & \text { SD } \\ & \text { SD } \\ & \text { SD } \end{aligned}$ | 1N4448 1N449 | IN4151 IN4150 |  | 75 75 40 40 |  | 25N/20 <br> 25N/20 <br> 50N/30 <br> 50N/30 | $\begin{aligned} & .72 / 5 \\ & .73 / 5 \\ & .87 / 100 \\ & .92 / 100 \end{aligned}$ | 4 4 10 4 |  |  |
| 1N4452 <br> IN4453 <br> iN4454 <br> IN4455 | $\begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}$ | $\begin{aligned} & \text { SD } \\ & \text { SD } \\ & \text { SD } \\ & \text { SD } \end{aligned}$ | 1N4454 | $\begin{aligned} & \text { 1N4608 } \\ & \text { IN4448 } \\ & \text { 1N4305 } \end{aligned}$ |  | 30 20 75 50 |  | $\begin{array}{r} 50 \mathrm{~N} / 30 \\ 50 \mathrm{~N} / 20 \\ .1 / 50 \\ .1 / 20 \end{array}$ | $\begin{gathered} 1 / 600 \\ .92 / 100 \\ 1 / 10 \\ .7 / 5 \end{gathered}$ | $\begin{array}{r} 20 \\ 2 \end{array}$ |  |  |
| 1N4456 <br> IN4457 <br> IN4458 <br> 1N4459 | $\begin{aligned} & 5 \\ & 5 \\ & 5 \\ & 5 \end{aligned}$ | $\left\lvert\, \begin{aligned} & S D \\ & S D \\ & R E \\ & R E \end{aligned}\right.$ | , | $\begin{aligned} & \text { 1N4150 } \\ & \text { 1N4150 } \end{aligned}$ |  | $\begin{array}{r} 35 \\ 50 \\ 800 \\ 1 \mathrm{~K} \end{array}$ | 5 5 | $\begin{aligned} & .2 / 30 \\ & .2 / 40 \\ & 500 / \\ & 500 / \end{aligned}$ | $\begin{aligned} & 1 / 150 \\ & 1 / 200 \\ & 1.5 / \\ & 1.5 / \end{aligned}$ | 1.5 |  |  |
| 1N4460 <br> IN4461 <br> 1N4462 <br> 1N4463 | $\left\lvert\, \begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}\right.$ | $\left\lvert\, \begin{aligned} & \mathrm{zD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \end{aligned}\right.$ |  | 1N4735A <br> 1N4736A <br> IN4737A <br> 1N4738A | $\begin{aligned} & 1.5 \mathrm{~W} \\ & 1.5 \mathrm{~W} \\ & 1.5 \mathrm{~W} \\ & 1.5 \mathrm{~W} \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 6.2 / 40 \\ & 6.8 / 37 \\ & 7.5 / 34 \\ & 8.2 / 31 \end{aligned}$ | 5 5 5 5 |
| 7N4464 <br> 1 N4465 <br> 1N4466 <br> 1NA467 | $\begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}$ | $\begin{aligned} & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \end{aligned}$ |  | 1N4739A <br> 1N4740A <br> IN4741A <br> 1N4742A | $\begin{aligned} & 1.5 \mathrm{~W} \\ & 1.5 \mathrm{~W} \\ & 1.5 \mathrm{~W} \\ & 1.5 \mathrm{~W} \end{aligned}$ |  |  |  |  |  | $\begin{gathered} 9.1 / 28 \\ 10 / 25 \\ 11 / 23 \\ 12 / 21 \end{gathered}$ | 5 5 5 5 |
| 1N4468 <br> 1N4469 <br> 1N4470 <br> 1 N4471 | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\begin{aligned} & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \end{aligned}$ |  | 1N4743A <br> 1N4744A <br> 1N4745A <br> 1N4746A | $\begin{aligned} & 1.5 \mathrm{~W} \\ & 1.5 \mathrm{~W} \\ & 1.5 \mathrm{~W} \\ & 1.5 \mathrm{~W} \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 13 / 19 \\ & 15 / 17 \\ & 16 / 16 \\ & 18 / 14 \end{aligned}$ | $\begin{aligned} & 5 \\ & 5 \\ & 5 \\ & 5 \end{aligned}$ |
| IN4472 <br> IN4473 <br> IN4474 <br> 1N4475 | $\left\lvert\, \begin{aligned} & 5 \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\left\|\begin{array}{l} \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \end{array}\right\|$ |  | 1N4747A <br> 1N4748A <br> 1N4749A <br> IN4750A | $\begin{aligned} & 1.5 \mathrm{~W} \\ & 1.5 \mathrm{~W} \\ & 1.5 \mathrm{~W} \\ & 1.5 \mathrm{~W} \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 20 / 13 \\ & 22 / 12 \\ & 24 / 11 \\ & 27 / 9.5 \end{aligned}$ | 5 5 5 5 |
| 1N476 <br> 1N4477 <br> 1N4478 <br> 1N4479 | $\begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{S} \\ & \mathbf{s} \end{aligned}$ | $\left\|\begin{array}{l} z 0 \\ z 0 \\ z 0 \\ z D \end{array}\right\|$ |  | 1N4751A 1N4752A | $\begin{aligned} & 1.5 \mathrm{~W} \\ & 1.5 \mathrm{~W} \\ & 1.5 \mathrm{~W} \\ & 1.5 \mathrm{~W} \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 30 / 8.5 \\ & 33 / 7.5 \\ & 36 / 7 \\ & 39 / 6.5 \end{aligned}$ | 5 5 5 5 |
| 1N4480 <br> 1N4481 <br> 1N4482 <br> IN4483 | $\left\lvert\, \begin{aligned} & \mathbf{s} \\ & \mathbf{S} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}\right.$ | $\left\|\begin{array}{l} z D \\ z D \\ z D \\ 20 \end{array}\right\|$ |  |  | $\begin{aligned} & 1.5 \mathrm{~W} \\ & 1.5 \mathrm{~W} \\ & 1.5 \mathrm{~W} \\ & 1.5 \mathrm{~W} \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 43 / 6 \\ & 47 / 5.5 \\ & 51 / 5 \\ & 56 / 4.5 \end{aligned}$ | 5 5 5 5 |
| IN4484 IN4885 IN4486 1N4487 | $\begin{aligned} & 5 \\ & 5 \\ & 5 \\ & 5 \end{aligned}$ | $\begin{aligned} & 20 \\ & 20 \\ & 20 \\ & 20 \end{aligned}$ |  |  | $\begin{aligned} & 1.5 \mathrm{~W} \\ & 1.5 \mathrm{~W} \\ & 1.5 \mathrm{~W} \\ & 1.5 \mathrm{~W} \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 62 / 4 \\ & 68 / 3.7 \\ & 75 / 3.3 \\ & 82 / 3 \end{aligned}$ | $\begin{aligned} & 5 \\ & 5 \\ & 5 \\ & 5 \end{aligned}$ |


| TYP: NUMEER |  |  | $\begin{gathered} \text { T } \\ \text { REPLACEMENT } \end{gathered}$ | $\begin{aligned} & \text { FOR } \\ & \text { NRW } \\ & \text { DESHCN } \end{aligned}$ | ratines |  |  | CHARACTERISTICS |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  |  | $\mathbf{V}_{\mathbf{R}}$ <br> (V) | I <br> (A) | $\begin{array}{ll} \mathbf{R} & \mathbf{V}_{\mathbf{R}} \\ \boldsymbol{\mu} & /(\mathbf{V}) \end{array}$ | $\begin{array}{ccc} \mathbf{V F}_{F} & \mathbf{F} \\ \text { (V) } & /(\mathrm{mA}) \end{array}$ | $\begin{gathered} \mathbf{I}_{\mathbf{r}} \\ \text { (ns) } \end{gathered}$ | $\begin{array}{ll} \mathbf{V}_{\mathbf{Z}} & \mathbf{l} \mathbf{Z} \\ (\mathbf{V}) & /(\mathrm{mA}) \end{array}$ | $\begin{gathered} \text { rol } \\ \times \end{gathered}$ |
| 1N4488 1N4489 <br> iN4490 1N4491 | $\begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}$ | $\begin{aligned} & \mathrm{ZD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \end{aligned}$ |  |  | $\begin{aligned} & 1.5 \mathrm{~W} \\ & 1.5 \mathrm{~W} \\ & 1.5 \mathrm{~W} \\ & 1.5 \mathrm{~W} \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 91 / 2.8 \\ & 100 / 2.5 \\ & 110 / 2.3 \\ & 120 / 2 \end{aligned}$ | 5 5 5 5 |
| 1N4492 <br> 1N4493 <br> IN4494 <br> 1N4495 | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\begin{aligned} & \mathrm{ZD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \end{aligned}$ |  |  | $\begin{aligned} & 1.5 \mathrm{~W} \\ & 1.5 \mathrm{~W} \\ & 1.5 \mathrm{~W} \\ & 1.5 \mathrm{~W} \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 130 / 1.9 \\ & 150 / 1.7 \\ & 160 / 1.6 \\ & 180 / 1.4 \end{aligned}$ | 5 5 5 5 |
| 1N4496 1N4497 IN4498 1N4499 | $\begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}$ | $\left\|\begin{array}{l} \mathrm{ZD} \\ \mathrm{RE} \\ \mathrm{RE} \\ \mathrm{ZD} \end{array}\right\|$ |  | 1N4735A | $1.5 \mathrm{~W}$ <br> IW | $\begin{array}{r} 1.6 K \\ 3 K \end{array}$ | $\begin{aligned} & .75 \\ & .75 \end{aligned}$ | $\begin{aligned} & 100 / \\ & 100 \% \end{aligned}$ | $\begin{aligned} & 3 / \\ & 5 / \end{aligned}$ |  | $\begin{aligned} & 200 / 1.2 \\ & 6.2 / 7.5 \end{aligned}$ | 5 <br> 5 |
| $\begin{aligned} & \text { IN4500 } \\ & \text { IN4502 } \\ & \text { IN4505 } \\ & \text { IN4506 } \end{aligned}$ | $\left\lvert\, \begin{aligned} & 5 \\ & G \\ & S \\ & S \end{aligned}\right.$ | $\left\lvert\, \begin{aligned} & S D \\ & S D \\ & R E \\ & R E \\ & R E \end{aligned}\right.$ |  | $\begin{aligned} & \text { 1NA607 } \\ & \text { 1N4305 } \end{aligned}$ |  | $\begin{array}{r} 100 \\ 20 \\ 6 K \\ 200 \end{array}$ | . 12 | $\begin{aligned} & .1 / 75 \\ & 10 / 6 \\ & 100 / \end{aligned}$ | $\begin{aligned} & 1 / 300 \\ & .3 / 3 \\ & 8.5 / \\ & 1.4 / \end{aligned}$ | 4 |  |  |
| $\begin{aligned} & \text { 1N4507 } \\ & \text { 1N4508 } \\ & \text { 1N4509 } \\ & \text { 1N4510 } \end{aligned}$ | $\begin{aligned} & s \\ & s \\ & s \\ & s \\ & s \end{aligned}$ | $\begin{array}{\|l\|} \mathbf{R E} \\ \mathrm{RE} \\ \mathrm{RE} \\ \mathrm{RE} \end{array}$ |  |  |  | 400 600 800 $1 K$ | $\begin{aligned} & 12 \\ & 12 \\ & 12 \\ & 12 \end{aligned}$ | 2M/ | $\begin{aligned} & 1.4 / \\ & 1.4 / \\ & 1.4 / \\ & 1.4 / \end{aligned}$ |  |  |  |
| IN4511 <br> 1N4512 <br> IN4513 <br> 1N4514 | $\begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}$ | $\begin{aligned} & \text { RE } \\ & \text { SD } \\ & \text { RE } \\ & \text { RE } \end{aligned}$ |  |  |  | $\begin{array}{r} 1.2 K \\ 10 \\ 2 K \\ 800 \end{array}$ | $\begin{aligned} & 12 \\ & .25 \\ & 1.1 \end{aligned}$ | $\begin{aligned} & 10 \mathrm{~N} / \\ & 100 / \\ & 100 / \end{aligned}$ | $\begin{aligned} & 1.4 / \\ & .77 / 5 \\ & 4.5 / \\ & 1 / \end{aligned}$ |  |  |  |
| 1N4517 <br> iN4523 <br> iN4524 <br> 1N4531 | $\left\lvert\, \begin{aligned} & s \\ & G \\ & G \\ & S \end{aligned}\right.$ | $\begin{array}{\|c\|} \text { RE } \\ \text { SD } \\ \text { SD } \\ \text { SD } \end{array}$ | 1N4531 | $\begin{aligned} & \text { 1N4305 } \\ & \text { IN4305 } \end{aligned}$ |  | 200 15 10 75 | 2 | $\begin{aligned} & 100 / \\ & 30 / 10 \\ & 12 / 6 \\ & 25 N / 20 \end{aligned}$ | $\begin{aligned} & 1.2 / \\ & .5 / 10 \\ & .65 / 10 \\ & 1 / 10 \end{aligned}$ | 8 3 4 |  |  |
| 1N4532 <br> 1N4533 <br> 1N4534 <br> 1N4535 | $\begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}$ | $\begin{aligned} & \text { SD } \\ & \text { SD } \\ & \text { SD } \\ & \mathrm{ZD} \end{aligned}$ | 1N4532 <br> 1N4533 <br> 1N4534 |  | 500 | 75 40 75 |  | $\begin{array}{r} .1 / 50 \\ 50 \mathrm{~N} / 30 \\ 50 \mathrm{~N} / 50 \end{array}$ | $\begin{array}{r} 1 / 10 \\ .88 / 20 \\ .88 / 20 \end{array}$ | 2 | 3.45/5 | 5 |
| 1N4536 <br> 1N4537 <br> 1N4538 <br> iN4539 | $\left\lvert\, \begin{aligned} & 5 \\ & 5 \\ & 5 \\ & 5 \end{aligned}\right.$ | $\begin{aligned} & \mathrm{SD} \\ & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \end{aligned}$ | 1N4536 |  |  | 35 $1.5 K$ $2 K$ $2.5 K$ | 3 3 3 | .1/25 | $\begin{array}{r} 1 / 30 \\ 1.8 / .3 \\ 1.8 / .3 \\ 1.8 / .3 \end{array}$ | 2 |  |  |
| iN4540 <br> 1N4541 <br> 1N4542 <br> 1N4543 | S S S S | $\begin{aligned} & \text { RE } \\ & \text { SD } \\ & \text { SD } \\ & \text { SD } \end{aligned}$ |  |  |  | $\begin{array}{r} 3 K \\ 225 \\ 400 \\ 600 \end{array}$ | 3 | $\begin{aligned} & 20 N / 225 \\ & 20 N / 400 \\ & 20 N / 600 \end{aligned}$ | $\begin{aligned} & 1.8 / .3 \\ & 1 / 400 \\ & 1 / 400 \\ & 1 / 400 \end{aligned}$ |  |  |  |


| TYPE number | $\begin{aligned} & \overrightarrow{2} \\ & \frac{2}{2} \\ & \frac{1}{E} \end{aligned}$ |  | $\underset{\text { REPLACEMENT }}{\text { II }}$ | $\begin{gathered} \text { FOR } \\ \text { NEW } \\ \text { DESIGN } \end{gathered}$ | $\begin{gathered} P_{D} \\ (m W) \end{gathered}$ | inges $\mathbf{V}_{\mathbf{R}}$ (V) | (A) | $\begin{array}{ll} \mathbf{l}_{\mathbf{R}} & \mathbf{V}_{\mathbf{R}} \\ \mu_{\mathrm{A}} & /(\mathbf{V}) \end{array}$ | $\mathbf{V F}_{\mathrm{F}}$ - $\mathrm{I}_{\mathrm{F}}$ <br> (V) $/$ (mA) | ristic <br> trr <br> (ms) | $\begin{array}{ccc} v_{z} & c & l z \\ (v) & /(\mathrm{ma}) \end{array}$ | $\begin{gathered} \text { rol } \\ \text { \% } \end{gathered}$ |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 1 N 4544 <br> 1N4545 <br> iN4546 <br> 1N4547 | $\begin{array}{\|l} \hline \mathbf{s} \\ \mathbf{s} \\ \mathbf{s} \\ \mathbf{s} \end{array}$ | S |  | 1N649 <br> 1N4151 |  | 800 $1 K$ $25 K$ 25 | 1 | $\begin{aligned} & 20 \mathrm{~N} / 800 \\ & 20 \mathrm{~N} / 1 \mathrm{~K} \\ & 100 / \\ & 10 \mathrm{~N} / 25 \end{aligned}$ | $\begin{gathered} 1 / 400 \\ 1 / 400 \\ 30 / \\ 1 / 25 \end{gathered}$ |  |  |  |
| 1N4548 <br> 1N4565 <br> 1N4565A <br> 1N4566 | $\begin{aligned} & \mathbf{s} \\ & s \\ & s \\ & s \end{aligned}$ | SD RD RD RD | - | IN4536 | $\begin{array}{r} 400 \\ 400 \\ 400 \end{array}$ | 35 |  | .1/25 | 1/30 | 4 | 6.4/. 5 <br> 6.4/.5 <br> 6.4/.5 | 5 5 5 |
| 1N4566A 1N4567 1N4567A 1N4568 | $\begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}$ |  |  |  | $\begin{aligned} & 400 \\ & 400 \\ & 400 \\ & 400 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 6.4 / .5 \\ & 6.4 / .5 \\ & 6.4 / .5 \\ & 6.4 / .5 \end{aligned}$ | 5 5 5 5 |
| 1N4568A 1N4569 1N4569A IN4570 | $\begin{array}{\|l} \hline \mathbf{s} \\ \mathrm{s} \\ \mathrm{~s} \\ \mathrm{~s} \end{array}$ | $\left.\begin{aligned} & \mathbf{R D} \\ & \mathbf{R D} \\ & \mathbf{R D} \\ & \mathbf{R D} \end{aligned} \right\rvert\,$ |  |  | $\begin{aligned} & 400 \\ & 400 \\ & 400 \\ & 400 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 6.4 / .5 \\ & 6.4 / .5 \\ & 6.4 / .5 \\ & 6.4 / 1 \end{aligned}$ | 5 5 5 5 |
| ina570A <br> 1N4571 <br> IN4571A <br> 1N4572 | $\begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \hline \end{aligned}$ | $\left.\begin{array}{\|l\|} \mathrm{RD} \\ \mathrm{RD} \\ \mathrm{RD} \\ \mathrm{RD} \end{array} \right\rvert\,$ |  |  | $\begin{aligned} & 400 \\ & 400 \\ & 400 \\ & 400 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 6.4 / 1 \\ & 6.4 / 1 \\ & 6.4 / 1 \\ & 6.4 / 1 \end{aligned}$ | 5 5 5 5 |
| 1N4572A <br> 1N4573 <br> iN4573A <br> in4574 | $\begin{aligned} & \hline s \\ & 5 \\ & s \\ & s \end{aligned}$ | $\left.\begin{array}{\|l\|} \hline R D \\ R D \\ R D \\ R D \\ R D \end{array} \right\rvert\,$ |  |  | $\begin{aligned} & 400 \\ & 400 \\ & 400 \\ & 400 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 6.4 / 1 \\ & 6.4 / 1 \\ & 6.4 / 1 \\ & 6.4 / 1 \end{aligned}$ | 5 5 5 5 |
| 1N4574A <br> 1N4575 <br> 1N4575A <br> IN4576 | $\begin{aligned} & \mathbf{s} \\ & s \\ & s \\ & s \end{aligned}$ | $\begin{array}{l\|} \mathrm{RD} \\ \mathrm{RD} \\ \mathrm{RD} \\ \mathrm{RD} \end{array}$ |  |  | $\begin{aligned} & 400 \\ & 400 \\ & 400 \\ & 400 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 6.4 / 1 \\ & 6.4 / 2 \\ & 8.4 / 2 \\ & 6.4 / 2 \end{aligned}$ | 5 5 5 5 |
| 1N4576A 1N4577 <br> 1N4577A <br> 1N4578 | $\begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}$ | $\left\|\begin{array}{l} R D \\ R D \\ R D \\ R D \end{array}\right\|$ |  |  | $\begin{aligned} & 400 \\ & 400 \\ & 400 \\ & 400 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 6.4 / 2 \\ & 6.4 / 2 \\ & 6.4 / 2 \\ & 6.4 / 2 \end{aligned}$ | 5 5 5 5 |
| iN4578A iN4579 IN4579A IN4580 | $\left\lvert\, \begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}\right.$ | $\left\|\begin{array}{l\|} \mathrm{RD} \\ \mathrm{RD} \\ \mathrm{RD} \\ \mathrm{RD} \end{array}\right\|$ |  |  | $\begin{aligned} & 400 \\ & 400 \\ & 400 \\ & 400 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 6.4 / 2 \\ & 6.4 / 2 \\ & 6.4 / 2 \\ & 6.4 / 4 \end{aligned}$ | 5 5 5 5 |
| IN4580A IN4581 IN4581A 1N4582 | $\begin{aligned} & \mathbf{s} \\ & s \\ & s \\ & s \\ & s \end{aligned}$ | $\left\|\begin{array}{l} R D \\ R D \\ R D \\ R D \end{array}\right\|$ |  |  | $\begin{aligned} & 400 \\ & 400 \\ & 400 \\ & 400 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 6.4 / 4 \\ & 6.4 / 4 \\ & 6.4 / 4 \\ & 6.4 / 4 \end{aligned}$ | 5 5 5 5 |


| TYPE NUMEER |  |  | $\pi$ <br> replacement |  | RAtings |  |  | CHARACTERISTICS |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  | PD <br> (mW) | $\begin{aligned} & V_{R} \\ & (V) \end{aligned}$ | I <br> (A) | $\begin{array}{ll} \mathbf{V}_{\mathbf{R}} & \mathbf{V}_{\mathbf{R}} \\ \mu_{\mathrm{A}} & /(\mathbf{V}) \end{array}$ | $\mathbf{V F}_{\mathrm{F}}$ - $\mathbf{I F}_{\mathbf{F}}$ <br> (V) $/$ (mA) | $\begin{aligned} & 1 \pi \\ & (n s) \end{aligned}$ | $\mathbf{v}_{\mathbf{z}}$ - $\mathbf{z}$ <br> (V) $/$ (mA) | $\begin{aligned} & \text { TOL } \\ & \% \end{aligned}$ |
| IN4582A <br> IN4583 <br> 1N4583A <br> 1N4584 | $\left\lvert\, \begin{aligned} & 5 \\ & 5 \\ & 5 \\ & 5 \end{aligned}\right.$ | $\left\lvert\, \begin{aligned} & \mathrm{RD} \\ & \mathrm{RD} \\ & \mathrm{RD} \\ & \mathrm{RD} \end{aligned}\right.$ |  |  | $\begin{array}{r} 400 \\ 400 \\ 400 \\ 400 \end{array}$ |  |  | . |  |  | 6.4/4 <br> 6.4/4 <br> 6.4/4 <br> 6.4/4 | 5 5 5 5 |
| 1N4584A <br> 1N4585 <br> 1N4586 <br> 1N4596 | $\left\lvert\, \begin{aligned} & \mathbf{S} \\ & \mathbf{S} \\ & \mathbf{S} \\ & \mathbf{s} \end{aligned}\right.$ | $\begin{aligned} & \mathrm{RD} \\ & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \end{aligned}$ |  | $\begin{aligned} & \text { TID387 } \\ & \text { TID387 } \end{aligned}$ | 400 | $\begin{array}{r} 800 \\ 1 \mathrm{~K} \\ 1.4 \mathrm{~K} \end{array}$ | $\begin{aligned} & 1 \\ & 1 \end{aligned}$ | $\begin{aligned} & 2 / 800 \\ & 2 / 1 K \end{aligned}$ | $\begin{aligned} & 1.3 / 1 \mathrm{~A} \\ & 1.3 / 1 \mathrm{~A} \\ & 1.3 / 3.5 \end{aligned}$ |  | 6.4/4 | 5 |
| 1N4597 <br> 1N4606 <br> 1N4607 <br> IN4608 | $\begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}$ | $\begin{array}{c\|c} \text { RE } & \\ \text { SD } & 1 \\ \text { SD } & 1 \\ \text { SD } & 1 \end{array}$ |  |  |  | $\begin{aligned} & 5 K \\ & 85 \\ & 85 \\ & 85 \end{aligned}$ | . 025 | $\begin{aligned} & .25 / 70 \\ & .25 / 70 \\ & .25 / 70 \end{aligned}$ | $\begin{aligned} & 5 / \\ & 1 / 200 \\ & .95 / 250 \\ & .96 / 350 \end{aligned}$ | 6 10 10 |  |  |
| 1N4610 1N4611 1N4611A 1N4611B | $\begin{aligned} & \mathbf{s} \\ & \mathbf{S} \\ & \mathbf{S} \\ & \mathbf{s} \end{aligned}$ | $\left.\begin{aligned} & \mathrm{SD} \\ & \mathrm{RD} \\ & \mathrm{RD} \\ & \mathrm{RD} \end{aligned} \right\rvert\,$ |  | IN4150 | $\begin{aligned} & 250 \\ & 250 \\ & 250 \end{aligned}$ | 80 |  | .1/55 | 1.1/300 | 2 | $\begin{aligned} & 6.6 / 2 \\ & 6.6 / 2 \\ & 6.6 / 2 \end{aligned}$ |  |
| 1N4611C <br> 1N4612 <br> 1N4612A <br> 1N4612B | $\left\lvert\, \begin{aligned} & 5 \\ & s \\ & s \\ & 5 \end{aligned}\right.$ | $\left.\begin{array}{\|l\|} \mathrm{RD} \\ \mathrm{RD} \\ \mathrm{RD} \\ \mathrm{RD} \\ \mathrm{RD} \end{array} \right\rvert\,$ |  |  | $\begin{aligned} & 250 \\ & 250 \\ & 250 \\ & 250 \end{aligned}$ |  | - |  |  |  | $\begin{aligned} & 6.6 / 2 \\ & 6.6 / 5 \\ & 6.6 / 5 \\ & 6.6 / 5 \end{aligned}$ |  |
| IN4612C <br> 1N4613 <br> IN4613A <br> 1N4613B | $\begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}$ | $\left.\begin{array}{\|l\|} \mathrm{RD} \\ \mathrm{RD} \\ \mathrm{RD} \\ \mathrm{RD} \end{array} \right\rvert\,$ |  |  | 250 250 250 250 |  |  |  |  |  | $\begin{aligned} & 6.6 / 5 \\ & 6.6 / 10 \\ & 6.6 / 10 \\ & 6.6 / 10 \end{aligned}$ |  |
| 1N4613C <br> 1N4614 <br> 1Na615 <br> 1N4616 | $\begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}$ | $\left\|\begin{array}{l} \mathrm{RD} \\ \mathrm{ZD} \\ \mathrm{ZD} \\ \mathrm{ZD} \end{array}\right\|$ |  |  | 250 250 250 250 |  |  |  |  |  | $\begin{array}{r} 6.6 / 10 \\ 1.8 / .25 \\ 2 / .25 \\ 2.2 / .25 \end{array}$ | 5 5 5 |
| 1 N4617 <br> 1N4618 <br> IN4619 <br> 1N4620 | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\left\|\begin{array}{l} \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{ZD} \end{array}\right\|$ |  |  | 250 250 250 250 |  |  | . |  |  | $\begin{array}{r} 2.4 / .25 \\ 2.7 / .25 \\ 3 / .25 \\ 3.3 / .25 \end{array}$ | 5 5 5 5 |
| IN4621 <br> IN4622 <br> 1N4623 <br> iN4624 | $\begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}$ | $\left\lvert\, \begin{aligned} & \mathrm{ZD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \end{aligned}\right.$ |  |  | 250 250 250 250 |  |  |  |  |  | $\begin{aligned} & 3.6 / .25 \\ & 3.9 / .25 \\ & 4.3 / .25 \\ & 4.7 / .25 \end{aligned}$ | 5 5 5 5 |
| 1N4625 <br> 1N4626 <br> 1N4627 <br> 1N4628 | S | $\begin{aligned} & \mathrm{ZD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \end{aligned}$ |  | 1N4736A | $\begin{aligned} & 250 \\ & 250 \\ & 250 \\ & 600 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 5.1 / .25 \\ & 5.6 / .25 \\ & 6.2 / .25 \\ & 6.8 / 19 \end{aligned}$ | 5 5 5 5 |

## DIODE INTERCHANGEABILITY



|  | 2 | $\left\|\begin{array}{l} \mathbf{z} \\ \mathbf{8} \end{array}\right\|$ |  |  | RAtines |  |  | CHARACTERHSTICS |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| TYPE MUMEER | $\frac{\text { 萨 }}{\frac{2}{2}}$ |  | $\pi$ <br> replacement | FOR <br> NEW DESTEN | $\begin{gathered} P D \\ (\mathrm{~mW}) \end{gathered}$ | $\begin{aligned} & V_{R} \\ & (V) \end{aligned}$ | 1 <br> (A) | $\begin{array}{ll} \mathbf{I}_{\mathbf{R}} & \oplus \mathbf{V}_{\mathbf{R}} \\ \mu_{\mathbf{N}} & /(\mathbf{V}) \end{array}$ | $\begin{array}{ll} \mathbf{V}_{F} & \mathbf{F}_{\mathbf{F}} \\ \text { (V) } & / \mathrm{ma}) \end{array}$ | (ns) | $\begin{array}{llc} \mathbf{v}_{\mathbf{z}} & \mathrm{Z} \\ (\mathrm{~V}) & / \mathrm{mA}) \end{array}$ | $\begin{aligned} & \text { 10 } \\ & \text { \% } \end{aligned}$ |
| IN4669 <br> IN4670 <br> IN4671 <br> 1N4672 | s | $\left\|\begin{array}{c} \mathrm{zD} \\ \mathbf{z D} \\ \mathbf{z D} \\ \mathbf{z D} \end{array}\right\|$ |  | IN4748A <br> IN4749A <br> IN4750A <br> IN4751A | $\begin{aligned} & \text { iw } \\ & \text { iw } \\ & \text { iw } \\ & \text { iw } \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 22 / 12 \\ & 24 / 11 \\ & 27 / 9.5 \\ & 30 / 8.5 \end{aligned}$ | 5 5 5 5 |
| 1N4673 <br> iN4674 <br> 1N4675 <br> IN4676 | $\left\lvert\, \begin{aligned} & 5 \\ & 5 \\ & 5 \\ & 5 \end{aligned}\right.$ | $\left\|\begin{array}{c} \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \end{array}\right\|$ |  | 1N4752A | $\begin{aligned} & 1 w \\ & 1 w \\ & 1 \mathbf{1 w} \\ & 1 w \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 33 / 7.5 \\ & 36 / 7 \\ & 39 / 6.5 \\ & 43 / 6 \end{aligned}$ | 5 5 5 5 |
| 1N4677 <br> 1N4678 <br> 1N4679 <br> IN4680 | $\left\lvert\, \begin{aligned} & 5 \\ & 5 \\ & 5 \\ & 5 \end{aligned}\right.$ | $\left\|\begin{array}{l} \mathrm{zD} \\ \mathrm{ZD} \\ \mathrm{ZD} \\ \mathrm{ZD} \end{array}\right\|$ |  |  | $\begin{aligned} & 1 w \\ & 250 \\ & 250 \\ & 250 \end{aligned}$ |  |  |  |  |  | $\begin{array}{r} 47 / 5.5 \\ 1.8 / .05 \\ 2 / .05 \\ 2.2 / .05 \end{array}$ | 5 5 5 5 |
| 1N4681 <br> 1N4682 <br> 1N4683 <br> 1N4684 | $\begin{aligned} & \mathbf{S} \\ & \mathbf{S} \\ & \mathbf{S} \\ & \mathbf{S} \end{aligned}$ | $\left\|\begin{array}{l} \mathrm{ZD} \\ \mathrm{ZD} \\ \mathrm{ZD} \\ \mathrm{zD} \end{array}\right\|$ |  |  | $\begin{aligned} & 250 \\ & 250 \\ & 250 \\ & 250 \end{aligned}$ |  |  |  |  |  | $\begin{array}{r} 2.4 / .05 \\ 2.7 / .05 \\ 3 / .05 \\ 3.3 / .05 \end{array}$ | 5 5 5 5 |
| 1N4685 <br> 1N4686 <br> IN4687 <br> 1N4688 | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\begin{aligned} & \mathrm{ZD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \end{aligned}$ |  |  | $\begin{aligned} & 250 \\ & 250 \\ & 250 \\ & 250 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 3.6 / .05 \\ & 3.9 / .05 \\ & 4.3 / .05 \\ & 4.7 / .05 \end{aligned}$ | 5 5 5 5 |
| 1N4689 <br> IN4690 <br> IN4691 <br> 1N4692 | $\left\lvert\, \begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{S} \\ & \mathbf{s} \end{aligned}\right.$ | $\left\|\begin{array}{l} \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \end{array}\right\|$ |  |  | $\begin{aligned} & 250 \\ & 250 \\ & 250 \\ & 250 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 5.1 / .05 \\ & 5.6 / .05 \\ & 6.2 / .05 \\ & 6.8 / .05 \end{aligned}$ | 5 5 5 5 |
| 1N4693 <br> IN4694 <br> 1N4695 <br> IN4696 | $\left\lvert\, \begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}\right.$ | $\left\|\begin{array}{l} \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \end{array}\right\|$ |  |  | $\begin{aligned} & 250 \\ & 250 \\ & 250 \\ & 250 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 7.5 / .05 \\ & 8.2 / .05 \\ & 8.7 / .05 \\ & 9.1 / .05 \end{aligned}$ | 5 5 5 5 |
| $\begin{aligned} & \text { IN4697 } \\ & \text { iN4698 } \\ & \text { iN4699 } \\ & \text { iN4700 } \end{aligned}$ | $\begin{aligned} & 5 \\ & 5 \\ & 5 \\ & 5 \end{aligned}$ | $\begin{aligned} & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \end{aligned}$ |  |  | $\begin{aligned} & 250 \\ & 250 \\ & 250 \\ & 250 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 10 / .05 \\ & 11 / .05 \\ & 12 / .05 \\ & 13 / .05 \end{aligned}$ | 5 5 5 5 |
| $\begin{aligned} & \text { 1N4701 } \\ & \text { 1N4702 } \\ & \text { 1N4703 } \\ & \text { IN4704 } \end{aligned}$ | $\begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}$ | $\begin{aligned} & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \end{aligned}$ |  |  | $\begin{aligned} & 250 \\ & 250 \\ & 250 \\ & 250 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 14 / .05 \\ & 15 / .05 \\ & 16 / .05 \\ & 17 / .05 \end{aligned}$ | 5 5 5 5 |
| $\begin{aligned} & \text { 1N4705 } \\ & \text { IN4706 } \\ & \text { IN4707 } \\ & \text { 1N4708 } \end{aligned}$ | $\begin{aligned} & \mathbf{s} \\ & s \\ & s \\ & s \end{aligned}$ | $\begin{aligned} & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{ZD} \end{aligned}$ |  |  | $\begin{aligned} & 250 \\ & 250 \\ & 250 \\ & 250 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 18 / .05 \\ & 19 / .05 \\ & 20 / .05 \\ & 22 / .05 \end{aligned}$ | 5 5 5 5 |

## DIODE INTERCHANGEABILITY

| TYPE NUMBER | $\frac{\text { 畐 }}{\frac{1}{2}}$ | $\begin{aligned} & \mathbf{z} \\ & \mathbf{y} \\ & \mathbf{y} \\ & \frac{1}{2} \\ & \frac{3}{3} \end{aligned}$ | II |  | RAtines |  |  | CHARAACTERISTICS |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  | $\begin{gathered} \text { PD } \\ (\mathrm{mW}) \end{gathered}$ | $\mathbf{V}_{\mathbf{R}}$ <br> (V) | (A) | $\begin{array}{ll} \mathbf{I}_{\mathbf{R}} & \mathbf{V}_{\mathbf{R}} \\ \mu_{\mathbf{A}} & /(\mathbf{V}) \end{array}$ | $\begin{gathered} V_{F} \quad l_{F} \\ \text { (V) } /(\mathrm{mA}) \end{gathered}$ | $\begin{aligned} & \mathbf{t}_{\mathbf{r r}} \\ & \text { (ns) } \end{aligned}$ | $\mathbf{V}_{\mathbf{Z}} \cdot \mathbf{I} \mathbf{Z}$ <br> (V) $/$ (mA) | $\begin{aligned} & \mathrm{rOf} \\ & \text { \% } \end{aligned}$ |
| 1N4709 <br> 1N4710 <br> 1N4711 <br> 1N4712 | $\begin{aligned} & \mathrm{s} \\ & \mathrm{~s} \\ & \mathrm{~s} \\ & \mathrm{~s} \end{aligned}$ | $\begin{aligned} & \mathrm{ZD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \end{aligned}$ |  |  | $\begin{aligned} & 250 \\ & 250 \\ & 250 \\ & 250 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 24 / .05 \\ & 25 / .05 \\ & 27 / .05 \\ & 28 / .05 \end{aligned}$ | 5 5 5 5 |
| 1N4713 <br> IN4714 <br> iN4715 <br> 1N4716 | $\begin{aligned} & \mathrm{s} \\ & \mathrm{~s} \\ & \mathrm{~s} \\ & \mathrm{~s} \end{aligned}$ | $\begin{aligned} & \mathrm{ZD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \end{aligned}$ |  |  | $\begin{aligned} & 250 \\ & 250 \\ & 250 \\ & 250 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 30 / .05 \\ & 33 / .05 \\ & 36 / .05 \\ & 39 / .05 \end{aligned}$ | 5 5 5 5 |
| 1N4717 <br> 1N4718 <br> 1N4719 <br> 1N4720 | $\begin{aligned} & \mathbf{S} \\ & \mathbf{S} \\ & \mathbf{S} \\ & \mathbf{s} \end{aligned}$ | $\begin{aligned} & \mathrm{ZD} \\ & \mathrm{SD} \\ & \mathrm{RE} \\ & \mathrm{RE} \end{aligned}$ |  | 1N4608 | 250 | 50 50 100 | 3 3 | $\begin{aligned} & 50 / 50 \\ & 1 \mathrm{M} / \\ & 1 \mathrm{M} / \end{aligned}$ | $\begin{aligned} & 1.2 / 750 \\ & 1 / \\ & 1 / \end{aligned}$ | 180 | 40/.05 | 5 |
| 1N4721 <br> 1N4722 <br> 1N4723 <br> 1N4724 | $\begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}$ | $\begin{array}{\|l\|} \mathbf{R E} \\ \mathrm{RE} \\ \mathrm{RE} \\ \mathrm{RE} \end{array}$ |  |  |  | $\begin{aligned} & 200 \\ & 400 \\ & 600 \\ & 800 \end{aligned}$ | $\begin{aligned} & 3 \\ & 3 \\ & 3 \\ & 3 \end{aligned}$ | $\begin{aligned} & 1 \mathrm{M} / \\ & 1 \mathrm{M} / \\ & 1 \mathrm{M} / \\ & 1 \mathrm{M} / \end{aligned}$ | $\begin{aligned} & 1 / \\ & 1 / \\ & 1 / \\ & 1 / \end{aligned}$ |  |  |  |
| iN4725 <br> iN4726 <br> 1N4727 <br> 1NA728 | $\begin{aligned} & \mathbf{S} \\ & \mathbf{S} \\ & \mathbf{S} \\ & \mathbf{s} \end{aligned}$ | $\begin{aligned} & \mathrm{RE} \\ & \mathrm{SD} \\ & \mathrm{SD} \\ & \mathrm{ZD} \end{aligned}$ | $\begin{aligned} & \text { 1N4727 } \\ & \text { iN4728 } \end{aligned}$ | 1N4727 | 1W | $1 K$ 30 30 | 3 | 1M/ <br> .1/20 <br> $.1 / 20$ |  |  | 3.3/76 | 10 |
| 1N4728A <br> 1N4729 <br> 1N4729A <br> iN4730 | $\left\lvert\, \begin{aligned} & \mathbf{s} \\ & \mathbf{S} \\ & \mathbf{S} \\ & \mathbf{S} \end{aligned}\right.$ | $\left\|\begin{array}{l} \mathrm{ZD} \\ \mathrm{ZD} \\ \mathrm{ZD} \\ \mathrm{ZD} \end{array}\right\|$ | 1N4728A <br> 1N4729 <br> IN4729A <br> 1N4730 |  | $\begin{aligned} & \text { iw } \\ & \text { iw } \\ & \text { iw } \\ & \text { iw } \end{aligned}$ |  |  |  |  |  | 3.3/76 <br> 3.6/69 <br> 3.6/69 <br> 3.9/64 | 5 10 5 10 |
| 1N4730A <br> 1N4731 <br> 1N4731A <br> 1N4732 | $\begin{aligned} & \mathrm{S} \\ & \mathrm{~s} \\ & \mathrm{~s} \\ & \mathrm{~s} \end{aligned}$ | $\left\|\begin{array}{l} \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{ZD} \\ \mathrm{ZD} \end{array}\right\|$ | IN4730A 1N4731 IN4731A 1N4732 |  | IW <br> IW <br> IW <br> IW |  |  |  |  |  | $\begin{aligned} & 3.9 / 64 \\ & 4.3 / 58 \\ & 4.3 / 58 \\ & 4.7 / 53 \end{aligned}$ | 5 10 5 10 |
| 1N4732A <br> 1N4733 <br> 1N4733A <br> 1N4734 | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\begin{aligned} & \mathrm{ZD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \end{aligned}$ | 1N4732A <br> 1N4733 <br> 1N4733A <br> 1N4734 |  | $\begin{aligned} & \text { iw } \\ & \text { iw } \\ & \text { iw } \\ & \text { iw } \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 4.7 / 53 \\ & 5.1 / 49 \\ & 5.1 / 49 \\ & 5.6 / 45 \end{aligned}$ | 5 10 5 10 |
| 1N4734A <br> 1N4735 <br> 1N4735A <br> 1N4736 | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\left\lvert\, \begin{aligned} & \mathrm{ZD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \end{aligned}\right.$ | 1N4734A <br> 1N4735 <br> 1N4735A <br> 1 N4736 |  | $\begin{aligned} & 16 \\ & 1 w \\ & 1 w \\ & 1 w \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 5.6 / 45 \\ & 6.2 / 41 \\ & 6.2 / 41 \\ & 6.8 / 37 \end{aligned}$ | 5 10 5 10 |
| 1N4736A <br> 1N4737 <br> IN4737A <br> 1N4738 | $\begin{aligned} & \mathrm{s} \\ & \mathrm{~S} \\ & \mathrm{~s} \\ & \mathrm{~s} \end{aligned}$ | $\begin{aligned} & \mathrm{zD} \\ & \mathrm{zo} \\ & \mathrm{zD} \\ & \mathrm{zD} \end{aligned}$ | 1N4736A <br> 1N4737 <br> 1N4737A <br> 1N4738 |  | $\begin{aligned} & 1 w \\ & 1 w \\ & 1 w \\ & 1 w \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 6.8 / 37 \\ & 7.5 / 34 \\ & 7.5 / 3 A \\ & 8.2 / 31 \end{aligned}$ | $\begin{array}{r} 5 \\ 10 \\ 5 \\ 10 \end{array}$ |


| $\begin{gathered} \text { type } \\ \text { numaek } \end{gathered}$ | 売 |  | $\begin{array}{\|c\|} \text { TI } \\ \text { Remacement } \end{array}$ | $\begin{aligned} & \text { Hon } \\ & \text { NEW } \\ & \text { DESNCN } \end{aligned}$ | ratings |  |  | CHARACTERISTICS |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  | $\begin{gathered} P_{D} \\ (\mathrm{~mW}) \end{gathered}$ | $\mathbf{V}_{\mathbf{R}}$ <br> (V) | (A) | $\begin{array}{cc} \mathbf{l}_{\mathbf{R}} & \bullet \mathbf{V}_{\mathbf{R}} \\ \mu_{\mathrm{A}} & /(\mathrm{V}) \end{array}$ | $\begin{array}{ccc} \mathbf{v}_{\mathbf{F}} & \bullet & \mathbf{F}_{\mathbf{F}} \\ \text { (V) } & /(\mathrm{mA}) \end{array}$ | $\pi$ (ns) | $\begin{array}{lll} v_{z} & \bullet \\ (v) & /(\mathrm{mA}) \end{array}$ | $\begin{aligned} & \text { rot } \\ & \text { \% } \end{aligned}$ |
| 1N4738A <br> IN4739 <br> IN4739A <br> 1N4740 | $\begin{array}{\|l} \hline \begin{array}{l} 5 \\ s \\ s \\ s \end{array} \\ \hline \end{array}$ | $\left.\begin{array}{\|l\|} \hline \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \end{array} \right\rvert\,$ | 1N4738A <br> IN4739 <br> 1N4739A <br> 1N4740 |  | $\begin{aligned} & \text { iw } \\ & \text { iw } \\ & \text { iw } \\ & \text { iw } \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 8.2 / 31 \\ & 9.1 / 28 \\ & 9.1 / 28 \\ & 10 / 25 \end{aligned}$ | 5 10 5 10 |
| 1N4740A <br> 1N4741 <br> ina741a <br> iN4742 | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\left\|\begin{array}{l} \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \end{array}\right\|$ | 1M4740A <br> IN4741 <br> 1N4741A <br> 1N4742 |  | $\begin{aligned} & \text { iw } \\ & \text { iw } \\ & \text { iw } \\ & \text { iw } \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 10 / 25 \\ & 11 / 23 \\ & 11 / 23 \\ & 12 / 21 \end{aligned}$ | 5 10 5 10 |
| 1N4742A <br> 1N4743 <br> 1N4743A <br> 1N4744 | $\begin{aligned} & \mathrm{s} \\ & \mathrm{~s} \\ & \mathrm{~s} \\ & \mathrm{~s} \end{aligned}$ | $\left.\begin{aligned} & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \end{aligned} \right\rvert\,$ | 1N4742A <br> 1N4743 <br> 1N4743A <br> IN474 |  | $\begin{aligned} & \text { iw } \\ & \text { iw } \\ & \text { iw } \\ & \text { iw } \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 12 / 21 \\ & 13 / 19 \\ & 13 / 19 \\ & 15 / 17 \end{aligned}$ | 5 10 5 10 |
| 1N4744A <br> 1N4745 <br> 1N4745A <br> 1N4746 | $\left\lvert\, \begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}\right.$ | $\left\|\begin{array}{l} \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \end{array}\right\|$ | 1N4744A IN474S iN4745A IN4746 |  | $\begin{aligned} & i w \\ & i w \\ & i w \\ & i w \end{aligned}$ |  |  |  |  |  | 15/17 <br> 16/15 <br> 16/15 <br> 18/14 | 5 10 5 10 |
| 1N4746A iN4747 <br> IN4747A <br> 1N4748 | $\begin{aligned} & \mathrm{s} \\ & \mathrm{~s} \\ & \mathrm{~s} \\ & \mathrm{~s} \end{aligned}$ | $\left.\begin{aligned} & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \end{aligned} \right\rvert\,$ | 1N4746A <br> iN4747 <br> 1N4747A <br> 1N4748 |  | $\begin{aligned} & \text { iw } \\ & \text { iw } \\ & \text { iw } \\ & \text { iw } \end{aligned}$ |  |  |  |  |  | 18/14 <br> 20/12 <br> 20/12 <br> 22/11 | 5 10 5 10 |
| 1N4748A <br> 1N4749 <br> iN4749A <br> 1N4750 | s | $\left\|\begin{array}{l} \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \end{array}\right\|$ |  |  | $\begin{aligned} & \text { iw } \\ & \text { iw } \\ & \text { iw } \\ & \text { iw } \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 22 / 11 \\ & 24 / 10 \\ & 24 / 10 \\ & 27 / 9.5 \end{aligned}$ | 5 10 5 10 |
| 1N4750A 1N4751 INA751A 1N4752 | $\left\lvert\, \begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}\right.$ | $\left\|\begin{array}{l} \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \end{array}\right\|$ | 1N4750A IN4751A 1N4752 |  | iw iw iw iw |  |  |  |  |  | 27/9.5 <br> 30/8.5 <br> 30/8.5 <br> 33/7.5 | 5 10 5 10 |
| 1N4752A IN4753 iN4753A ina754 | $\begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}$ | $\left\|\begin{array}{l} \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \end{array}\right\|$ | 1N4752A |  | $\begin{aligned} & 1 \mathbf{w} \\ & 1 \mathbf{w} \\ & 1 W \\ & 1 W \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 33 / 7.5 \\ & 36 / 7 \\ & 36 / 7 \\ & 39 / 6.5 \end{aligned}$ | 5 10 5 10 |
| 1N4754A <br> IN4755 <br> IN4755A <br> IN4756 | $\begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}$ | \|l| |  |  | 1w 10 10 $1 w$ |  |  |  |  |  | $\begin{aligned} & 39 / 6.5 \\ & 43 / 6 \\ & 43 / 6 \\ & 47 / 5.5 \end{aligned}$ | 5 10 5 10 |
| in4756A <br> in4737 in4757A <br> IN4758 | $\left\lvert\, \begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}\right.$ | $\left\|\begin{array}{l} \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \end{array}\right\|$ |  |  | $\begin{aligned} & 1 W \\ & 1 w \\ & 1 w \\ & 1 w \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 47 / 5.5 \\ & 51 / 5 \\ & 51 / 5 \\ & 56 / 4.5 \end{aligned}$ | 5 10 5 10 |

## DIODE INTERCHANGEABILITY

| TYPE MUMEER |  |  | TI | $\begin{aligned} & \text { FOR } \\ & \text { NEW } \\ & \text { DESICN } \end{aligned}$ | RATINOS |  |  | CHARACTERISTICS |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  | $\begin{gathered} P_{D} \\ (\mathrm{~mW}) \end{gathered}$ | $\mathbf{V}_{\mathbf{R}}$ <br> (V) | I <br> (A) | $\begin{array}{ll} \mathbf{I}_{\mathbf{R}} & \mathbf{V}_{\mathbf{R}} \\ \mu \mathrm{A} & /(\mathbf{V}) \end{array}$ | $\mathbf{V}_{\mathbf{F}}$ <br> (V) | $\begin{gathered} c \\ \hline \text { f } \\ \hline(\mathrm{mA}) \end{gathered}$ | $\begin{aligned} & t_{r r} \\ & (n s) \end{aligned}$ | $\mathbf{v}_{\mathbf{Z}} \cdot \mathbf{I}_{\mathbf{z}}$ <br> (V) / (mA) | TOL * |
| 1N4758A <br> 1N4759 <br> 1N4759A <br> 1N4780 | $\begin{aligned} & \hline \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}$ | $\begin{aligned} & \mathrm{ZD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \end{aligned}$ |  |  | $\begin{aligned} & 1 w \\ & 1 w \\ & 1 w \\ & 1 w \end{aligned}$ |  |  |  |  |  |  | $\begin{aligned} & 56 / 4.5 \\ & 62 / 4 \\ & 62 / 4 \\ & 68 / 3.7 \end{aligned}$ | $\begin{array}{\|r\|} \hline 5 \\ 10 \\ 5 \\ 10 \end{array}$ |
| 1N4760A 1N4761 1N4761A 1N4762 | $\begin{aligned} & \mathbf{s} \\ & s \\ & s \\ & s \end{aligned}$ | $\begin{array}{\|l\|} \hline \mathbf{Z D} \\ \mathrm{ZD} \\ \mathrm{ZD} \\ \mathrm{ZD} \\ \hline \end{array}$ |  |  | $\begin{aligned} & \text { iw } \\ & \text { iw } \\ & \text { iw } \\ & \text { iw } \end{aligned}$ |  |  |  |  |  |  | $\begin{aligned} & 68 / 3.7 \\ & 75 / 3.3 \\ & 75 / 3.3 \\ & 82 / 3 \end{aligned}$ | 5 10 5 10 |
| 1N4762A <br> IN4763 <br> 1N4763A <br> 1N4764 | $\begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}$ | $\begin{aligned} & \mathrm{zo} \\ & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \end{aligned}$ |  |  | IW <br> IW <br> IW <br> IW |  |  |  |  |  |  | $\begin{gathered} 82 / 3 \\ 91 / 2.8 \\ 91 / 2.8 \\ 100 / 2.5 \end{gathered}$ | 5 10 5 10 |
| 1N4764A <br> 1N4765 <br> 1N4765A <br> 1N4765B | $\begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}$ | $\begin{array}{\|l\|} \mathrm{ZD} \\ \mathrm{RD} \\ \mathrm{RD} \\ \mathrm{RD} \end{array}$ |  |  | 1w |  |  |  |  |  |  | $\begin{gathered} 100 / 2.5 \\ 9.1 / .5 \\ 9.1 / .5 \\ 9.1 / .5 \end{gathered}$ | 5 |
| 1N4766 <br> 1N4766A <br> 1N47668 <br> 1N4767 | $\begin{aligned} & 5 \\ & 5 \\ & 5 \\ & 5 \end{aligned}$ | $\begin{aligned} & R D \\ & R D \\ & R D \\ & R D \end{aligned}$ |  |  |  |  |  |  |  |  |  | $\begin{aligned} & 9.1 / .5 \\ & 9.1 / 5 \\ & 9.1 / 5 \\ & 9.1 / .5 \end{aligned}$ |  |
| 1N4767A <br> 1N47678 <br> 1N4768 <br> 1N4768A | $\begin{aligned} & 5 \\ & s \\ & s \\ & s \end{aligned}$ | $\begin{aligned} & \mathrm{RD} \\ & \mathrm{RD} \\ & \mathrm{RD} \\ & \mathrm{RD} \end{aligned}$ |  |  |  |  |  |  |  |  |  | $\begin{aligned} & 9.1 / .5 \\ & 9.1 / 5 \\ & 9.1 / 5 \\ & 9.1 / .5 \end{aligned}$ |  |
| 1N4768B <br> 1N4769 <br> IN4769A <br> 1N4769B | $\begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}$ | $\begin{aligned} & R D \\ & R D \\ & R D \\ & R D \\ & R D \end{aligned}$ |  |  |  |  |  |  |  |  |  | $\begin{aligned} & 9.1 / 5 \\ & 9.1 / 5 \\ & 9.1 / .5 \\ & 9.1 / .5 \end{aligned}$ |  |
| 1N4770 <br> IN4770A <br> 1N47708 <br> 1N4771 | $\left\lvert\, \begin{aligned} & 5 \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\begin{array}{\|l\|} \hline R D \\ R D \\ R D \\ R D \end{array}$ |  |  |  |  |  |  |  |  |  | $\begin{aligned} & 9.1 / 1 \\ & 9.1 / 1 \\ & 9.1 / 1 \\ & 9.1 / 1 \end{aligned}$ |  |
| 1N4771A <br> 1N4771B <br> 1N4772 <br> 1N4772A | $\begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}$ | $\begin{array}{\|l\|} \hline R D \\ R D \\ R D \\ R D \end{array}$ |  |  |  |  |  |  |  |  |  | $\begin{aligned} & 9.1 / 1 \\ & 9.1 / 1 \\ & 9.1 / 1 \\ & 9.1 / 1 \end{aligned}$ |  |
| IN4772B <br> 1N4773 <br> IN4773A <br> iN47738 | $\begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}$ | $\begin{aligned} & R D \\ & R D \\ & R D \\ & R D \end{aligned}$ |  |  |  |  |  |  |  |  |  | $\begin{aligned} & 9.1 / 1 \\ & 9.1 / 1 \\ & 9.1 / 1 \\ & 9.1 / 1 \end{aligned}$ |  |


| TYPE MUMEER |  |  | $\frac{11}{\text { REPLACEMANT }}$ | $\begin{aligned} & \text { Fon } \\ & \text { New } \\ & \text { Desion } \end{aligned}$ | matmes |  |  | Cranacteramics |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  | $\mathrm{PD}$ <br> (mW) | $\begin{aligned} & \mathbf{V}_{\mathbf{R}} \\ & (\mathbf{V}) \end{aligned}$ | 1 <br> (A) | $\left.\begin{array}{lll} \mathbf{n} & \mathbf{V}_{\mathrm{R}} \\ \boldsymbol{\mu} & /(\mathrm{V}) \end{array} \right\rvert\,$ | $\begin{array}{cc} \mathbf{V}_{\mathrm{F}} & \mathrm{l}= \\ \text { (V) } & / \mathrm{m} A) \end{array}$ | $\begin{aligned} & i r \\ & \text { (na) } \end{aligned}$ | $\mathbf{V z}_{\mathbf{z}}$ - $\mathbf{z}$ <br> (V) $/$ (mA) | $\begin{aligned} & \text { rol } \\ & \% \end{aligned}$ |
| 1N4774 <br> 1N4774A <br> 1N47748 <br> 1N4775 | $\begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}$ | $\begin{aligned} & R D \\ & R D \\ & R D \\ & R D \end{aligned}$ |  |  |  |  |  |  |  |  | $\begin{aligned} & 9.1 / 1 \\ & 9.1 / 1 \\ & 9.1 / 1 \\ & 8.5 / .5 \end{aligned}$ |  |
| 1N4775A <br> 1N4775B <br> 1NA776 <br> 1Na776A | $\left\lvert\, \begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}\right.$ | $\left\lvert\, \begin{aligned} & R D \\ & R D \\ & R D \\ & R D \end{aligned}\right.$ |  |  |  |  |  |  |  |  | $\begin{aligned} & 8.5 / .5 \\ & 8.5 / .5 \\ & 8.5 / .5 \\ & 8.5 / .5 \end{aligned}$ |  |
| $\begin{aligned} & \text { 1N4776B } \\ & \text { IN4777 } \\ & \text { 1N4777A } \\ & \text { 1N47778 } \end{aligned}$ | $\left\lvert\, \begin{aligned} & 5 \\ & 5 \\ & 5 \\ & s \end{aligned}\right.$ | $\begin{aligned} & R D \\ & R D \\ & R D \\ & R D \end{aligned}$ |  |  |  |  |  |  |  |  | $\begin{aligned} & 8.5 / .5 \\ & 8.5 / .5 \\ & 8.5 / .5 \\ & 8.5 / .5 \end{aligned}$ |  |
| 1N4778 <br> 1N4778A <br> 1N47788 <br> 1N4779 | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\left\|\begin{array}{l} R D \\ R D \\ R D \\ R D \end{array}\right\|$ |  |  |  |  |  |  |  |  | $\begin{aligned} & 8.5 / .5 \\ & 8.5 / .5 \\ & 8.5 / .5 \\ & 8.5 / .5 \end{aligned}$ |  |
| $\begin{aligned} & \text { 1NA779A } \\ & \text { INA779B } \\ & \text { IN4780 } \\ & \text { INA780A } \end{aligned}$ | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\left\|\begin{array}{l} R D \\ R D \\ R D \\ R D \end{array}\right\|$ |  |  |  |  |  |  |  |  | $\begin{aligned} & 8.5 / .5 \\ & 8.5 / .5 \\ & 8.5 / 1 \\ & 8.5 / 1 \end{aligned}$ |  |
| IN47808 <br> 1N4781 <br> IN4781A <br> 1N4781B | $\begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}$ | $\left.\begin{array}{\|l\|} \mathrm{RD} \\ \mathrm{RD} \\ \mathrm{RD} \\ \mathrm{RD} \end{array} \right\rvert\,$ |  |  |  |  |  |  |  |  | $\begin{aligned} & 8.5 / 1 \\ & 8.5 / 1 \\ & 8.5 / 1 \\ & 8.5 / 1 \end{aligned}$ |  |
| 1N4782 <br> IN4782A <br> 1N4782B <br> 1N4783 | $\begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}$ | $\left\|\begin{array}{l} R D \\ R D \\ R D \\ R D \end{array}\right\|$ |  |  |  |  |  |  |  |  | $\begin{aligned} & 8.5 / 1 \\ & 8.5 / 1 \\ & 8.5 / 1 \\ & 8.5 / 1 \end{aligned}$ |  |
| 1NA783A <br> 1N4783B <br> 1N4784 <br> 1N4784A | $\begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}$ | $\left.\begin{aligned} & R D \\ & R D \\ & R D \\ & R D \end{aligned} \right\rvert\,$ |  |  |  |  |  |  |  |  | $\begin{aligned} & 8.5 / 1 \\ & 8.5 / 1 \\ & 8.5 / 1 \\ & 8.5 / 1 \end{aligned}$ |  |
| 1N4784B <br> 1N4816 <br> 1N4817 <br> 1N4818 | $\left\lvert\, \begin{aligned} & 5 \\ & 5 \\ & 5 \\ & 5 \end{aligned}\right.$ | $\left\|\begin{array}{l} R D \\ R E \\ R E \\ R E \\ R E \end{array}\right\|$ |  |  |  | $\begin{array}{r} 50 \\ 100 \\ 200 \end{array}$ | $\begin{aligned} & 1.5 \\ & 1.5 \\ & 1.5 \end{aligned}$ | $\begin{aligned} & 250 / \\ & 250 / \\ & 250 / \end{aligned}$ | $\begin{aligned} & 1.3 / \\ & 1.3 / \\ & 1.3 / \end{aligned}$ |  | 8.5/1 |  |
| $\left\lvert\, \begin{aligned} & \text { IN4819 } \\ & \text { IN4820 } \\ & \text { IN4821 } \\ & \text { IN4822 } \end{aligned}\right.$ | $\left\lvert\, \begin{aligned} & 5 \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\left\lvert\, \begin{aligned} & \text { RE } \\ & \mathbf{R E} \\ & \mathbf{R E} \\ & \mathbf{R E} \end{aligned}\right.$ |  |  |  | $\begin{aligned} & 300 \\ & 400 \\ & 500 \\ & 600 \end{aligned}$ | $\begin{aligned} & 1.5 \\ & 1.5 \\ & 1.5 \\ & 1.5 \end{aligned}$ | $\begin{aligned} & 250 / \\ & 250 / \\ & 250 / \\ & 250 / \end{aligned}$ | $\begin{aligned} & 1.3 / \\ & 1.3 / \\ & 1.3 / \\ & 1.3 / \end{aligned}$ |  |  |  |

## DIODE INTERCHANGEABILITY

| TYFE NUMEER |  | $\begin{aligned} & 3 \\ & 8 \\ & 0 \\ & 3 \\ & 3 \\ & 3 \\ & 3 \end{aligned}$ | $\begin{gathered} \text { TI } \\ \text { REPLACEMENT } \end{gathered}$ |  | Ratines |  |  | Charactarimes |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  | $\begin{gathered} \text { PD } \\ (\mathrm{mW}) \end{gathered}$ | $\mathbf{V}_{\mathbf{R}}$ <br> (V) | 1 <br> (A) | $\begin{array}{ll} \mathbf{I}_{\mathrm{R}} & \bullet \mathbf{V}_{\mathrm{R}} \\ \mu_{\mathrm{A}} & /(\mathrm{V}) \end{array}$ | $\begin{array}{ccc} V_{F} & \text { 体 } \\ \text { (V) } & / \text { (ma) } \end{array}$ | $\left.\begin{gathered} i_{r} \\ (n s) \end{gathered} \right\rvert\,$ | $\begin{array}{lc} \mathbf{V}_{\mathbf{Z}} & \mathbf{Z} \\ (\mathrm{V}) & / \mathrm{mA}) \end{array}$ | TOL |
| 1N4823 <br> IN4824 <br> 1N4825 <br> IN4826 | $\begin{aligned} & s \\ & s \\ & S \\ & 5 \end{aligned}$ | $\begin{array}{\|l\|} \hline R E \\ \mathrm{RE} \\ \mathrm{RE} \\ \mathrm{RE} \end{array}$ |  |  |  | 100 200 400 600 | 1 1 1 | $\begin{aligned} & 1 \mathrm{M} / \\ & 1 \mathrm{M} / \\ & 1 \mathrm{M} / \\ & 1 \mathrm{M} / \end{aligned}$ | $\begin{aligned} & 1.2 / \\ & 1.2 / \\ & 1.2 / \\ & 1.2 / \end{aligned}$ | $\begin{aligned} & 100 \\ & 100 \\ & 100 \\ & 100 \end{aligned}$ |  |  |
| IN4827 <br> 1N4828 <br> IN4829 <br> IN4830 | $\begin{aligned} & G \\ & s \\ & s \\ & s \end{aligned}$ | $\begin{aligned} & \text { SD } \\ & \text { SD } \\ & \text { SD } \\ & \text { SD } \end{aligned}$ |  | 1 N 4448 |  | 30 20 20 20 |  | $\begin{aligned} & 15 / 10 \\ & .1 / \\ & .1 / \\ & .1 / \end{aligned}$ | $\begin{gathered} 1 / 40 \\ 1.1 / 100 \\ 1.8 / 100 \\ 2.6 / 100 \end{gathered}$ | 200 |  |  |
| 1N4831 <br> 1N4831A <br> 1N4831B <br> 1N4832 | $\begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}$ | $\left.\begin{aligned} & \mathrm{ZD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \end{aligned} \right\rvert\,$ |  | $\begin{aligned} & \text { 1N4739 } \\ & \text { 1N4739 } \\ & \text { 1N4739A } \\ & \text { 1N4740 } \end{aligned}$ | $\begin{aligned} & 1.2 \mathrm{~W} \\ & 1.2 \mathrm{~W} \\ & 1.2 \mathrm{~W} \\ & 1.2 \mathrm{~W} \end{aligned}$ |  |  |  |  |  | $\begin{gathered} 9.1 / 28 \\ 9.1 / 28 \\ 9.1 / 28 \\ 10 / 25 \end{gathered}$ | $\begin{array}{r} 20 \\ 10 \\ 5 \\ 20 \end{array}$ |
| 1N4832A <br> 1N4832B <br> iN4833 <br> iN4833A | S | $\left\|\begin{array}{l} \mathrm{ZD} \\ \mathrm{ZD} \\ \mathrm{ZD} \\ \mathrm{ZD} \end{array}\right\|$ |  | iN4740 <br> IN4740A <br> 1N4741 <br> 1N4741 | 1.2W <br> 1.2W <br> 1.2W <br> 1.2W |  |  |  |  |  | $\begin{aligned} & 10 / 25 \\ & 10 / 25 \\ & 11 / 23 \\ & 11 / 23 \end{aligned}$ | $\begin{array}{r} 10 \\ 5 \\ 20 \\ 10 \end{array}$ |
| 1N48338 <br> 1N4834 <br> IN4834A <br> 1N4834B | $\begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}$ | $\left\|\begin{array}{l} \mathrm{ZD} \\ \mathrm{ZD} \\ \mathrm{ZD} \\ \mathrm{ZD} \end{array}\right\|$ |  | INA741A <br> 1N4742 <br> 1N4742 <br> 1N4742A | $\begin{aligned} & 1.2 W \\ & 1.2 W \\ & 1.2 W \\ & 1.2 W \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 11 / 23 \\ & 12 / 21 \\ & 12 / 21 \\ & 12 / 21 \end{aligned}$ | 5 20 10 5 |
| 1N4835 IN4835A 1N4835B 1N4836 | $\begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}$ | $\begin{aligned} & \mathrm{zo} \\ & \mathrm{zo} \\ & \mathrm{zD} \\ & \mathrm{zD} \end{aligned}$ |  | IN4743 <br> INA743 <br> 1N4743A <br> IN4744 | 1.2W <br> 1.2W <br> 1.2W <br> 1.2W |  |  |  |  |  | $\begin{aligned} & 13 / 19 \\ & 13 / 19 \\ & 13 / 19 \\ & 15 / 17 \end{aligned}$ | 20 10 5 20 |
| 1N4836A <br> 1N48368 <br> 1N4837 <br> IN4837A | $\begin{aligned} & 5 \\ & 5 \\ & 5 \\ & 5 \end{aligned}$ | $\begin{aligned} & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \end{aligned}$ |  | 1N4744 <br> 1N4744A <br> 1N4745 <br> 1N4745 | $\begin{aligned} & 1.2 \mathrm{~W} \\ & 1.2 \mathrm{~W} \\ & 1.2 \mathrm{~W} \\ & 1.2 \mathrm{~W} \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 15 / 17 \\ & 15 / 17 \\ & 16 / 16 \\ & 16 / 16 \end{aligned}$ | $\begin{array}{r} 10 \\ 5 \\ 20 \\ 10 \end{array}$ |
| $\begin{aligned} & \text { IN4837B } \\ & \text { IN4838 } \\ & \text { 1N4838A } \\ & \text { IN4838B } \end{aligned}$ | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\begin{aligned} & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \end{aligned}$ |  | 1N4745A <br> 1N4746 <br> 1N4746 <br> IN4746A | $\begin{aligned} & 1.2 \mathrm{~W} \\ & 1.2 \mathrm{~W} \\ & 1.2 \mathrm{w} \\ & 1.2 \mathrm{~W} \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 16 / 16 \\ & 18 / 14 \\ & 18 / 14 \\ & 18 / 14 \end{aligned}$ | $\begin{array}{r} 5 \\ 20 \\ 10 \\ 5 \end{array}$ |
| 1N4839 <br> IN4839A <br> 1N4839B <br> 1N4840 | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\begin{aligned} & \mathrm{zo} \\ & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \end{aligned}$ |  | 1N4747 <br> 1N4747 <br> 1N4747A <br> 1N4748 | 1.2 W <br> 1.2 W <br> 1.2w <br> 1.2 w |  |  |  |  |  | $\begin{aligned} & 20 / 19 \\ & 20 / 19 \\ & 20 / 19 \\ & 22 / 11 \end{aligned}$ | $\begin{array}{r} 20 \\ 10 \\ 5 \\ 20 \end{array}$ |
| IN4840A <br> 1N4840B <br> 1N4841 <br> 1N4841A | $\begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}$ | $\begin{aligned} & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \end{aligned}$ |  | 1N4748 <br> IN4748A <br> 1N4749 <br> 1N4749 | $\begin{aligned} & 1.2 \mathrm{~W} \\ & 1.2 \mathrm{~W} \\ & 1.2 \mathrm{~W} \\ & 1.2 \mathrm{~W} \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 22 / 11 \\ & 22 / 11 \\ & 24 / 11 \\ & 24 / 11 \end{aligned}$ | $\begin{array}{r} 10 \\ 5 \\ 20 \\ 10 \end{array}$ |


|  |  | $\mathbf{O}$ |  |  | RAFINGS |  |  | CHARACTERISTICS |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| TYPE NUMBER |  | $\left\lvert\, \begin{aligned} & \mathbf{U} \\ & \frac{巳}{2} \\ & \mathbf{y} \\ & \mathbf{U} \end{aligned}\right.$ | $\begin{gathered} \text { TI } \\ \text { REPLACEMENT } \end{gathered}$ |  |  | $\mathbf{V}_{\mathrm{R}}$ <br> (V) | I <br> (A) | $\begin{array}{ll} \mathbf{I}_{\mathbf{R}} & \bullet \mathbf{V}_{\mathbf{R}} \\ \mu_{\mathbf{A}} & /(\mathbf{V}) \end{array}$ | $\begin{array}{ll} \mathbf{V F}_{F} & \mathbf{l}_{\mathbf{F}} \\ \text { (V) } & I \mathrm{~mA}) \end{array}$ | $\mathrm{t}_{7}$ <br> (ns) | $\begin{array}{lc} V_{Z} & \mathbf{I}_{\mathbf{z}} \\ (\mathrm{V}) & /(\mathrm{mA}) \end{array}$ | $\begin{gathered} \text { rot } \\ \% \end{gathered}$ |
| 1N4841B <br> iN4842 <br> IN4842A <br> IN4842B | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\left\lvert\, \begin{aligned} & \mathrm{ZD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \end{aligned}\right.$ |  | 1N4749A <br> 1N4750 <br> IN4750 <br> 1N4750A | $\begin{aligned} & 1.2 \mathrm{~W} \\ & 1.2 \mathrm{~W} \\ & 1.2 \mathrm{~W} \\ & 1.2 \mathrm{~W} \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 24 / 11 \\ & 27 / 9.3 \\ & 27 / 9.3 \\ & 27 / 9.3 \end{aligned}$ | 5 20 10 5 |
| 1N4843 <br> 1N4843A <br> iN4843B <br> 1N4844 | $\begin{aligned} & 5 \\ & 5 \\ & s \\ & 5 \end{aligned}$ | $\left\lvert\, \begin{aligned} & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \end{aligned}\right.$ |  | 1N4751 <br> 1N4751 <br> IN4751A <br> 1N4752 | $\begin{aligned} & 1.2 \mathrm{~W} \\ & 1.2 \mathrm{~W} \\ & 1.2 \mathrm{~W} \\ & 1.2 \mathrm{~W} \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 30 / 8.3 \\ & 30 / 8.3 \\ & 30 / 8.3 \\ & 33 / 7.5 \end{aligned}$ | $\begin{array}{r} 20 \\ 10 \\ 5 \\ 20 \end{array}$ |
| 1N4844A <br> 1N48448 <br> 1N4845 <br> 1N4845A | $\begin{aligned} & \mathbf{S} \\ & \mathbf{S} \\ & \mathbf{S} \\ & \mathbf{S} \end{aligned}$ | $\begin{aligned} & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \end{aligned}$ |  | $\begin{aligned} & \text { IN4752 } \\ & \text { IN4752A } \end{aligned}$ | $\begin{aligned} & 1.2 \mathrm{~W} \\ & 1.2 \mathrm{~W} \\ & 1.2 \mathrm{~W} \\ & 1.2 \mathrm{~W} \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 33 / 7.5 \\ & 33 / 7.5 \\ & 36 / 7 \\ & 36 / 7 \end{aligned}$ | $\begin{array}{r} 10 \\ 5 \\ 20 \\ 10 \end{array}$ |
| 1N48458 <br> 1N4846 <br> 1N4846A <br> 1N4846B | $\begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}$ | $\begin{aligned} & 20 \\ & 20 \\ & z D \\ & 20 \end{aligned}$ |  |  | $\begin{aligned} & 1.2 W \\ & 1.2 W \\ & 1.2 W \\ & 1.2 W \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 36 / 7 \\ & 39 / 6.5 \\ & 39 / 6.5 \\ & 39 / 6.5 \end{aligned}$ | 5 20 10 5 |
| 1N4847 <br> 1N4847A <br> 1N48478 <br> 1N4848 | $\begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}$ | $\left\lvert\, \begin{aligned} & \mathrm{zo} \\ & \mathrm{zD} \\ & \mathrm{zo} \\ & \mathrm{zO} \end{aligned}\right.$ |  |  | $\begin{aligned} & 1.2 \mathrm{~W} \\ & 1.2 \mathrm{~W} \\ & 1.2 \mathrm{~W} \\ & 1.2 \mathrm{~W} \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 43 / 5.8 \\ & 43 / 5.8 \\ & 43 / 5.8 \\ & 47 / 5.3 \end{aligned}$ | $\begin{array}{r} 20 \\ 10 \\ 5 \\ 20 \end{array}$ |
| IN48A8A <br> 1N4848B <br> IN4849 <br> IN4849A | $\left\lvert\, \begin{aligned} & 5 \\ & 5 \\ & 5 \\ & 5 \end{aligned}\right.$ | $\left.\begin{aligned} & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \end{aligned} \right\rvert\,$ |  |  | $\begin{aligned} & 1.2 \mathrm{~W} \\ & 1.2 \mathrm{~W} \\ & 1.2 \mathrm{~W} \\ & 1.2 \mathrm{~W} \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 47 / 5.3 \\ & 47 / 5.3 \\ & 51 / 5 \\ & 51 / 5 \end{aligned}$ | 10 5 20 10 |
| $\begin{aligned} & \text { IN4849B } \\ & \text { 1N4850 } \\ & \text { IN4850A } \\ & \text { IN4850B } \end{aligned}$ | $\begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}$ | $\left.\begin{aligned} & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \end{aligned} \right\rvert\,$ |  |  | $\begin{aligned} & 1.2 \mathrm{~W} \\ & 1.2 \mathrm{~W} \\ & 1.2 \mathrm{~W} \\ & 1.2 \mathrm{~W} \end{aligned}$ |  |  |  |  |  | 51/5 <br> 56/4.5 <br> 56/4.5 <br> 56/4.5 | 5 20 10 5 |
| 1N4851 <br> 1N4851A <br> iN4851B <br> IN4852 | $\begin{aligned} & s \\ & s \\ & s \\ & s \\ & s \end{aligned}$ | $\left\lvert\, \begin{aligned} & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \end{aligned}\right.$ |  |  | $\begin{aligned} & 1.2 W \\ & 1.2 W \\ & 1.2 W \\ & 1.2 W \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 62 / 4 \\ & 62 / 4 \\ & 62 / 4 \\ & 68 / 3.7 \end{aligned}$ | 20 10 5 20 |
| $\begin{aligned} & \text { 1N4852A } \\ & \text { 1N4852B } \\ & \text { 1N4853 } \\ & \text { 1N4853A } \end{aligned}$ | $\begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}$ | $\begin{aligned} & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \end{aligned}$ |  |  | $\begin{aligned} & 1.2 W \\ & 1.2 W \\ & 1.2 W \\ & 1.2 W \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 68 / 3.7 \\ & 68 / 3.7 \\ & 75 / 3.3 \\ & 75 / 3.3 \end{aligned}$ | 10 5 20 10 |
| 1N48538 IN4854 IN4854A IN4854B | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\begin{aligned} & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \end{aligned}$ |  |  | $\begin{aligned} & 1.2 W \\ & 1.2 W \\ & 1.2 W \\ & 1.2 W \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 75 / 3.3 \\ & 82 / 3 \\ & 82 / 3 \\ & 82 / 3 \end{aligned}$ | $\begin{array}{r} 5 \\ 20 \\ 10 \\ 5 \end{array}$ |

## DIODE INTERCHANGEABILITY



| TYPE MuMEER |  | $\begin{aligned} & \frac{3}{2} \\ & \frac{3}{3} \\ & \frac{1}{2} \\ & 3 \end{aligned}$ | $\begin{gathered} \text { TI } \\ \text { REMACEMENT } \end{gathered}$ | $\begin{aligned} & \text { FOR } \\ & \text { NEW } \\ & \text { DESHON } \end{aligned}$ | Ratines |  |  | Chatacteristics |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  | $\begin{gathered} \mathrm{PD} \\ (\mathrm{~mW}) \end{gathered}$ | $\mathbf{V}_{\mathbf{R}}$ <br> (V) | I <br> (A) | $\begin{array}{ll} \mathbf{I}_{\mathbf{n}} & \bullet \mathbf{V}_{\mathbf{R}} \\ \mu \mathrm{A} & /(\mathbf{V}) \end{array}$ | $\begin{array}{lll} \mathbf{V F}_{F} & \mathbf{L} \\ \text { (V) } & /(\mathrm{mA}) \end{array}$ | $\begin{aligned} & t_{r r} \\ & (n s) \end{aligned}$ | $\mathbf{v}_{\mathbf{Z}}$ - $\mathbf{z}$ <br> (V) $/$ (mA) | $\begin{aligned} & \text { tor } \\ & \text { \% } \end{aligned}$ |
| 1N4890 <br> IN4690A <br> IN4891 <br> 1N4891A | $\begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}$ | $\begin{array}{\|l\|} \mathbf{R D} \\ R D \\ R D \\ R D \end{array}$ |  |  | $\begin{array}{r} 400 \\ 400 \\ 400 \\ 400 \end{array}$ |  |  |  |  |  | $\begin{aligned} & 6.35 / 7.5 \\ & 6.35 / 7.5 \\ & 6.35 / 7.5 \\ & 6.35 / 7.5 \end{aligned}$ | 5 5 5 5 |
| 1 N4892 <br> IN4892A <br> 1N4893 <br> IN4893A | $\left\lvert\, \begin{aligned} & 5 \\ & s \\ & s \\ & 5 \end{aligned}\right.$ | $\begin{aligned} & R D \\ & R D \\ & R D \\ & R D \end{aligned}$ |  |  | $\begin{array}{r} 400 \\ 400 \\ 400 \\ 400 \end{array}$ |  |  |  |  |  | $\begin{aligned} & 6.35 / 7.5 \\ & 6.35 / 7.5 \\ & 6.35 / 7.5 \\ & 6.35 / 7.5 \end{aligned}$ | 5 5 5 5 |
| 1N4894 1N4891A 1N4895 iN4895A | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\left.\begin{array}{\|l\|} R D \\ R D \\ R D \\ R D \\ R D \end{array} \right\rvert\,$ |  |  | $\begin{array}{r} 400 \\ 400 \\ 400 \\ 400 \end{array}$ |  |  |  |  |  | $\begin{aligned} & 6.35 / 7.5 \\ & 6.35 / 7.5 \\ & 6.35 / 7.5 \\ & 6.35 / 7.5 \end{aligned}$ | 5 5 5 5 |
| 1N4896 in4896A 1N4897 1N4897A | $\left\lvert\, \begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}\right.$ | $\left.\begin{aligned} & R D \\ & R D \\ & R D \\ & R D \end{aligned} \right\rvert\,$ |  |  | $\begin{aligned} & 400 \\ & 400 \\ & 400 \\ & 400 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 12.8 / .5 \\ & 12.8 / .5 \\ & 12.8 / .5 \\ & 12.8 / .5 \end{aligned}$ | 5 5 5 5 |
| IN4898 1N4898A 1N4899 IN4899A | $\begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}$ | $\left.\begin{aligned} & R D \\ & R D \\ & R D \\ & R D \\ & R D \end{aligned} \right\rvert\,$ |  |  | $\begin{array}{r} 400 \\ 400 \\ 400 \\ 400 \end{array}$ |  |  |  |  |  | $\begin{aligned} & 12.8 / .5 \\ & 12.8 / .5 \\ & 12.8 / .5 \\ & 12.8 / .5 \end{aligned}$ | 5 5 5 5 |
| IN4900 <br> IN4900A <br> 1N4901 <br> IN4901A | $\begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}$ | $\left\|\begin{array}{l} R D \\ R D \\ R D \\ R D \end{array}\right\|$ |  |  | $\begin{array}{r} 400 \\ 400 \\ 400 \\ 400 \end{array}$ |  |  |  |  |  | $\begin{aligned} & 12.8 / 1 \\ & 12.8 / 1 \\ & 12.8 / 1 \\ & 12.8 / 1 \end{aligned}$ | 5 5 5 5 |
| 1N4902 <br> 1N4902A <br> 1N4903 <br> 1N4903A | $\begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{S} \\ & \mathbf{s} \end{aligned}$ |  |  |  | $\begin{array}{r} 400 \\ 400 \\ 400 \\ 400 \end{array}$ |  |  |  |  |  | $\begin{aligned} & 12.8 / 1 \\ & 12.8 / 1 \\ & 12.8 / 1 \\ & 12.8 / 1 \end{aligned}$ | 5 5 5 5 |
| INA9OA 1N4904A 1N4905 IN4P05A | $\left\lvert\, \begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}\right.$ | $\left.\begin{array}{\|l\|} \mathrm{RD} \\ \mathrm{RD} \\ \mathrm{RD} \\ \mathrm{RD} \end{array} \right\rvert\,$ |  |  | $\begin{aligned} & 400 \\ & 400 \\ & 400 \\ & 400 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 12.8 / 2 \\ & 12.8 / 2 \\ & 12.8 / 2 \\ & 12.8 / 2 \end{aligned}$ | 5 5 5 5 |
| 1N4906 <br> 1N4906A <br> 1N4907 <br> iN4907A | $\begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}$ | $\left.\begin{array}{\|l\|} \mathbf{R D} \\ \mathrm{RD} \\ \mathrm{RD} \\ \mathrm{RD} \end{array} \right\rvert\,$ |  |  | $\begin{aligned} & 400 \\ & 400 \\ & 400 \\ & 400 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 12.8 / 2 \\ & 12.8 / 2 \\ & 12.8 / 2 \\ & 12.8 / 2 \end{aligned}$ | 5 5 5 5 |
| 1N4908 <br> 1N4908A <br> 1N4909 <br> IN4909A | $\left\lvert\, \begin{aligned} & 5 \\ & 5 \\ & 5 \\ & 5 \end{aligned}\right.$ | $\begin{aligned} & R D \\ & R D \\ & R D \\ & R D \\ & R D \end{aligned}$ |  |  | $\begin{array}{r} 400 \\ 400 \\ 400 \\ 400 \end{array}$ |  |  |  |  |  | $\begin{aligned} & 12.8 / 4 \\ & 12.8 / 4 \\ & 12.8 / 4 \\ & 12.8 / 4 \end{aligned}$ | 5 5 5 5 |


| TYPE NUMBER |  |  | $\begin{gathered} \text { TI } \\ \text { REPLACEMENT } \end{gathered}$ | $\begin{aligned} & \text { FOR } \\ & \text { NEW } \\ & \text { DESICN } \end{aligned}$ | $\begin{gathered} P_{D} \\ (\mathrm{~mW}) \end{gathered}$ | rings <br> $\mathbf{V}_{\mathrm{R}}$ <br> (V) | I <br> (A) | $\begin{array}{ll} \mathrm{I}_{\mathrm{R}} & \mathrm{~V}_{\mathrm{R}} \\ \mu_{\mathrm{A}} & /(\mathrm{V}) \end{array}$ | $\mathbf{V F}_{\mathrm{F}}$ - IF <br> (V) $/$ (mA) | $\begin{aligned} & \text { ERISTICS } \\ & \left\|\begin{array}{c} I_{I I} \\ \text { (ns) } \end{array}\right\| \end{aligned}$ | $\begin{array}{cc} \mathbf{v}_{\mathbf{z}} & \cdot \\ (\mathrm{V}) & / \mathrm{mA}) \end{array}$ | TOL \% |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| IN4910 1N4910A 1N4911 1N4911A | s | $\begin{array}{\|l\|} \hline R D \\ \mathbf{R D} \\ \mathbf{R D} \\ \hline \mathbf{R D} \end{array}$ |  |  | $\begin{aligned} & 400 \\ & 400 \\ & 400 \\ & 400 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 12.8 / 4 \\ & 12.8 / 4 \\ & 12.8 / 4 \\ & 12.8 / 4 \end{aligned}$ | 5 5 5 5 |
| 1N4912 <br> 1N4912A <br> 1N4913 <br> 1N4913A | S | $\left\|\begin{array}{l} R D \\ R D \\ R D \\ R D \end{array}\right\|$ |  |  | 400 400 400 400 |  |  |  |  |  | $12.8 / 7.5$ $12.8 / 7.5$ <br> 12.8/7.5 <br> 12.8/7.5 | 5 5 5 5 |
| 1N4914 <br> 1N4914A <br> 1N4915 <br> 1N4915A | [ | $\begin{array}{\|l\|} \hline R D \\ R D \\ R D \\ R D \\ \hline R D \end{array}$ |  |  | $\begin{aligned} & 400 \\ & 400 \\ & 400 \\ & 400 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 12.8 / 7.5 \\ & 12.8 / 7.5 \\ & 12.8 / 7.5 \\ & 12.8 / 7.5 \end{aligned}$ | 5 5 5 5 |
| 1N4916 <br> IN4916A 1N4917 <br> IN4917A | $\begin{array}{\|l} \hline s \\ s \\ s \\ s \\ s \end{array}$ | $\left\|\begin{array}{l\|} \mathrm{RD} \\ \mathrm{RD} \\ \mathrm{RD} \\ \mathrm{RD} \end{array}\right\|$ |  |  | $\begin{aligned} & 400 \\ & 400 \\ & 400 \\ & 400 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 19.2 / .5 \\ & 19.2 / .5 \\ & 19.2 / .5 \\ & 19.2 / .5 \end{aligned}$ | 5 5 5 5 |
| 1N4918 1N4918A 1 N 4919 1N4919A | $\begin{aligned} & \mathrm{s} \\ & \mathrm{~s} \\ & \mathrm{~s} \\ & \mathrm{~s} \end{aligned}$ | $\begin{aligned} & R D \\ & R D \\ & R D \\ & R D \\ & R D \end{aligned}$ |  |  | $\begin{aligned} & 400 \\ & 400 \\ & 400 \\ & 400 \end{aligned}$ |  |  |  |  |  | 19.2/.5 19.2/. 5 19.2/1 <br> 19.2/1 | 5 5 5 5 |
| IN4920 <br> IN4920A <br> 1N4921 <br> 1N4921A | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\begin{aligned} & \mathbf{R D} \\ & \mathbf{R D} \\ & \mathbf{R D} \\ & \mathbf{R D} \\ & \hline \end{aligned}$ |  |  | 400 400 400 400 |  |  |  |  |  | $\begin{aligned} & 19.2 / 1 \\ & 19.2 / 1 \\ & 19.2 / 1 \\ & 19.2 / 1 \end{aligned}$ | 5 5 5 5 |
| IN4922 <br> IN4922A <br> IN4923 <br> 1N4923A | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\left.\begin{aligned} & \mathrm{RD} \\ & \mathrm{RD} \\ & \mathrm{RD} \\ & \mathrm{RD} \end{aligned} \right\rvert\,$ |  |  | $\begin{aligned} & 400 \\ & 400 \\ & 400 \\ & 400 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 19.2 / 2 \\ & 19.2 / 2 \\ & 19.2 / 2 \\ & 19.2 / 2 \end{aligned}$ | 5 5 5 5 |
| 1N4924 1N4924A 1N4925 1N4925A | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\left.\begin{array}{l\|} \mathbf{R D} \\ \mathbf{R D} \\ R D \\ R D \end{array} \right\rvert\,$ |  |  | $\begin{aligned} & 400 \\ & 400 \\ & 400 \\ & 400 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 19.2 / 2 \\ & 19.2 / 2 \\ & 19.2 / 4 \\ & 19.2 / 4 \end{aligned}$ | 5 5 5 5 |
| 1N4926 iN4926A 1N4927 1N4927A | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\left\|\begin{array}{l} R D \\ R D \\ R D \\ R D \end{array}\right\|$ |  |  | $\begin{aligned} & 400 \\ & 400 \\ & 400 \\ & 400 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 19.2 / 4 \\ & 19.2 / 4 \\ & 19.2 / 4 \\ & 19.2 / 4 \end{aligned}$ | 5 5 5 5 |
|  | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\left\|\begin{array}{l} \mathrm{RD} \\ \mathrm{RD} \\ \mathrm{RD} \\ \mathrm{RD} \end{array}\right\|$ |  |  | $\begin{aligned} & 400 \\ & 400 \\ & 400 \\ & 400 \end{aligned}$ |  |  |  |  |  | 19.2/4 19.2/4 19.2/7.5 19.2/7.5 | 5 5 5 5 |


| $\begin{gathered} \text { TYE } \\ \text { Mumer } \end{gathered}$ |  | $\begin{aligned} & \frac{8}{6} \\ & \frac{8}{2} \\ & \frac{3}{8} \\ & 3 \end{aligned}$ | II |  | Ratines |  |  | CHARACTERISTCS |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  |  | $\mathbf{V}_{\mathbf{R}}$ <br> (V) | (A) | $\begin{array}{ll} \mathbf{U}_{\mathbf{R}} & \bullet \mathbf{V}_{\mathbf{R}} \\ \mu_{\mathrm{A}} & /(\mathbf{V}) \end{array}$ | $V_{F} \quad \mathbf{l}_{F}$ <br> (V) 1 (mA) | $\begin{gathered} I_{r r} \\ \text { (ns) } \end{gathered}$ | $\begin{aligned} & \mathbf{V Z}_{\mathbf{Z}}<\mathbf{Z} \\ & (\mathbf{V}) /(\mathrm{mA}) \end{aligned}$ | rot |
| 1N4930 <br> 1N4930A <br> 1N4931 <br> 1N4931A |  | $\left\|\begin{array}{l} R D \\ R D \\ R D \\ R D \end{array}\right\|$ |  |  | $\begin{array}{r} 400 \\ 400 \\ 400 \\ 400 \end{array}$ |  |  |  |  |  | $\begin{aligned} & 19.2 / 7.5 \\ & 19.2 / 7.5 \\ & 19.2 / 7.5 \\ & 19.2 / 7.5 \end{aligned}$ | $\begin{aligned} & 5 \\ & 5 \\ & 5 \\ & 5 \end{aligned}$ |
| 1N4932 <br> 1N4932A <br> 1N4933 <br> 1N4934 | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\begin{array}{\|l\|} \mathbf{R D} \\ R D \\ R E \\ R E \\ R E \end{array}$ |  |  | $\begin{aligned} & 400 \\ & 400 \end{aligned}$ | 50 100 | 1 | $\begin{aligned} & 300 / \\ & 300 / \end{aligned}$ | $\begin{aligned} & 1.2 / \\ & 1.2 / \end{aligned}$ | $\begin{aligned} & 200 \\ & 200 \end{aligned}$ | $\begin{aligned} & 19.2 / 7.5 \\ & 19.2 / 7.5 \end{aligned}$ | $\begin{aligned} & 5 \\ & 5 \end{aligned}$ |
| IN4935 IN4936 IN4937 1N4938 | $\begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{S} \\ & \mathbf{s} \end{aligned}$ | $\begin{aligned} & R E \\ & R E \\ & R E \\ & R E \\ & \text { SD } \end{aligned}$ | 1N4938 |  | - | 200 400 600 200 | 1 1 1 | $\begin{aligned} & 300 / \\ & 300 / \\ & 300 / \\ & .1 / 175 \end{aligned}$ | $\begin{aligned} & 1.2 / \\ & 1.2 / \\ & 1.2 / \\ & 1 / 100 \end{aligned}$ | $\begin{array}{r} 200 \\ 200 \\ 200 \\ 50 \end{array}$ |  |  |
| 1N4942 <br> iN4943 <br> 1N4944 <br> 1N4945 | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\begin{aligned} & \text { SD } \\ & \text { SD } \\ & \text { SD } \\ & \text { SD } \end{aligned}$ |  |  |  | $\begin{aligned} & 200 \\ & 300 \\ & 400 \\ & 500 \end{aligned}$ | 1 1 1 1 | $\begin{aligned} & 500 / \\ & 500 / \\ & 500 / \\ & 500 / \end{aligned}$ | $\begin{aligned} & 1.5 / 3 \\ & 1.5 / 3 \\ & 1.5 / 3 \\ & 1.5 / 3 \end{aligned}$ | $\begin{aligned} & 150 \\ & 150 \\ & 150 \\ & 150 \end{aligned}$ |  |  |
| 1N4946 <br> 1N4947 <br> IN4948 <br> 1N4949 | $\begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{S} \\ & \mathbf{s} \end{aligned}$ | $\left\lvert\, \begin{aligned} & S D \\ & S D \\ & S D \\ & S D \end{aligned}\right.$ |  | T10701 |  | $\begin{array}{r} 600 \\ 800 \\ 1 K \\ 35 \end{array}$ | 1 1 1 | $\begin{aligned} & 500 / \\ & 500 / \\ & 500 / \\ & 50 N / 30 \end{aligned}$ | $\begin{aligned} & 1.5 / 3 \\ & 1.5 / 3 \\ & 1.5 / 3 \\ & 1 / 150 \end{aligned}$ | $\begin{array}{r} 250 \\ 300 \\ 500 \\ .3 \end{array}$ |  |  |
| 1N4950 <br> 1N4951 <br> IN4952 <br> 1 N4953 | $\left\lvert\, \begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}\right.$ | $\begin{aligned} & \text { SD } \\ & \text { SD } \\ & S D \\ & S D \end{aligned}$ |  | 1N4150 <br> IN4607 <br> 1N4607 <br> TID701 |  | 25 20 50 30 |  | $\begin{array}{r} 100 / 25 \\ .1 / 20 \\ .1 / 20 \\ .5 / 30 \end{array}$ | $\begin{gathered} 1 / 300 \\ .85 / 1 \\ .85 / 1 \\ 1 / 100 \end{gathered}$ | $\begin{aligned} & 4 \\ & 1 \end{aligned}$ |  |  |
| $\begin{aligned} & \text { IN4997 } \\ & \text { iN4998 } \\ & \text { IN4999 } \\ & \text { IN5000 } \end{aligned}$ | $\begin{aligned} & 5 \\ & 5 \\ & 5 \\ & 5 \end{aligned}$ | $\begin{aligned} & R E \\ & R E \\ & R E \\ & R E \\ & R E \end{aligned}$ |  |  |  | 50 100 200 400 | 3 3 3 3 | 2M/ | $\begin{aligned} & 1 / 2 \\ & 1 / 2 \\ & 1 / 2 \\ & 1 / \end{aligned}$ |  |  |  |
| $\begin{aligned} & \text { IN5001 } \\ & \text { IN5002 } \\ & \text { 1N5003 } \\ & \text { iN5004 } \end{aligned}$ | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\begin{aligned} & \text { RE } \\ & \text { RE } \\ & \text { RE } \\ & \text { RE } \end{aligned}$ |  |  |  | $\begin{array}{r} 600 \\ 800 \\ 1 \mathrm{~K} \\ 100 \end{array}$ | 3 3 3 1 | IM/ <br> 1M/ <br> 1M/ <br> $1 \mathrm{M} /$ | $\begin{gathered} 1 / \\ 1 / \\ 1 / \\ 1.3 / \end{gathered}$ | 120 |  |  |
| $\begin{aligned} & \text { IN5005 } \\ & \text { iN5006 } \\ & \text { 1N5007 } \\ & \text { iN5053 } \end{aligned}$ | $\begin{aligned} & s \\ & s \\ & s \\ & s \\ & s \end{aligned}$ | $\begin{aligned} & R E \\ & R E \\ & R E \\ & R E \\ & R E \end{aligned}$ |  |  |  | 200 400 600 800 | 1 1 1 1.5 | $\begin{aligned} & 1 \mathrm{M} / \\ & 1 \mathrm{M} / \\ & 1 \mathrm{M} / \\ & 500 / \end{aligned}$ | $\begin{aligned} & 1.3 / \\ & 1.3 / \\ & 1.3 / \\ & 1.3 / \end{aligned}$ | 120 120 120 |  |  |
| $\begin{aligned} & \text { IN5054 } \\ & \text { IN5055 } \\ & \text { IN5056 } \\ & \text { IN5057 } \end{aligned}$ | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\begin{array}{\|l\|} \hline R E \\ \text { RE } \\ \text { RE } \\ \text { RE } \end{array}$ |  |  |  | $\begin{array}{r} 1 K \\ 100 \\ 200 \\ 300 \end{array}$ | $\begin{array}{r} 1.5 \\ 1 \\ 1 \\ .8 \end{array}$ | $\begin{aligned} & 500 / \\ & 250 / \\ & 250 / \\ & 250 / \end{aligned}$ | $\begin{aligned} & 1.3 / \\ & 1.4 / \\ & 1.4 \prime \\ & 1.4 / \end{aligned}$ | $\begin{aligned} & 200 \\ & 200 \\ & 400 \end{aligned}$ |  |  |

## DIODE INTERCHANGEABILITY

| TYPE Number | 言 |  | $\underset{\text { RERLACEMENT }}{\text { Ti }}$ | $\begin{gathered} \text { FOR } \\ \text { NEW } \\ \text { DESICN } \end{gathered}$ | ${ }^{\circ}$ (mW) | tincs <br> $\mathbf{V}_{\mathbf{R}}$ <br> (V) | 1 <br> (A) | $\begin{array}{ll} \mathbf{L}_{\mathrm{R}} & \bullet V_{\mathrm{R}} \\ \mu \mathrm{~A} & /(\mathrm{V}) \end{array}$ | $\begin{array}{cc}  & \text { charact } \\ \mathbf{v}_{\mathrm{F}} & 0 \\ \text { (v) } & / \text { (ma) } \end{array}$ | aisncs <br> trr <br> (ms) | $\begin{array}{ccc} v_{\mathbf{z}} & 0 & \mathbf{z} \\ (\mathrm{~V}) & 1 & (\mathrm{~mA}) \end{array}$ | ${ }_{x}^{\mathrm{TOL}}$ |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| $\begin{array}{\|l} \hline \text { 1N5058 } \\ \text { 1N5059 } \\ \text { 1 } 15060 \\ \text { 1N5061 } \\ \hline \end{array}$ | $\begin{aligned} & \mathrm{s} \\ & \mathrm{~s} \\ & \mathrm{~s} \\ & \mathrm{~s} \end{aligned}$ |  |  | $\begin{aligned} & \text { TiD383 } \\ & \text { TiD384 } \\ & \text { TiD385 } \end{aligned}$ |  | 400 200 400 600 | .8 1 1 1 | $250 /$ <br> 300/200 <br> 300/400 <br> 200/600 | $\begin{aligned} & 1.4 / \\ & 1.2 / 1 \mathrm{~A} \\ & 1.2 / 1 \mathrm{~A} \\ & 1.2 / 1 \mathrm{~A} \end{aligned}$ | 800 |  |  |
| $\begin{aligned} & \text { 1N5062 } \\ & \text { 1N5170 } \\ & \text { 1NS171 } \\ & \text { IN5172 } \end{aligned}$ | $\begin{aligned} & s \\ & 5 \\ & 5 \\ & 5 \end{aligned}$ | $\begin{aligned} & \mathbf{R E} \\ & \mathbf{R E} \\ & \mathbf{R E} \\ & \mathbf{R E} \end{aligned}$ |  | 7D386 |  | 800 15 50 100 | 1 2 2 2 2 | $\begin{aligned} & 200 / 800 \\ & 25 / \\ & 25 / \\ & 25 / \end{aligned}$ | $\begin{aligned} & 1.2 / 1 A \\ & 1.21 \\ & 1.21 \\ & 1.21 \\ & \hline \end{aligned}$ |  |  |  |
| $\begin{aligned} & \text { INS173 } \\ & \text { INS174 } \\ & \text { INS175 } \\ & \text { INS176 } \end{aligned}$ | $\begin{array}{\|l} \mathbf{s} \\ \mathbf{s} \\ \mathbf{s} \\ \mathbf{s} \end{array}$ | $\left.\begin{array}{\|c\|} \mathrm{RE} \\ \mathrm{RE} \\ \mathrm{RE} \\ \mathrm{RE} \end{array} \right\rvert\,$ |  |  |  | $\begin{aligned} & 300 \\ & 400 \\ & 500 \\ & 600 \end{aligned}$ | 2 2 2 2 | $\begin{aligned} & 25 / \\ & 251 \\ & 251 \\ & 25 / \end{aligned}$ | $\begin{aligned} & 1.21 \\ & 1.21 \\ & 1.21 \\ & 1.21 \end{aligned}$ |  |  |  |
| $\begin{aligned} & \text { INS177 } \\ & \text { iN5178 } \\ & \text { iN5179 } \\ & \text { iNS180 } \end{aligned}$ | $\left\lvert\, \begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}\right.$ | $\left.\begin{aligned} & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{SD} \\ & \mathrm{RE} \end{aligned} \right\rvert\,$ |  |  |  | $\begin{array}{r} 800 \\ 1 K \\ 30 \\ 100 \end{array}$ | $\begin{aligned} & 2 \\ & 2 \\ & 4 \end{aligned}$ | $\begin{array}{r} 25 / \\ 25 / \\ 50 \mathrm{~N} / \\ 5 / \end{array}$ | $\begin{aligned} & 1.21 \\ & 1.2 \prime \\ & 3.7 / 100 \end{aligned}$ |  |  |  |
| $\begin{aligned} & \text { 1N5181 } \\ & \text { 1N5182 } \\ & \text { 1N5183 } \\ & \text { 1N5184 } \end{aligned}$ | $\begin{aligned} & \mathrm{s} \\ & \mathrm{~s} \\ & \mathrm{~s} \\ & \mathrm{~s} \end{aligned}$ | $\begin{aligned} & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \end{aligned}$ |  |  |  | $\begin{array}{r} 4 K \\ 5 K \\ 7.5 \mathrm{~K} \\ 10 \mathrm{~K} \end{array}$ | $\begin{aligned} & .6 \\ & .6 \\ & .6 \\ & .6 \end{aligned}$ | $\begin{aligned} & 201 \\ & 20 \prime \\ & 20 \prime \\ & 20 \prime \end{aligned}$ |  |  |  |  |
| 1N5185 <br> IN5185A <br> 1N5186 <br> IN5186A | $\left[\begin{array}{l} s \\ s \\ s \\ s \end{array}\right.$ | $\begin{aligned} & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \end{aligned}$ |  |  |  | $\begin{array}{r} 50 \\ 50 \\ 100 \\ 100 \end{array}$ | $\left.\begin{aligned} & 3 \\ & 4 \\ & 3 \\ & 4 \end{aligned} \right\rvert\,$ | $\begin{array}{r} 100 \prime \\ 22 \prime \\ 100 / \\ 22 \prime \end{array}$ | $\begin{aligned} & 1.1 / \\ & 1.1 / \\ & 1.1 / \\ & 1.1 / \end{aligned}$ |  |  |  |
| IN5187 <br> INS187A <br> INSI88 <br> INSI88A | $\left\lvert\, \begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}\right.$ | $\left.\begin{aligned} & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \end{aligned} \right\rvert\,$ |  |  |  | $\begin{aligned} & 200 \\ & 200 \\ & 400 \\ & 400 \end{aligned}$ | 3 4 3 4 | $\begin{array}{r} 100 / \\ 22 \prime \\ 100 \prime \\ 22 \prime \end{array}$ | $\begin{aligned} & 1.1 / \\ & 1.1 / \\ & 1.1 / \\ & 1.1 / \end{aligned}$ |  |  |  |
| IN5189 1N5189A 1N5190 IN5190A | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\begin{aligned} & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \end{aligned}$ |  |  |  | $\begin{aligned} & 500 \\ & 500 \\ & 600 \\ & 600 \end{aligned}$ | $\begin{aligned} & 3 \\ & 4 \\ & 3 \\ & 4 \end{aligned}$ | $\begin{gathered} 100 / \\ 22 / \\ 100 / \\ 22 / \end{gathered}$ | $\begin{aligned} & 1.1 / \\ & 1.1 / \\ & 1.1 / \\ & 1.1 / \end{aligned}$ |  |  |  |
| 1N5194 <br> 1N5195 <br> 1N5196 <br> 1N5197 | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\left.\begin{array}{\|l\|} \hline \mathrm{SD} \\ \mathrm{SD} \\ \mathrm{SD} \\ \mathrm{RE} \end{array} \right\rvert\,$ |  | 1N483 IN485 1N486 |  | $\begin{array}{r} 80 \\ 200 \\ 250 \\ 50 \end{array}$ | 2 | 25N/70 <br> 25N/180 <br> 25N/225 <br> 100/ | $\begin{aligned} & 1 / 100 \\ & 1 / 100 \\ & 1 / 100 \\ & 1.21 \end{aligned}$ |  |  |  |
| INS198 1N5199 1N5200 IN52O1 | $s$ | $\left\|\begin{array}{l} R E \\ R E \\ R E \\ R E \end{array}\right\|$ |  |  |  | $\begin{aligned} & 100 \\ & 200 \\ & 400 \\ & 600 \end{aligned}$ | $\begin{aligned} & 2 \\ & 2 \\ & 2 \\ & 2 \end{aligned}$ | 100/ 1001 100/ 100/ | $\begin{aligned} & 1.2 / \\ & 1.2 / \\ & 1.21 \\ & 1.21 \end{aligned}$ |  |  |  |


| TYPE mumeer | $\begin{aligned} & \frac{3}{3} \\ & \frac{1}{3} \\ & \frac{3}{3} \end{aligned}$ | $\begin{aligned} & \frac{3}{6} \\ & \frac{0}{3} \\ & \frac{3}{3} \\ & \frac{3}{3} \end{aligned}$ | TI |  | Ratines |  |  | CHARACTERISTICS |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  |  | $\mathbf{V}_{\mathbf{R}}$ <br> (V) | I <br> (A) | $\begin{array}{ll} \mathbf{I}_{\mathbf{R}} & \mathbf{V}_{\mathrm{R}} \\ \mu_{\mathrm{A}} & /(\mathrm{V}) \end{array}$ | $\mathbf{V F}_{F}$ - $\mathbf{F}_{F}$ <br> (V) $/$ (mA) | $\begin{aligned} & t_{r r} \\ & (n s) \end{aligned}$ | $\begin{array}{llc} \mathbf{V}_{\mathbf{Z}} & \mathbf{Z} \\ (\mathrm{V}) & / \mathrm{ma}) \end{array}$ | $\begin{aligned} & \text { TOL } \\ & \text { \% } \end{aligned}$ |
| 1N5206 <br> IN5207 <br> 1N5208 <br> IN5209 | $\begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}$ | $\left\|\begin{array}{l} R E \\ R E \\ S D \\ S D \end{array}\right\|$ |  | $\left\lvert\, \begin{aligned} & \text { IN457 } \\ & \text { 1N458 } \end{aligned}\right.$ |  | 400 400 70 150 | 2 | $\begin{gathered} 3 / \\ 5 / \\ 25 \mathrm{~N} / 175 \\ 25 \mathrm{~N} / 125 \end{gathered}$ | $\begin{aligned} & 1.2 / \\ & 1.2 / \\ & 1 / 20 \\ & 1 / 7 \end{aligned}$ |  |  |  |
| 1N5210 <br> 1N5211 <br> IN5212 <br> IN5213 | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\begin{aligned} & S D \\ & R E \\ & R E \\ & R E \\ & R E \end{aligned}$ |  | $\begin{array}{\|l} \left\lvert\, \begin{array}{l} \text { IN459 } \end{array}\right. \\ \text { TID383 } \\ \text { TID384 } \\ \text { TID385 } \end{array}$ |  | $\begin{aligned} & 200 \\ & 200 \\ & 400 \\ & 600 \end{aligned}$ | 1 1 1 | $\begin{aligned} & 25 N / 175 \\ & 200 / 200 \\ & 200 / 400 \\ & 200 / 600 \end{aligned}$ | 1.2/3 <br> $1.2 / 1 \mathrm{~A}$ <br> $1.2 / 1 \mathrm{~A}$ <br> 1.2/1A |  |  |  |
| 1N5214 <br> iN5215 <br> 1N5216 <br> 1N5217 | $\left\lvert\, \begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}\right.$ | $\begin{aligned} & R E \\ & R E \\ & R E \\ & R E \end{aligned}$ |  | $\begin{aligned} & \text { TID386 } \\ & \text { TID383 } \\ & \text { TID384 } \\ & \text { TID385 } \end{aligned}$ |  | $\begin{aligned} & 800 \\ & 200 \\ & 400 \\ & 600 \end{aligned}$ | $\begin{array}{r} 75 \\ 1 \\ 1 \\ 1 \end{array}$ | $\begin{aligned} & 200 / 800 \\ & 200 / 200 \\ & 200 / 400 \\ & 200 / 600 \end{aligned}$ | $\begin{aligned} & 1.2 / 1 \mathrm{~A} \\ & 1.2 / 1 \mathrm{~A} \\ & 1.2 / 1 \mathrm{~A} \\ & 1.2 / 1 \mathrm{~A} \end{aligned}$ |  |  |  |
| $\begin{array}{\|l} \text { IN5218 } \\ \text { 1N5219 } \\ \text { 1N5220 } \\ \text { IN5221 } \end{array}$ | $\begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}$ | $\left.\begin{aligned} & \mathrm{RE} \\ & \mathrm{SD} \\ & \mathrm{SD} \\ & \mathrm{ZD} \end{aligned} \right\rvert\,$ |  | $\begin{aligned} & \text { TID386 } \\ & \text { TID } 701 \\ & \text { TID701 } \end{aligned}$ | 500 | $\begin{array}{r} 800 \\ 30 \\ 30 \end{array}$ | . 75 | $\begin{aligned} & 200 / 800 \\ & 50 N / 20 \\ & 50 N / 20 \end{aligned}$ | $\begin{array}{r} 1.2 / 1 A \\ 1 / 50 \\ 1.2 / 50 \end{array}$ | $\begin{aligned} & 2 \\ & 2 \end{aligned}$ | 2.4/20 | 20 |
| $\begin{aligned} & \text { 1N5221A } \\ & \text { iN5221B } \\ & \text { IN5222 } \\ & \text { IN5222A } \end{aligned}$ | $\begin{aligned} & s \\ & s \\ & s \\ & s \\ & s \end{aligned}$ | $\left.\begin{aligned} & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \end{aligned} \right\rvert\,$ |  |  | $\begin{aligned} & 500 \\ & 500 \\ & 500 \\ & 500 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 2.4 / 20 \\ & 2.4 / 20 \\ & 2.5 / 20 \\ & 2.5 / 20 \end{aligned}$ | 10 5 20 10 |
| $\begin{aligned} & \text { IN5222B } \\ & \text { 1N5223 } \\ & \text { IN5223A } \\ & \text { IN5223B } \end{aligned}$ | $\left\lvert\, \begin{aligned} & 5 \\ & 5 \\ & 5 \\ & 5 \end{aligned}\right.$ | $\left.\begin{aligned} & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \end{aligned} \right\rvert\,$ |  |  | $\begin{aligned} & 500 \\ & 500 \\ & 500 \\ & 500 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 2.5 / 20 \\ & 2.7 / 20 \\ & 2.7 / 20 \\ & 2.7 / 20 \end{aligned}$ | 5 20 10 5 |
| 1N5224 <br> 1N5224A <br> 1N52248 <br> 1N5225 | $\left\lvert\, \begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}\right.$ | $\left.\begin{aligned} & z 0 \\ & z 0 \\ & z 0 \\ & z D \end{aligned} \right\rvert\,$ |  |  | $\begin{aligned} & 500 \\ & 500 \\ & 500 \\ & 500 \end{aligned}$ |  |  |  |  |  | $\begin{array}{r} 2.8 / 20 \\ 2.8 / 20 \\ 2.8 / 20 \\ 3 / 20 \end{array}$ | 20 10 5 20 |
| $\begin{aligned} & \text { 1N5225A } \\ & \text { IN5225B } \\ & \text { 1N5226 } \\ & \text { 1N5226A } \end{aligned}$ | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\left.\begin{aligned} & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \end{aligned} \right\rvert\,$ | IN5226 <br> 1N5226A |  | 500 500 500 500 |  |  |  |  |  | $\begin{array}{r} 3 / 20 \\ 3 / 20 \\ 3.3 / 20 \\ 3.3 / 20 \end{array}$ | 10 5 20 10 |
| $\begin{array}{\|l} \text { IN522SB } \\ \text { IN5227 } \\ \text { IN5227A } \\ \text { IN5227B } \end{array}$ | $\begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}$ | $\begin{aligned} & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \end{aligned}$ | $\begin{aligned} & \text { IN5226B } \\ & \text { IN5227 } \\ & \text { 1N5227A } \\ & \text { IN5227B } \end{aligned}$ |  | $\begin{aligned} & 500 \\ & 500 \\ & 500 \\ & 500 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 3.3 / 20 \\ & 3.6 / 20 \\ & 3.6 / 20 \\ & 3.6 / 20 \end{aligned}$ | 5 20 10 5 |
| $\begin{aligned} & \text { IN5228 } \\ & \text { 1N5228A } \\ & \text { 1N52288 } \\ & \text { IN5229 } \end{aligned}$ | $\begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}$ | $\begin{aligned} & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{ZD} \\ & \mathrm{zD} \end{aligned}$ | $\begin{aligned} & \text { IN5228 } \\ & \text { IN5228A } \\ & \text { IN52288 } \\ & \text { IN5229 } \end{aligned}$ |  | 500 500 500 500 |  |  |  |  |  | $\begin{aligned} & 3.9 / 20 \\ & 3.9 / 20 \\ & 3.9 / 20 \\ & 4.3 / 20 \end{aligned}$ | 20 10 5 20 |

## DIODE INTERCHANGEABILITY

| TYPE NUMSER |  |  |  | $\begin{array}{\|c\|} \hline \text { REPLACEMENT } \\ \hline \end{array}$ | $\begin{gathered} \text { FOR } \\ \text { NRW } \\ \text { DESIGN } \end{gathered}$ | PD (mW) | $\begin{gathered} \text { VTMOS } \\ \mathbf{V}_{\mathbf{R}} \\ \text { (v) } \end{gathered}$ | I <br> (A) | $\begin{array}{ll} I_{\mathbf{R}} & V_{\mathbf{R}} \\ \mu_{\mathbf{A}} & /(\mathbf{V}) \end{array}$ | $\begin{array}{cc}  & \text { characte } \\ \mathbf{v F}_{\mathbf{F}} & \bullet \\ (\mathbf{v}) & / \text { (ma) } \end{array}$ | $\begin{gathered} i_{1 \pi} \\ (n=151 C \end{gathered}$ | $\begin{array}{llc} \mathrm{v}_{\mathrm{z}} & \bullet & \mathrm{lz} \\ (\mathrm{~V}) & /(\mathrm{mA}) \end{array}$ | \% |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| $\begin{aligned} & \text { 1N5229A } \\ & \text { 1N52298 } \\ & \text { 1N5230 } \\ & \text { 1N5230A } \end{aligned}$ | S |  |  | $\begin{array}{\|l\|} \hline \text { 1N5229A } \\ \text { IN52298 } \\ \text { 1N5230 } \\ \text { 1N5230A } \end{array}$ |  | $\begin{aligned} & 500 \\ & 500 \\ & 500 \\ & 500 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 4.3 / 20 \\ & 4.3 / 20 \\ & 4.7 / 20 \\ & 4.7 / 20 \end{aligned}$ | 10 5 20 10 |
| $\begin{aligned} & \text { IN5230B } \\ & \text { IN5231 } \\ & \text { IN5231A } \\ & \text { IN5231B } \end{aligned}$ | $\begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}$ | 2 zi |  | IN5230B <br> IN5231 <br> in5231A <br> IN5231B |  | $\begin{aligned} & 500 \\ & 500 \\ & 500 \\ & 500 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 4.7 / 20 \\ & 5.1 / 20 \\ & 5.1 / 20 \\ & 5.1 / 20 \end{aligned}$ | 5 20 10 5 |
| $\begin{aligned} & \text { 1N5232 } \\ & \text { 1N5232A } \\ & \text { 1N5232B } \\ & \text { 1N5233 } \end{aligned}$ | ( | ZD |  | 1N5232 <br> 1N5232A <br> IN5232B <br> 1N5233 |  | $\begin{aligned} & 500 \\ & 500 \\ & 500 \\ & 500 \end{aligned}$ |  |  |  |  |  | $\begin{array}{r} 5.6 / 20 \\ 5.6 / 20 \\ 5.6 / 20 \\ 6 / 20 \end{array}$ | 20 10 5 20 |
|  | $\begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}$ |  |  | iN5233A <br> 1N5233B <br> 1N5234 <br> IN5234A |  | $\begin{aligned} & 500 \\ & 500 \\ & 500 \\ & 500 \end{aligned}$ |  |  |  |  |  | $\begin{array}{r} 6 / 20 \\ 6 / 20 \\ 6.2 / 20 \\ 6.2 / 20 \end{array}$ | 10 5 20 10 |
| JN5234B <br> 1N5235 <br> 1N5235A <br> 1N5235B | $\left\lvert\, \begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}\right.$ | zD |  | 1N5234: <br> 1N5235 <br> 1N5235A <br> 1N5235B |  | $\begin{aligned} & 500 \\ & 500 \\ & 500 \\ & 500 \end{aligned}$ |  |  |  |  |  | 6.2/20 <br> 6.8/20 <br> 6.8/20 <br> 6.8/20 | 5 20 10 5 |
|  | s s s s | zD |  | 1N5236 <br> IN5238A <br> 1N5236B <br> IN5237 |  | $\begin{aligned} & 500 \\ & 500 \\ & 500 \\ & 500 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 7.5 / 20 \\ & 7.5 / 20 \\ & 7.5 / 20 \\ & 8.2 / 20 \end{aligned}$ | 20 10 5 20 |
|  | s | ZD |  | IN5237A <br> iN5237B <br> in5238 <br> in5238A |  | $\begin{aligned} & 500 \\ & 500 \\ & 500 \\ & 500 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 8.2 / 20 \\ & 8.2 / 20 \\ & 8.7 / 20 \\ & 8.7 / 20 \end{aligned}$ | 10 5 20 10 |
| IN52388 1N5239 1N5239A 1N5239B | S | $\left\lvert\, \begin{aligned} & \mathrm{zD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \end{aligned}\right.$ |  | $\begin{aligned} & \text { IN5238B } \\ & \text { IN5239 } \\ & \text { IN5239A } \\ & \text { IN5239B } \end{aligned}$ |  | $\begin{aligned} & 500 \\ & 500 \\ & 500 \\ & 500 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 8.7 / 20 \\ & 9.1 / 20 \\ & 9.1 / 20 \\ & 9.1 / 20 \end{aligned}$ | 5 20 10 5 |
|  | $\begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}$ | $\begin{aligned} & \mathrm{ZD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \end{aligned}$ |  | N5240 N5240A N5240B N5241 |  | $\begin{aligned} & 500 \\ & 500 \\ & 500 \\ & 500 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 10 / 20 \\ & 10 / 20 \\ & 1020 \\ & 11 / 20 \end{aligned}$ | 20 10 5 20 |
| 1N5241A 1N5241B 1N5242 iN5242A | $\begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}$ | $\begin{aligned} & \mathrm{ZD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \end{aligned}$ |  | N5241A N5241B N5242 N5242A |  | $\begin{aligned} & 500 \\ & 500 \\ & 500 \\ & 500 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 11 / 20 \\ & 11 / 20 \\ & 12 / 20 \\ & 12 / 20 \end{aligned}$ | 10 5 20 10 |



## DIODE INTERCHANGEABILTTY

| TYPE NUMPER |  | $\begin{aligned} & \frac{3}{3} \\ & \frac{5}{5} \\ & \frac{2}{2} \\ & \frac{3}{3} \end{aligned}$ | II REPLACEMENT |  | $\begin{aligned} & \mathrm{PD} \\ & (\mathrm{~mW}) \end{aligned}$ | RATINGS $\begin{aligned} & \mathbf{V}_{\mathbf{R}} \\ & (\mathbf{V}) \end{aligned}$ | I <br> (A) | $\begin{array}{ll} \mathrm{I}_{\mathrm{R}} & \mathrm{~V}_{\mathrm{R}} \\ \mu_{\mathrm{A}} & /(\mathrm{V}) \end{array}$ | $\begin{array}{cc} \mathbf{V}_{F} & \mathbf{I F}_{\mathbf{F}} \\ (\mathrm{V}) & /(\mathrm{mA}) \end{array}$ | RISTIC <br> $t_{0}$ <br> (ns) | $\begin{array}{ll} \mathbf{v z}_{z} & \mathrm{lz} \\ (\mathrm{~V}) & / \mathrm{ma}) \end{array}$ | TOL <br> \% |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| $\begin{aligned} & \text { IN5284 } \\ & \text { IN5285 } \\ & \text { IN5286 } \\ & \text { IN5287 } \end{aligned}$ | s s s S | $\begin{aligned} & \mathrm{RD} \\ & \mathrm{RD} \\ & \mathrm{RD} \\ & \mathrm{RD} \end{aligned}$ |  |  | $\begin{aligned} & 600 \\ & 600 \\ & 600 \\ & 600 \end{aligned}$ |  |  |  |  |  |  |  |
| 1N5288 <br> 1N5289 <br> 1N5290 <br> IN5291 | $\begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}$ | $\begin{aligned} & R D \\ & R D \\ & R D \\ & R D \end{aligned}$ |  |  | $\begin{aligned} & 600 \\ & 600 \\ & 600 \\ & 600 \end{aligned}$ |  |  | , |  |  |  |  |
| $\begin{aligned} & \text { IN5292 } \\ & \text { iN5293 } \\ & \text { IN5294 } \\ & \text { IN5295 } \end{aligned}$ | $\left\lvert\, \begin{aligned} & 5 \\ & 5 \\ & 5 \\ & 5 \end{aligned}\right.$ | $\begin{aligned} & R D \\ & R D \\ & R D \\ & R D \end{aligned}$ |  |  | $\begin{aligned} & 600 \\ & 600 \\ & 600 \\ & 600 \end{aligned}$ |  |  |  |  |  |  |  |
| $\begin{aligned} & \text { IN5296 } \\ & \text { IN5297 } \\ & \text { IN5298 } \\ & \text { IN5300 } \end{aligned}$ | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\begin{aligned} & R D \\ & R D \\ & R D \\ & R D \end{aligned}$ |  |  | $\begin{aligned} & 600 \\ & 600 \\ & 600 \\ & 600 \end{aligned}$ |  |  |  |  |  |  |  |
| $\left(\begin{array}{l} \text { 1N5301 } \\ \text { 1N5302 } \\ \text { 1N5303 } \\ \text { IN5304 } \end{array}\right.$ | $\left[\begin{array}{l} s \\ s \\ s \\ s \end{array}\right.$ | $\begin{aligned} & R D \\ & R D \\ & R D \\ & R D \end{aligned}$ |  |  | $\begin{aligned} & 600 \\ & 600 \\ & 600 \\ & 600 \end{aligned}$ |  |  |  |  |  |  |  |
| $\begin{aligned} & \text { 1N5305 } \\ & \text { IN5306 } \\ & \text { 1N5307 } \\ & \text { 1N5308 } \end{aligned}$ | $\left\lvert\, \begin{aligned} & S \\ & s \\ & S \\ & s \end{aligned}\right.$ | $\left\|\begin{array}{l} R D \\ R D \\ R D \\ R D \end{array}\right\|$ |  |  | $\begin{aligned} & 600 \\ & 600 \\ & 600 \\ & 600 \end{aligned}$ |  |  |  |  |  |  |  |
| 1N5309 <br> IN5310 <br> 1N5311 <br> 1N5312 | S | RD <br> RD <br> RD <br> $R D$ |  |  | $\begin{aligned} & 600 \\ & 600 \\ & 600 \\ & 600 \end{aligned}$ |  |  |  |  |  |  |  |
| 1N5313 <br> 1N5315 <br> 1N5316 <br> 1N5317 | $\left\lvert\, \begin{aligned} & \mathbf{S} \\ & \mathbf{s} \\ & \mathbf{S} \\ & \mathbf{s} \end{aligned}\right.$ | $\left.\begin{aligned} & R D \\ & S D \\ & S D \\ & S D \end{aligned} \right\rvert\,$ |  | 1N4153 <br> 1N4153 <br> 1N4150 | 600 | $\begin{array}{r} 100 \\ 100 \\ 80 \end{array}$ |  | $\begin{array}{r} 50 \mathrm{~N} / 50 \\ 50 \mathrm{~N} / 50 \\ .1 / 55 \end{array}$ | $\begin{array}{r} 1 / 200 \\ 1 / 100 \\ 1.3 / 500 \end{array}$ | 4 4 4 |  |  |
| 1N5318 <br> 1N5319 <br> 1N5314 <br> 1N5320 | $\begin{aligned} & 5 \\ & s \\ & s \\ & s \end{aligned}$ | $\left\lvert\, \begin{aligned} & S D \\ & S D \\ & R D \\ & R E \\ & R E \end{aligned}\right.$ |  | 1N4150 1N4305 | 600 | $\begin{array}{r} 75 \\ 40 \\ 100 \end{array}$ | 1 | $\begin{array}{r} .1 / 50 \\ 100 / 25 \\ 100 / 100 \end{array}$ | $\begin{aligned} & 1 / 200 \\ & 1 / 100 \\ & 1.1 / 1 \mathrm{~A} \end{aligned}$ | $\begin{array}{r} 4 \\ 4 \\ 250 \end{array}$ |  |  |
| IN5324 <br> IN5326 <br> IN5329 <br> IN5330 | $S$ $S$ $S$ $S$ | $\begin{aligned} & R E \\ & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \end{aligned}$ |  |  |  | $\begin{aligned} & 15 K \\ & 100 \\ & 1.8 K \\ & 1.6 K \end{aligned}$ | $\begin{array}{r} .01 \\ 12 \\ .135 \\ .54 \end{array}$ | $\begin{gathered} 25 / \\ 150 / \\ 150 / \end{gathered}$ | 24/ |  |  |  |


| TYPE NUMBER |  | 2003$\frac{3}{3}$3 | Ti | $\begin{aligned} & \text { FOR } \\ & \text { NEW } \\ & \text { DESICN } \end{aligned}$ | ratings |  |  | CHARACTERISTICS |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  | $\begin{gathered} \text { PD } \\ (\mathrm{mW}) \end{gathered}$ | $V_{R}$ <br> (V) | I <br> (A) | $\begin{array}{ll} \mathbf{l}_{\mathbf{R}} & \bullet \mathbf{V}_{\mathbf{R}} \\ \mu_{\mathbf{A}} & /(\mathbf{V}) \end{array}$ | $\begin{array}{cc} \mathbf{V}_{\mathrm{F}} & \mathbf{I F}_{\mathrm{F}} \\ (\mathrm{~V}) & /(\mathrm{mA}) \end{array}$ | $t_{\pi r}$ <br> (ns) | $\begin{array}{lc} \mathbf{V Z}_{\mathbf{z}} & \mathrm{lz} \\ (\mathrm{~V}) & / \mathrm{mA}) \end{array}$ | $\begin{aligned} & \text { ror } \\ & \% \end{aligned}$ |
| $\begin{aligned} & \text { 1N5242B } \\ & \text { 1N5243 } \\ & \text { 1N5243A } \\ & \text { IN5243B } \end{aligned}$ | $\begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}$ | $\left\|\begin{array}{l} \mathrm{ZD} \\ \mathrm{ZD} \\ \mathrm{ZD} \\ \mathrm{ZD} \end{array}\right\|$ | $\begin{aligned} & \text { 1N5242B } \\ & \text { 1N5243 } \\ & \text { 1N5243A } \\ & \text { 1N5243B } \end{aligned}$ |  | $\begin{aligned} & 500 \\ & 500 \\ & 500 \\ & 500 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 12 / 20 \\ & 13 / 9.5 \\ & 13 / 9.5 \\ & 13 / 9.5 \end{aligned}$ | $\begin{array}{r} 5 \\ 20 \\ 10 \\ 5 \end{array}$ |
| $\begin{aligned} & \text { IN5244 } \\ & \text { IN5244A } \\ & \text { 1N524AB } \\ & \text { IN5245 } \end{aligned}$ | $\begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}$ | $\begin{aligned} & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{ZD} \\ & \mathrm{zD} \end{aligned}$ | $\begin{aligned} & \text { 1N5244 } \\ & \text { iN5244A } \\ & \text { 1N5244B } \\ & \text { 1N5245 } \end{aligned}$ |  | $\begin{aligned} & 500 \\ & 500 \\ & 500 \\ & 500 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 14 / 9 \\ & 14 / 9 \\ & 14 / 9 \\ & 15 / 8.5 \end{aligned}$ | $\begin{array}{r} 20 \\ 10 \\ 5 \\ 20 \end{array}$ |
| $\begin{aligned} & \text { IN5245A } \\ & \text { IN5245B } \\ & \text { IN5246 } \\ & \text { IN5246A } \end{aligned}$ | $\left\lvert\, \begin{aligned} & 5 \\ & 5 \\ & 5 \\ & 5 \end{aligned}\right.$ | $\begin{aligned} & \mathrm{ZD} \\ & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \end{aligned}$ | $\begin{aligned} & \text { 1N5245A } \\ & \text { IN5245B } \\ & \text { IN5246 } \\ & \text { IN5246A } \end{aligned}$ |  | $\begin{aligned} & 500 \\ & 500 \\ & 500 \\ & 500 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 15 / 8.5 \\ & 15 / 8.5 \\ & 16 / 7.8 \\ & 16 / 7.8 \end{aligned}$ | $\begin{array}{r} 10 \\ 5 \\ 20 \\ 10 \end{array}$ |
| $\begin{array}{\|l} \text { 1N5246B } \\ \text { 1N5247 } \\ \text { 1N5247A } \\ \text { 1N5247B } \end{array}$ | $\left[\begin{array}{l} 5 \\ 5 \\ 5 \\ 5 \end{array}\right.$ | $\begin{aligned} & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \end{aligned}$ | $\begin{aligned} & \text { IN5246B } \\ & \text { IN5247 } \\ & \text { IN5247A } \\ & \text { IN5247B } \end{aligned}$ |  | $\begin{aligned} & 500 \\ & 500 \\ & 500 \\ & 500 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 16 / 7.8 \\ & 17 / 7.4 \\ & 17 / 7.4 \\ & 17 / 7.4 \end{aligned}$ | $\begin{array}{r} 5 \\ 20 \\ 10 \\ 5 \end{array}$ |
| $\begin{aligned} & \text { 1N5248 } \\ & \text { 1N5248A } \\ & \text { 1N5248B } \\ & \text { iN5249 } \end{aligned}$ | $\left\lvert\, \begin{aligned} & \mathbf{S} \\ & \mathbf{S} \\ & \mathbf{S} \\ & \mathbf{s} \end{aligned}\right.$ | $\left\|\begin{array}{l} \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \end{array}\right\|$ | $\begin{aligned} & \text { IN5248 } \\ & \text { 1N5248A } \\ & \text { 1N5248B } \\ & \text { IN5249 } \end{aligned}$ |  | $\begin{aligned} & 500 \\ & 500 \\ & 500 \\ & 500 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 18 / 7 \\ & 18 / 7 \\ & 18 / 7 \\ & 19 / 6.6 \end{aligned}$ | $\begin{array}{r} 20 \\ 10 \\ 5 \\ 20 \end{array}$ |
| $\begin{array}{\|l} \text { 1N5249A } \\ \text { 1N52498 } \\ \text { 1N5250 } \\ \text { IN5250A } \end{array}$ | $\begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}$ | $\left\|\begin{array}{l} \mathrm{ZD} \\ \mathrm{zD} \\ \mathrm{ZD} \\ \mathrm{ZD} \end{array}\right\|$ | $\begin{aligned} & \text { IN5249A } \\ & \text { lN5249B } \\ & \text { 1N5250 } \\ & \text { 1N5250A } \end{aligned}$ |  | $\begin{aligned} & 500 \\ & 500 \\ & 500 \\ & 500 \end{aligned}$ |  |  |  |  |  | 19/6.6 19/6.6 20/6.2 <br> 20/6.2 | 10 5 20 10 |
| $\begin{aligned} & \text { IN5250B } \\ & \text { IN5251 } \\ & \text { IN5251A } \\ & \text { IN5251B } \end{aligned}$ | $\begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}$ | $\left\|\begin{array}{l} z 0 \\ z D \\ z D \\ z D \end{array}\right\|$ | $\begin{aligned} & \text { 1N5250B } \\ & \text { 1N5251 } \\ & \text { IN5251A } \\ & \text { IN5251B } \end{aligned}$ |  | $\begin{aligned} & 500 \\ & 500 \\ & 500 \\ & 500 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 20 / 6.2 \\ & 22 / 5.6 \\ & 22 / 5.6 \\ & 22 / 5.6 \end{aligned}$ | 5 20 10 5 |
| $\begin{aligned} & \text { IN5252 } \\ & \text { 1N5252A } \\ & \text { IN5252B } \\ & \text { IN5253 } \end{aligned}$ | $\begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}$ | $\left.\begin{aligned} & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \end{aligned} \right\rvert\,$ | $\begin{aligned} & \text { IN5252 } \\ & \text { IN5252A } \\ & \text { IN5252B } \\ & \text { IN5253 } \end{aligned}$ |  | $\begin{aligned} & 500 \\ & 500 \\ & 500 \\ & 500 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 24 / 5.2 \\ & 24 / 5.2 \\ & 24 / 5.2 \\ & 25 / 5 \end{aligned}$ | 20 10 5 20 |
| $\begin{aligned} & \text { 1N5253A } \\ & \text { 1N5253B } \\ & \text { 1N5254 } \\ & \text { 1N5254A } \end{aligned}$ | $\begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{S} \\ & \mathbf{s} \end{aligned}$ | $\begin{aligned} & \mathrm{zD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \\ & \mathrm{zD} \end{aligned}$ | $\begin{aligned} & \text { 1N5253A } \\ & \text { IN5253B } \\ & \text { IN5254 } \\ & \text { IN5254A } \end{aligned}$ |  | $\begin{aligned} & 500 \\ & 500 \\ & 500 \\ & 500 \end{aligned}$ |  |  | . |  |  | $\begin{aligned} & 25 / 5 \\ & 25 / 5 \\ & 27 / 4.6 \\ & 27 / 4.6 \end{aligned}$ | 10 5 20 10 |
| $\begin{aligned} & \text { 1N5254B } \\ & \text { 1 N5255 } \\ & \text { iN5255A } \\ & \text { iN5255B } \end{aligned}$ | $\left\lvert\, \begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}\right.$ | $\begin{aligned} & \mathrm{ZD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \end{aligned}$ | $\begin{aligned} & \text { 1N52548 } \\ & \text { 1N5255 } \\ & \text { 1N5255A } \\ & \text { 1N5255B } \end{aligned}$ |  | $\begin{aligned} & 500 \\ & 500 \\ & 500 \\ & 500 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 27 / 4.6 \\ & 28 / 4.5 \\ & 28 / 4.5 \\ & 28 / 4.5 \end{aligned}$ | 5 20 10 5 |

## DIODE INTERCHANGEABILITY



| TYPE MUMEER |  |  | $\text { n } 1$ | $\begin{aligned} & \text { FOR } \\ & \text { NEW } \\ & \text { DESICN } \end{aligned}$ | Ratanos |  |  | CHARACTERISTICS |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  | $\begin{gathered} \mathrm{m} \\ (\mathrm{mw}) \end{gathered}$ | $\begin{aligned} & \mathbf{V}_{\mathbf{R}} \\ & (\mathbf{V}) \end{aligned}$ | 1 <br> (A) | $\begin{array}{lll} \mathbf{I}_{\mathbf{R}} & \mathbf{V}_{\mathrm{R}} \\ \mu \mathrm{~A} & / \mathrm{V}) \end{array}$ | $\begin{array}{ccc} V_{F} & I_{F} \\ (V) & /(\mathrm{mA}) \end{array}$ | $\begin{gathered} t_{\pi} \\ (\mathrm{ms}) \end{gathered}$ | $\mathbf{V Z}_{\mathbf{Z}}$ - $\mathbf{z}$ <br> (V) / (mA) | $\begin{aligned} & \text { TOX } \\ & \text { \% } \end{aligned}$ |
| $\begin{array}{\|l} \text { IN5269A } \\ \text { IN52698 } \\ \text { IN5270 } \\ \text { IN5270A } \end{array}$ | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\left.\begin{aligned} & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \end{aligned} \right\rvert\,$ |  |  | 500 500 500 500 |  |  |  |  |  | 87/1.4 <br> 87/1.4 <br> $91 / 1.4$ <br> 91/1.4 | 10 5 20 10 |
| $\begin{aligned} & \text { IN52708 } \\ & \text { IN5271 } \\ & \text { IN5271A } \\ & \text { IN5271B } \end{aligned}$ | $\left\lvert\, \begin{aligned} & 5 \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\left\|\begin{array}{c} \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \end{array}\right\|$ |  |  | $\begin{aligned} & 500 \\ & 500 \\ & 500 \\ & 500 \end{aligned}$ |  |  |  |  |  | $\begin{array}{r} 91 / 1.4 \\ 100 / 1.3 \\ 100 / 1.3 \\ 100 / 1.3 \end{array}$ | $\begin{array}{r} 5 \\ 20 \\ 10 \\ 5 \end{array}$ |
| $\begin{aligned} & \text { IN5272 } \\ & \text { 1N5272A } \\ & \text { 1N5272B } \\ & \text { iN5273 } \end{aligned}$ | $\begin{aligned} & 5 \\ & 5 \\ & s \\ & s \end{aligned}$ | $\begin{aligned} & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \end{aligned}$ |  |  | 500 500 500 500 |  |  |  |  |  | 110/1.1 <br> 110/1.1 <br> 110/1.1 <br> 120/1 | $\begin{array}{r} 20 \\ 10 \\ 5 \\ 20 \end{array}$ |
| $\begin{aligned} & \text { IN5273A } \\ & \text { IN52738 } \\ & \text { IN5274 } \\ & \text { IN527AA } \end{aligned}$ | $\begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{S} \\ & \mathbf{s} \end{aligned}$ | $\left\|\begin{array}{l} \mathrm{ZD} \\ \mathrm{ZD} \\ \mathrm{ZD} \\ \mathrm{ZD} \end{array}\right\|$ |  |  | 500 500 500 500 |  |  |  |  |  | $\begin{aligned} & 120 / 1 \\ & 120 / 1 \\ & 130 / .95 \\ & 130 / .95 \end{aligned}$ | $\begin{array}{r} 10 \\ 5 \\ 20 \\ 10 \end{array}$ |
| $\begin{aligned} & \text { IN5274B } \\ & \text { IN5275 } \\ & \text { IN5275A } \\ & \text { IN5275B } \end{aligned}$ | $\left\lvert\, \begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}\right.$ | $\begin{aligned} & z 0 \\ & z 0 \\ & z 0 \\ & z 0 \end{aligned}$ |  |  | 500 500 500 500 |  |  |  |  |  | $\begin{aligned} & 130 / .95 \\ & 140 / .9 \\ & 140 / .9 \\ & 140 / .9 \end{aligned}$ | 5 20 10 5 |
| $\begin{aligned} & \text { IN5276 } \\ & \text { IN5276A } \\ & \text { IN5276B } \\ & \text { IN5277 } \end{aligned}$ | $\begin{aligned} & s \\ & s \\ & s \\ & s \\ & s \end{aligned}$ | $\begin{aligned} & \mathrm{zo} \\ & \mathrm{zO} \\ & \mathrm{zo} \\ & \mathrm{zo} \end{aligned}$ |  |  | 500 500 500 500 |  |  |  |  |  | $\begin{aligned} & 150 / .85 \\ & 150 / .85 \\ & 150 / .85 \\ & 160 / .80 \end{aligned}$ | 20 10 5 20 |
| $\begin{aligned} & \text { 1N5277A } \\ & \text { 1N5277B } \\ & \text { 1N5278 } \\ & \text { 1N5278A } \end{aligned}$ | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\begin{aligned} & z 0 \\ & z 0 \\ & z 0 \\ & z D \end{aligned}$ |  |  | 500 500 500 500 |  |  |  |  |  | $\begin{aligned} & 160 / .80 \\ & 160 / .80 \\ & 170 / .74 \\ & 170 / .74 \end{aligned}$ | 10 5 20 10 |
| $\begin{aligned} & \text { 1N52788 } \\ & \text { 1N5279 } \\ & \text { IN5279A } \\ & \text { IN52798 } \end{aligned}$ | S 5 5 5 | $\left\|\begin{array}{l} 20 \\ 20 \\ 20 \\ 20 \end{array}\right\|$ |  |  | 500 500 500 500 |  |  |  |  |  | $\begin{aligned} & 170 / .74 \\ & 180 / .68 \\ & 180 / .68 \\ & 180 / .68 \end{aligned}$ | 5 20 10 5 |
| IN5280 <br> IN5280A <br> 1N52806 <br> 1N5281 | S | $\begin{aligned} & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{ZD} \\ & \mathrm{zD} \end{aligned}$ |  |  | 500 500 500 500 |  |  |  |  |  | $\begin{aligned} & 190 / .66 \\ & 190 / .66 \\ & 190 / .66 \\ & 200 / .65 \end{aligned}$ | 20 10 5 20 |
| $\begin{aligned} & \text { IN5281A } \\ & \text { IN5281B } \\ & \text { IN5282 } \\ & \text { IN5283 } \end{aligned}$ | S |  |  | 1N4150 | $\begin{aligned} & 500 \\ & 500 \\ & \\ & 800 \end{aligned}$ | 80 |  | . $1 / 55$ | 1.3/500 | 4 | $\begin{array}{l\|l} 200 / .65 \\ 200 / .65 \end{array}$ | 10 5 |

## DIODE INTERCHANGEABILITY

| $\begin{aligned} & \text { TYPE } \\ & \text { NUMBER } \end{aligned}$ |  |  |  | $\pi$ replacement | $\begin{array}{\|c\|c\|c\|} \text { FOR } \\ \text { NEW } \\ \text { DESIGN } \end{array}$ | PD (mW) | $\begin{aligned} & \text { RAting! } \\ & \boldsymbol{V}_{\mathrm{R}} \\ & (\mathrm{~V}) \end{aligned}$ | I <br> (A) | $\begin{array}{ll} I_{R} & V_{R} \\ \mu_{A} & /(V) \end{array}$ | $\mathbf{V F}_{\mathrm{F}}$. $\mathbf{I F}_{\mathbf{F}}$ <br> (V) $/$ (ma) | $\begin{aligned} & \text { ERISTIC } \\ & \begin{array}{c} \text { nrr } \\ \text { (ns) } \end{array} \end{aligned}$ | $\begin{array}{cc} v_{z} & \mathbf{I z}_{z} \\ (\mathrm{~V}) & /(\mathrm{mA}) \end{array}$ | $\begin{gathered} \text { rol } \\ \% \end{gathered}$ |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| $\begin{aligned} & \text { 1N5284 } \\ & \text { iN5285 } \\ & \text { IN5286 } \\ & \text { iN5287 } \end{aligned}$ | s |  | RD |  |  | $\begin{aligned} & 600 \\ & 600 \\ & 600 \\ & 600 \end{aligned}$ |  |  |  |  |  |  |  |
| $\begin{aligned} & \text { IN5288 } \\ & \text { IN5289 } \\ & \text { IN5290 } \\ & \text { IN5291 } \end{aligned}$ | s |  |  |  |  | $\begin{aligned} & 600 \\ & 600 \\ & 600 \\ & 600 \end{aligned}$ |  |  |  |  |  |  |  |
| $\begin{aligned} & \text { IN5292 } \\ & \text { 1N5293 } \\ & \text { IN5294 } \\ & \text { iN5295 } \end{aligned}$ | s $\mathbf{s}$ $\mathbf{s}$ s | R |  |  |  | $\begin{aligned} & 600 \\ & 600 \\ & 600 \\ & 600 \end{aligned}$ |  |  |  |  |  |  |  |
| $\begin{aligned} & \text { 1N5296 } \\ & \text { IN5297 } \\ & \text { iN5298 } \\ & \text { IN5300 } \end{aligned}$ | s s s s | RD |  |  |  | $\begin{aligned} & 600 \\ & 600 \\ & 600 \\ & 600 \end{aligned}$ |  |  |  |  |  |  |  |
| iN5301 <br> iN5302 <br> 1N5303 <br> iN5304 | s | RD | - |  |  | $\begin{aligned} & 600 \\ & 600 \\ & 600 \\ & 600 \end{aligned}$ |  |  |  |  |  |  |  |
| IN5305 <br> IN5306 <br> IN5307 <br> 1N5308 | s s s s | RD |  |  |  | $\begin{aligned} & 600 \\ & 600 \\ & 600 \\ & 600 \end{aligned}$ |  |  |  |  |  |  |  |
| iN5309 <br> 1N5310 <br> 1N5311 <br> 1N5312 | s s s s | RD |  |  |  |  |  |  |  |  |  |  |  |
| IN5313 <br> 1N5315 <br> 1N5316 <br> in5317 | s s s s | $\begin{array}{\|l\|} \hline R D \\ \text { SD } \\ \text { SD } \\ \text { SD } \end{array}$ |  |  | 1NA153 <br> 1N4153 <br> 1N4150 | 600 | $\begin{array}{r} 100 \\ 100 \\ 80 \end{array}$ |  | $50 N / 50$ $50 N / 50$ $.1 / 55$ | $\begin{array}{r} 1 / 200 \\ 1 / 100 \\ 1.3 / 500 \end{array}$ | 4 4 4 |  |  |
|  | s | SD SD RD RE |  |  | 1N4150 <br> 1N4305 | 600 | $\begin{array}{r} 75 \\ 40 \\ 100 \end{array}$ | 1 | $\begin{gathered} .1 / 50 \\ 100 / 25 \\ 100 / 100 \end{gathered}$ | $\begin{aligned} & 1 / 200 \\ & 1 / 100 \end{aligned}$ <br> $1.1 / 1 \mathrm{~A}$ | $\begin{array}{r} 4 \\ 4 \\ 250 \end{array}$ |  |  |
| 1N5324 <br> 1N5326 <br> IN5329 <br> IN5330 | s s s s | $\begin{aligned} & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \end{aligned}$ |  |  |  |  | $\begin{aligned} & 15 \mathrm{~K} \\ & 100 \\ & 1.6 \mathrm{~K} \\ & 1.6 \mathrm{~K} \end{aligned}$ | $\begin{array}{r} .01 \\ 12 \\ .135 \\ .54 \end{array}$ | $\begin{aligned} & 25 / \\ & 150 / \\ & 150 / \end{aligned}$ | $24 /$ |  |  |  |

## DIODE INTERCHANGEABILITY

| TYPE MUMEER |  | $\left.\begin{gathered} z \\ \frac{z}{3} \\ \frac{3}{3} \\ \frac{3}{3} \\ 3 \\ 3 \end{gathered} \right\rvert\,$ | $\begin{gathered} 11 \\ \text { REPLACEMENT } \end{gathered}$ | $\begin{aligned} & \text { FOR } \\ & \text { NEW } \\ & \text { DESION } \end{aligned}$ | ratines |  |  | CHARACTERISTICS |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  | $P$ ( mW W) |  | (A) | $\begin{array}{ll} \mathbf{V}_{\mathbf{R}} & \bullet \mathbf{V}_{\mathbf{R}} \\ \mu \mathrm{A} & / \mathbf{V}) \end{array}$ | $\begin{array}{ll} \mathbf{V}_{F} & \mathbf{F}_{\mathbf{F}} \\ \text { (V) } & / \mathrm{mA}) \end{array}$ | $\begin{gathered} \mathbf{t}_{\boldsymbol{r}} \\ \mathrm{ns}) \end{gathered}$ | $\begin{array}{ll} \mathbf{V Z}_{\mathbf{Z}} & \mathrm{z} \\ (\mathrm{~V}) & / \mathrm{mA}) \end{array}$ | $\begin{gathered} \mathrm{tal} \\ \times \end{gathered}$ |
| $\begin{array}{\|l\|} \text { IN5331 } \\ \text { IN5332 } \\ \text { IN5389 } \\ \text { IN5391 } \end{array}$ | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}\right.$ |  |  |  |  | $\begin{array}{r} 1.2 \mathrm{~K} \\ 1.2 \mathrm{~K} \\ 40 \mathrm{~K} \\ 50 \end{array}$ | $\begin{array}{r} 12 \\ 35 \\ .1 \\ 1.5 \end{array}$ | $\begin{aligned} & 100 / \\ & 300 / \end{aligned}$ | $\begin{aligned} & 80 / \\ & 1.4 / \end{aligned}$ |  |  |  |
| 1N5392 <br> JN5393 <br> 1N5394 <br> 1N5395 | $\left\lvert\, \begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}\right.$ | $\begin{aligned} & R E \\ & R E \\ & R E \\ & R E \\ & R E \end{aligned}$ |  |  |  | $\begin{aligned} & 100 \\ & 200 \\ & 300 \\ & 400 \end{aligned}$ | $\begin{aligned} & 1.5 \\ & 1.5 \\ & 1.5 \\ & 1.5 \end{aligned}$ | $\begin{aligned} & 300 / \\ & 300 / \\ & 300 / \\ & 300 / \end{aligned}$ | 1.4/ <br> 1.41 <br> 1.4/ <br> 1.4/ |  |  |  |
| $\begin{aligned} & \text { IN5396 } \\ & \text { IN5397 } \\ & \text { 1N5398 } \\ & \text { IN5399 } \end{aligned}$ | $\left\lvert\, \begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}\right.$ | $\begin{aligned} & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \end{aligned}$ |  |  |  | $\begin{array}{r} 500 \\ 600 \\ 800 \\ 1 K \end{array}$ | $\begin{aligned} & 1.5 \\ & 1.5 \\ & 1.5 \\ & 1.5 \end{aligned}$ | $\begin{aligned} & 300 / \\ & 300 / \\ & 300 / \\ & 300 / \end{aligned}$ | 1.41 <br> 1.4/ <br> $1.4 /$ <br> 1.4/ |  |  |  |
| $\begin{aligned} & \text { IN5400 } \\ & \text { IN5401 } \\ & \text { IN5402 } \\ & \text { IN5403 } \end{aligned}$ | $\begin{aligned} & 5 \\ & 5 \\ & 5 \\ & 5 \end{aligned}$ | $\begin{aligned} & R E \\ & R E \\ & R E \\ & R E \end{aligned}$ |  |  |  | $\begin{array}{r} 50 \\ 100 \\ 200 \\ 300 \end{array}$ | $\begin{aligned} & 3 \\ & 3 \\ & 3 \\ & 3 \end{aligned}$ | $\begin{aligned} & 500 / \\ & 500 / \\ & 500 / \\ & 500 / \end{aligned}$ | $\begin{aligned} & 1.2 / \\ & 1.2 / \\ & 1.2 / \\ & 1.2 / \end{aligned}$ |  |  |  |
| $\begin{aligned} & \text { 1N5404 } \\ & \text { 1N5405 } \\ & \text { 1N5406 } \\ & \text { 1N5407 } \end{aligned}$ | $\begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}$ | $\begin{aligned} & R E \\ & R E \\ & R E \\ & R E \\ & R E \end{aligned}$ |  |  |  | $\begin{aligned} & 400 \\ & 500 \\ & 600 \\ & 800 \end{aligned}$ | $\begin{aligned} & 3 \\ & 3 \\ & 3 \\ & 3 \end{aligned}$ | $\begin{aligned} & 500 / \\ & 500 / \\ & 500 / \\ & 500 / \end{aligned}$ | $\begin{aligned} & 1.2 / \\ & 1.2 / \\ & 1.2 / \\ & 1.2 / \end{aligned}$ |  |  |  |
| $\begin{aligned} & \text { 1N5408 } \\ & \text { 1N5 } 12 \\ & \text { 1N5413 } \\ & \text { 1N5414 } \end{aligned}$ | $\begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & s \\ & s \end{aligned}$ | $\left.\begin{aligned} & R E \\ & S D \\ & S D \\ & S D \end{aligned} \right\rvert\,$ |  | IN4305 IN4305 IN4305 |  | $1 K$ 30 80 75 | 3 | $\begin{aligned} & 500 / \\ & .1 / 30 \\ & .1 / 80 \\ & .1 / 75 \end{aligned}$ | $\begin{aligned} & 1.2 / \\ & .5 / .1 \\ & .5 / .1 \\ & .5 / .1 \end{aligned}$ | 2 2 2 |  |  |
| 1N5415 <br> 1N5416 <br> IN5417 <br> IN5418 | $\begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}$ | $\left.\begin{aligned} & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \end{aligned} \right\rvert\,$ |  |  |  | $\begin{array}{r} 50 \\ 100 \\ 200 \\ 400 \end{array}$ |  | $\begin{aligned} & 1 / \\ & 1 / \\ & 1 / \\ & 1 / \end{aligned}$ | $\begin{aligned} & 1.1 / 3 A \\ & 1.1 / 3 A \\ & 1.1 / 3 A \\ & 1.1 / 3 A \end{aligned}$ | $\begin{aligned} & 150 \\ & 150 \\ & 150 \\ & 150 \end{aligned}$ |  |  |
| IN5419 <br> 1N5420 <br> IN5426 <br> 1N5427 | $\begin{aligned} & 5 \\ & 5 \\ & 5 \\ & 5 \end{aligned}$ | $\left.\begin{aligned} & R E \\ & R E \\ & \mathrm{RD} \\ & \mathrm{SD} \end{aligned} \right\rvert\,$ |  | 1 N 148 |  | $\begin{array}{r} 500 \\ 600 \\ 25 \\ 75 \end{array}$ |  | $\begin{aligned} & 1 / \\ & 1 / \\ & 1 / 6 \\ & .1 / 50 \end{aligned}$ | $\begin{gathered} 1.1 / 3 A \\ 1.1 / 3 A \\ 1 / 40 \\ 1 / 10 \end{gathered}$ | $\begin{array}{r} 250 \\ 400 \\ .1 \\ 4 \end{array}$ |  |  |
| IN5428 <br> 1N5429 <br> iN5430 <br> IN5431 | $\begin{aligned} & \mathbf{S} \\ & \mathbf{S} \\ & \mathbf{S} \\ & \mathbf{S} \end{aligned}$ | $\begin{aligned} & \text { SD } \\ & \text { SD } \\ & \text { SD } \\ & \text { SD } \end{aligned}$ |  | 1N4938 <br> 1N485 <br> IN4150 <br> 1N4608 |  | 200 200 75 80 |  | $\begin{aligned} & .1 / 175 \\ & 5 N / 125 \\ & .1 / 50 \\ & .1 / 55 \end{aligned}$ | $\begin{aligned} & 1 / 100 \\ & 1 / 200 \\ & 1 / 200 \\ & 1 / 500 \end{aligned}$ | 5 4 4 |  |  |
| 1N5432 <br> 1N5477 <br> 1N5478 <br> 1N5479 | $\begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}$ | $\begin{aligned} & \mathrm{SD} \\ & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \end{aligned}$ |  | TID777 |  | $\begin{array}{r} 20 \\ 6 K \\ 7.2 K \\ 8.4 K \end{array}$ | 1 1 1 | $\begin{aligned} & 50 N / 10 \\ & 350 / \\ & 350 / \\ & 350 / \end{aligned}$ | $\begin{aligned} & 1 / 50 \\ & .6 / \\ & .6 / \\ & .6 / \end{aligned}$ | . 75 |  |  |

## DIODE INTERCHANGEABILITY



| TYPENumber |  |  | $\stackrel{\text { II }}{\text { REELACEMENT }}$ | $\begin{gathered} \text { FOR } \\ \text { NEW } \\ \text { DESNON } \end{gathered}$ | Ratings |  |  | CHARACTERISTICS |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  | $\begin{gathered} P_{D} \\ (m w) \end{gathered}$ | $\mathbf{V}_{\mathbf{R}}$ <br> (V) | (A) | $\begin{array}{ll} l_{R} & \bullet V_{R} \\ \mu_{\mathrm{A}} & /(\mathrm{V}) \end{array}$ | $\begin{array}{cc} \mathbf{V}_{\mathbf{F}} & \bullet \mathbf{l} \\ \text { (V) } & /(\mathrm{ma}) \end{array}$ | ${ }_{(m)}^{t_{\pi}}$ | $\begin{array}{lll} v_{z} & 0 & z \\ \text { (v) } & /(\mathrm{ma}) \end{array}$ | $\left.\right\|_{x} ^{\text {rot }}$ |
| $\begin{array}{\|l} \hline \text { 1N55240 } \\ \text { 1N5525 } \\ \text { 1N5525A } \\ \text { 1N5525B } \end{array}$ | $\begin{aligned} & \hline \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}$ |  |  |  | $\begin{aligned} & 400 \\ & 400 \\ & 400 \\ & 400 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 5.6 / 3 \\ & 6.2 / 1 \\ & 6.2 / 1 \\ & 6.2 / 1 \end{aligned}$ | 1 20 10 5 |
| $\begin{aligned} & \text { IN5525C } \\ & \text { IN5525D } \\ & \text { IN5526 } \\ & \text { IN5526A } \end{aligned}$ | $\left\lvert\, \begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}\right.$ | ( $\begin{aligned} & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD}\end{aligned}$ |  |  | $\begin{aligned} & 400 \\ & 400 \\ & 400 \\ & 400 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 6.2 / 1 \\ & 6.2 / 1 \\ & 6.8 / 1 \\ & 6.8 / 1 \end{aligned}$ | 2 1 20 10 |
| $\begin{aligned} & \text { IN5526B } \\ & \text { IN5526C } \\ & \text { IN55260 } \\ & \text { IN5527 } \end{aligned}$ | $\begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}$ | $\left\|\begin{array}{l} \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \end{array}\right\|$ |  |  | $\begin{aligned} & 400 \\ & 400 \\ & 400 \\ & 400 \end{aligned}$ |  |  |  |  |  | 6.8/1 <br> 6.8/1 <br> 6.8/1 <br> 7.5/1 | 5 2 1 20 |
| 1N5527A <br> 1N5527B <br> IN5527C <br> 1N5527D | $\begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}$ | $\begin{aligned} & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \end{aligned}$ |  |  | $\begin{aligned} & 400 \\ & 400 \\ & 400 \\ & 400 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 7.5 / 1 \\ & 7.5 / 1 \\ & 7.5 / 1 \\ & 7.5 / 1 \end{aligned}$ | 10 5 2 1 |
| 1N5528 <br> IN5528A <br> 1N5528B <br> iN5528C | $\begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}$ | $\left\|\begin{array}{l} \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \end{array}\right\|$ |  |  | $\begin{aligned} & 400 \\ & 400 \\ & 400 \\ & 400 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 8.2 / 1 \\ & 8.2 / 1 \\ & 8.2 / 1 \\ & 8.2 / 1 \end{aligned}$ | 20 10 5 2 |
| 1N5528D <br> 1N5529 <br> 1N5529A <br> 1N5529B | s | $\left\|\begin{array}{l\|} \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \end{array}\right\|$ |  |  | $\begin{aligned} & 400 \\ & 400 \\ & 400 \\ & 400 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 8.2 / 1 \\ & 9.1 / 1 \\ & 9.1 / 1 \\ & 9.1 / 1 \end{aligned}$ | 1 20 10 5 |
| 1N5529C <br> 1N5529D <br> 1N5530 <br> 1N5530A | $\left\lvert\, \begin{aligned} & \mathrm{s} \\ & \mathrm{~s} \\ & \mathrm{~s} \\ & \mathrm{~s} \end{aligned}\right.$ | $\left\|\begin{array}{l} \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \end{array}\right\|$ |  |  | $\begin{aligned} & 400 \\ & 400 \\ & 400 \\ & 400 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 9.1 / 1 \\ & 9.1 / 1 \\ & 10 / 1 \\ & 10 / 1 \end{aligned}$ | 2 1 20 10 |
| IN5530B <br> IN5530C <br> IN5530D <br> 1N5531 | $\left\lvert\, \begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}\right.$ | $\left\|\begin{array}{l\|} \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \end{array}\right\|$ |  |  | $\begin{aligned} & 400 \\ & 400 \\ & 400 \\ & 400 \end{aligned}$ |  |  |  |  |  | $10 / 1$ <br> 10/1 <br> 10/1 <br> $11 / 1$ | 5 2 1 20 |
| 1N5531A <br> 1N5531B <br> IN5331C <br> iN55310 | s | $\left\|\begin{array}{l} \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \end{array}\right\|$ |  |  | $\begin{aligned} & 400 \\ & 400 \\ & 400 \\ & 400 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 11 / 1 \\ & 11 / 1 \\ & 11 / 1 \\ & 11 / 1 \end{aligned}$ | 10 5 2 1 |
| 1N5532 1N5532A 1N5532B 1N5532C | $\left\lvert\, \begin{aligned} & \mathrm{s} \\ & \mathrm{~s} \\ & \mathrm{~s} \\ & \mathrm{~s} \end{aligned}\right.$ | $\left.\begin{aligned} & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \end{aligned} \right\rvert\,$ |  |  | $\begin{aligned} & 400 \\ & 400 \\ & 400 \\ & 400 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 12 / 1 \\ & 12 / 1 \\ & 12 / 1 \\ & 12 / 1 \end{aligned}$ | 20 10 5 2 |

## DIODE INTERCHANGEABILITY

| $\begin{aligned} & \text { TYPE } \\ & \text { MUMBER } \end{aligned}$ |  |  |  | $\underset{\text { REPLACEMENT }}{\mathbf{n}}$ | $\begin{gathered} \text { FOR } \\ \text { NEW } \\ \text { DESIGN } \end{gathered}$ | PD (mW) | atines <br> $V_{\mathbf{R}}$ <br> (V) | (A) | $\begin{array}{ll} I_{R} & V_{R} \\ \mu_{A} & /(V) \end{array}$ | $\begin{aligned} & \mathbf{V}_{\mathbf{F}} \\ & (\mathbf{V}) \end{aligned}$ | Charact $\begin{aligned} & I_{F} \\ & /(\mathrm{mA}) \end{aligned}$ | ristic <br> ${ }^{\dagger} \pi$ <br> (ns) | $\begin{array}{ccc} v_{z} & 1 \\ (\mathrm{~V}) & /(\mathrm{mA}) \end{array}$ | $\left.\right\|_{x} ^{\mathrm{tot}}$ |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| $\begin{aligned} & \text { IN5532D } \\ & \text { 1N5533 } \\ & \text { 1N5533A } \\ & \text { 1N5533B } \end{aligned}$ | S |  | $\left.\begin{aligned} & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \end{aligned} \right\rvert\,$ |  |  | 400 400 400 400 |  |  |  |  |  |  | $\begin{aligned} & 12 / 1 \\ & 13 / 1 \\ & 13 / 1 \\ & 13 / 1 \end{aligned}$ | 1 20 10 5 |
| $\begin{aligned} & \text { 1N5533C } \\ & \text { 1N5533D } \\ & \text { 1N5534 } \\ & \text { 1N5534A } \end{aligned}$ |  |  | $\left\|\begin{array}{l} \mathrm{zD} \\ \mathrm{zo} \\ \mathrm{zo} \\ \mathrm{zD} \end{array}\right\|$ |  |  | $\begin{aligned} & 400 \\ & 400 \\ & 400 \\ & 400 \end{aligned}$ |  |  |  |  |  |  | $\begin{aligned} & 13 / 1 \\ & 13 / 1 \\ & 14 / 1 \\ & 14 / 1 \end{aligned}$ | 2 1 20 10 |
| iN5534B IN553AC 1N5534D 1N5535 | ( |  | $\begin{aligned} & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \end{aligned}$ |  |  | $\begin{aligned} & 400 \\ & 400 \\ & 400 \\ & 400 \end{aligned}$ |  |  |  |  |  |  | 14/1 <br> 14/1 <br> 14/1 <br> 15/1 | 5 2 1 20 |
| 1N5535A 1N5535B 1N5535C 1N5535D | s |  |  |  |  | 400 400 400 400 |  |  |  |  |  |  | $\begin{aligned} & 15 / 1 \\ & 15 / 1 \\ & 15 / 1 \\ & 15 / 1 \end{aligned}$ | 10 5 2 1 |
| 1N5536 <br> IN5536A <br> IN5536B <br> 1N5536C | $\begin{aligned} & s \\ & s \\ & s \\ & s \\ & s \end{aligned}$ |  |  |  |  | $\begin{aligned} & 400 \\ & 400 \\ & 400 \\ & 400 \end{aligned}$ |  |  |  |  |  |  | 16/1 <br> 16/1 <br> 16/1 <br> 16/1 | 20 10 5 2 |
| 1N5536D 1N5537 1N5537A 1N5537B | S |  | $\begin{gathered} \mathrm{zD} \\ \mathrm{CD} \\ \mathrm{zD} \\ \mathrm{zD} \end{gathered}$ |  |  | $\begin{aligned} & 400 \\ & 400 \\ & 400 \\ & 400 \end{aligned}$ |  |  |  |  |  |  | $\begin{aligned} & 16 / 1 \\ & 17 / 1 \\ & 17 / 1 \\ & 17 / 1 \end{aligned}$ | 1 20 10 5 |
| iN5537C <br> IN5537D <br> IN5538 <br> IN5538A | S | ZD zD zD ZD | (10 |  |  | $\begin{aligned} & 400 \\ & 400 \\ & 400 \\ & 400 \end{aligned}$ |  |  |  |  |  |  | $\begin{aligned} & 17 / 1 \\ & 17 / 1 \\ & 18 / 1 \\ & 18 / 1 \end{aligned}$ | 2 1 20 10 |
| 1N5538B IN5538C 1N5538D 1N5539 | $\begin{aligned} & s \\ & s \\ & s \\ & s \\ & s \end{aligned}$ | ZD ZD ZD | O |  |  | 400 400 400 400 |  |  |  |  |  |  | $\begin{aligned} & 18 / 1 \\ & 18 / 1 \\ & 18 / 1 \\ & 19 / 1 \end{aligned}$ | 5 2 1 20 |
| 1N5539A <br> 1N5539B <br> IN5539C <br> IN5539D | $\begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}$ | $\left\lvert\, \begin{aligned} & 2 D \\ & Z D \\ & Z D \end{aligned}\right.$ |  |  |  | $\begin{array}{r} 400 \\ 400 \\ 400 \\ 400 \end{array}$ |  |  |  |  |  |  | $\begin{aligned} & 19 / 1 \\ & 19 / 1 \\ & 19 / 1 \\ & 19 / 1 \end{aligned}$ | 10 5 2 1 |
| in5540 1N5540A 1N5540B iN5540C | $\left\lvert\, \begin{aligned} & \mathrm{s} \\ & \mathrm{~s} \\ & \mathrm{~s} \\ & \mathrm{~s} \end{aligned}\right.$ | $\left\|\begin{array}{l} \mathrm{ZD} \\ \mathrm{ZD} \\ \mathrm{ZD} \\ \mathrm{ZD} \end{array}\right\|$ |  |  |  | $\begin{aligned} & 400 \\ & 400 \\ & 400 \\ & 400 \end{aligned}$ |  |  |  |  |  |  | $\begin{aligned} & 20 / 1 \\ & 20 / 1 \\ & 20 / 1 \\ & 20 / 1 \end{aligned}$ | 20 10 5 2 |



## DIODE INTERCHANGEABILITY

| TYPE NUMEE |  |  | TI |  | Ratines |  |  | CHARACTERISTICS |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  | $\begin{aligned} & \text { PD } \\ & (\mathrm{mW}) \end{aligned}$ | $\begin{aligned} & \mathbf{V}_{\mathbf{R}} \\ & (\mathbf{V}) \end{aligned}$ | I <br> (A) | $\begin{array}{ll} \mathbf{I}_{\mathbf{R}} & \mathbf{V}_{\mathbf{R}} \\ \mu_{\mathrm{A}} & f(\mathbf{V}) \end{array}$ | $\mathbf{V}_{\mathbf{F}}$ <br> (V) | $\begin{gathered} \text { if } \\ /(\mathrm{mA}) \end{gathered}$ | $\begin{aligned} & \mathbf{t}_{\mathrm{rr}} \\ & \text { (ns) } \end{aligned}$ | $\begin{array}{llc} V_{z} & \mathbf{l}_{2} \\ \text { (V) } & / \mathrm{mA}) \end{array}$ | ${ }^{70 t}$ |
| 1N5559 <br> IN5559A <br> IN55598 <br> IN5560 | $\begin{aligned} & \mathrm{s} \\ & \mathrm{~S} \\ & \mathrm{~s} \\ & \mathrm{~s} \end{aligned}$ | $\begin{aligned} & \mathrm{ZD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \end{aligned}$ |  | 1N4736 <br> 1N4736 <br> 1N4736A <br> 1N4737 | $\begin{aligned} & \text { iw } \\ & \text { iw } \\ & \text { iw } \\ & \text { iw } \end{aligned}$ |  |  |  |  |  |  | $\begin{aligned} & 6.8 / 37 \\ & 6.8 / 37 \\ & 6.8 / 37 \\ & 7.5 / 34 \end{aligned}$ | $\begin{array}{r} 20 \\ 10 \\ 5 \\ 20 \end{array}$ |
| 1N5560A <br> 1N5560B <br> IN5561 <br> 1N5561A | $\begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}$ | $\begin{aligned} & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \end{aligned}$ |  | 1N4737 <br> 1N4737A <br> 1N4738 <br> 1N4738 | $\begin{aligned} & \text { iw } \\ & \text { iw } \\ & \text { iw } \\ & \text { iw } \end{aligned}$ |  |  |  |  |  |  | $\begin{aligned} & 7.5 / 34 \\ & 7.5 / 34 \\ & 8.2 / 31 \\ & 8.2 / 31 \end{aligned}$ | $\begin{array}{r} 10 \\ 5 \\ 20 \\ 10 \end{array}$ |
| $\begin{aligned} & \text { IN5561B } \\ & \text { 1N5562 } \\ & \text { 1N5562A } \\ & \text { 1N5562B } \end{aligned}$ | $\begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}$ | $\left\|\begin{array}{l} \mathrm{zo} \\ \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \end{array}\right\|$ |  | 1N4738A <br> 1N4739 <br> 1N4739 <br> iN4739A | $\begin{aligned} & \text { iw } \\ & \text { iw } \\ & \text { iw } \\ & \text { iw } \end{aligned}$ |  |  |  |  |  |  | $\begin{aligned} & 8.2 / 31 \\ & 9.1 / 28 \\ & 9.1 / 28 \\ & 9.1 / 28 \end{aligned}$ | $\begin{array}{r} 5 \\ 20 \\ 10 \\ 5 \end{array}$ |
| 1N5563 <br> 1N5563A <br> 1N5563B <br> 1N5564 | $\begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}$ | $\begin{aligned} & \mathrm{ZD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \end{aligned}$ |  | 1N4740 <br> 1N4740 <br> IN4740A <br> 1N4741 | $\begin{aligned} & \text { iw } \\ & \text { iw } \\ & \text { iw } \\ & \text { iw } \end{aligned}$ |  |  |  |  |  |  | $\begin{aligned} & 10 / 25 \\ & 10 / 25 \\ & 10 / 25 \\ & 11 / 23 \end{aligned}$ | $\begin{array}{r} 20 \\ 10 \\ 5 \\ 20 \end{array}$ |
| 1N5564A <br> 1N556dB <br> 1N5565 <br> 1N5565A | $\begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}$ | $\begin{aligned} & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zO} \end{aligned}$ |  | 1N4741 <br> IN4741A <br> 1N4742 <br> 1N4742 | $\begin{aligned} & 16 \\ & 1 w \\ & 1 w \\ & 1 w \end{aligned}$ |  |  |  |  |  |  | $\begin{aligned} & 11 / 23 \\ & 11 / 23 \\ & 12 / 21 \\ & 12 / 21 \end{aligned}$ | 10 5 20 10 |
| 1N5565B <br> 1N5566 <br> 1N5566A <br> 1N5566B | $\begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}$ | $\begin{aligned} & \mathrm{zD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \end{aligned}$ |  | IN4742A <br> IN4743 <br> 1N4743 <br> IN4743A | $\begin{aligned} & 1 w \\ & i w \\ & 1 w \\ & i w \end{aligned}$ |  |  |  |  |  |  | $\begin{aligned} & 12 / 21 \\ & 13 / 19 \\ & 13 / 19 \\ & 13 / 19 \end{aligned}$ | 5 20 10 5 |
| 1N5567 <br> 1N5567A <br> 1N5567B <br> 1N5568 | $\begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}$ | $\begin{aligned} & \mathrm{ZD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \end{aligned}$ |  | IN4744 <br> IN4744 <br> 1 NATHAA <br> INA745 | $\begin{aligned} & 1 w \\ & \mathrm{iw} \\ & 1 \mathbf{w} \\ & 1 \mathbf{w} \end{aligned}$ |  |  |  |  |  |  | $\begin{aligned} & 15 / 17 \\ & 15 / 17 \\ & 15 / 17 \\ & 16 / 15 \end{aligned}$ | 20 10 5 20 |
| 1N5568A <br> 1N5568B <br> 1N5569 <br> 1N5569A | $\begin{aligned} & \mathbf{s} \\ & \mathbf{S} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}$ | $\begin{aligned} & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \end{aligned}$ |  | IN4745 <br> 1N4745A <br> IN4746 <br> 1N4746 | $\begin{aligned} & 1 \mathrm{w} \\ & 1 \mathrm{w} \\ & 1 \mathrm{w} \\ & 1 \mathrm{w} \end{aligned}$ |  |  |  |  |  |  | $\begin{aligned} & 16 / 15 \\ & 16 / 15 \\ & 18 / 14 \\ & 18 / 14 \end{aligned}$ | $\begin{array}{r} 10 \\ 5 \\ 20 \\ 10 \end{array}$ |
| 1N5569B <br> IN5570 <br> IN5570A <br> IN55708 | $\begin{aligned} & 5 \\ & 5 \\ & 5 \\ & 5 \end{aligned}$ | $\begin{aligned} & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \end{aligned}$ |  | 1NA746A <br> 1N4747 <br> 1N4747 <br> 1N4747A | $\begin{aligned} & 1 w \\ & 1 w \\ & 1 \mathbf{1 w} \\ & 1 \mathbf{w} \end{aligned}$ |  |  |  |  |  |  | $\begin{aligned} & 18 / 14 \\ & 20 / 12 \\ & 20 / 12 \\ & 20 / 12 \end{aligned}$ | 5 20 10 5 |
| 1N5571 <br> IN5571A <br> 1N5571B <br> 1N5572 | $\begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}$ | $\begin{aligned} & \mathrm{ZD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \end{aligned}$ |  | 1N4748 <br> 1N4748 <br> 1N4748A <br> 1N4749 | $\begin{aligned} & 1 W \\ & 1 W \\ & 1 W \\ & 1 w \end{aligned}$ |  |  |  | - |  |  | $\begin{aligned} & 22 / 11 \\ & 22 / 11 \\ & 22 / 11 \\ & 24 / 10 \end{aligned}$ | $\begin{array}{r} 20 \\ 10 \\ 5 \\ 20 \end{array}$ |


| TYPEnumbek |  |  |  |  | ratines |  |  | CHARACTERISTICS |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  | $\begin{gathered} \mathrm{PD}_{\mathrm{D}} \\ (\mathrm{~mW}) \end{gathered}$ | $V_{R}$ <br> (V) | (A) | $\begin{array}{ll} \mathbf{l}_{\mathbf{R}} & \mathbf{v}_{\mathbf{R}} \\ \mu_{\mathbf{R}} & /(\mathbf{V}) \end{array}$ | $\begin{array}{cc} \mathbf{v}_{\mathbf{F}} & \mathbf{l}_{\mathbf{F}} \\ \text { (v) } & / \text { (mA) } \end{array}$ | ${ }^{1} \mathrm{r}$ <br> (ns) | $\begin{array}{lll} v_{z} & \bullet & \mathbf{z} \\ (\mathrm{~V}) & 1 \mathrm{ma}) \end{array}$ | ${ }_{x}^{\text {tot }}$ |
| $\begin{aligned} & \text { IN5572A } \\ & \text { IN5572B } \\ & \text { IN5573 } \\ & \text { IN5573A } \end{aligned}$ | S | \|l|l|l| |  | 1N4749 <br> 1N4749A <br> 1N4750 <br> 1N4750 | $\begin{aligned} & \text { iw } \\ & 1 \mathrm{w} \\ & 1 \mathrm{w} \\ & 1 \mathrm{w} \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 24 / 10 \\ & 24 / 10 \\ & 27 / 9.5 \\ & 27 / 9.5 \end{aligned}$ | 10 5 20 10 |
| IN5573B <br> 1N5574 <br> 1N5574A <br> 1N5574B | $\begin{aligned} & \mathbf{s} \\ & s \\ & s \\ & s \end{aligned}$ | $\left\|\begin{array}{l} \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \end{array}\right\|$ |  | 1N4750A <br> 1N4751 <br> 1N4751 <br> 1N4751A | $\begin{aligned} & \text { iw } \\ & \text { iw } \\ & \text { iw } \\ & \text { iw } \end{aligned}$ |  |  |  |  |  | 27/9.5 <br> 30/8.5 <br> 30/8.5 <br> 30/8.5 | 5 20 10 5 |
| 1N5575 <br> IN5575A <br> IN5575B <br> 1N5576 | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\left\|\begin{array}{l} \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \end{array}\right\|$ |  | 1N4752 <br> 1N4752 <br> 1N4752A | $\begin{aligned} & \text { iw } \\ & \text { iw } \\ & \text { iw } \\ & \text { iw } \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 33 / 7.5 \\ & 33 / 7.5 \\ & 33 / 7.5 \\ & 36 / 7 \end{aligned}$ | 20 10 5 20 |
| IN5576A <br> 1N55768 <br> 1N5577 <br> 1N5577A | $\begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}$ | $\left\|\begin{array}{l} \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \end{array}\right\|$ |  |  | $\begin{aligned} & \text { iw } \\ & \text { iw } \\ & \text { iw } \\ & \text { iw } \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 36 / 7 \\ & 36 / 7 \\ & 39 / 6.5 \\ & 39 / 6.5 \end{aligned}$ | 10 5 20 10 |
| $\begin{aligned} & \text { IN5577B } \\ & \text { IN5578 } \\ & \text { INS578A } \\ & \text { IN5578B } \end{aligned}$ | S | $\left\|\begin{array}{l} \mathrm{zD} \\ \mathrm{zo} \\ \mathrm{zD} \\ \mathrm{zo} \end{array}\right\|$ |  |  | iw iw iw iw |  |  |  |  |  | $\begin{aligned} & 39 / 6.5 \\ & 43 / 6 \\ & 43 / 6 \\ & 43 / 6 \end{aligned}$ | 5 20 10 5 |
| 1N5579 <br> 1N5579A <br> 1N55798 <br> 1N5580 | $\begin{array}{\|l} s \\ s \\ s \\ s \\ s \end{array}$ | $\left\|\begin{array}{l} \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \end{array}\right\|$ |  |  | iw iw iw iw |  |  |  |  |  | $\begin{aligned} & 47 / 5.5 \\ & 47 / 5.5 \\ & 47 / 5.5 \\ & 51 / 5 \end{aligned}$ | 20 10 5 20 |
| in55s0A <br> INS5808 <br> IN5581 <br> in5S81A | $\left\lvert\, \begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}\right.$ | $\left\|\begin{array}{l} \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \end{array}\right\|$ |  |  | $\begin{aligned} & \text { iw } \\ & \text { iw } \\ & \text { iW } \\ & \text { iw } \end{aligned}$ |  |  |  |  |  | 51/5 <br> 51/5 <br> 56/4.5 <br> 56/4.5 | 10 5 20 10 |
| 1N55818 <br> 1N5582 <br> 1N5582A <br> 1N5582B | S |  |  |  | iw iw iw iw |  |  |  |  |  | $\begin{aligned} & 56 / 4.5 \\ & 62 / 4 \\ & 62 / 4 \\ & 62 / 4 \end{aligned}$ | 5 20 10 5 |
| 1 N5583 1N5583A 1N5583B IN5584 | s | \|l| |  |  | iw iw iw iw |  |  |  |  |  | 68/3.7 <br> 68/3.7 <br> 68/3.7 <br> 75/3.3 | 20 10 5 20 |
| IN5584A iN5584B 1N5585 1N5585A | $\left\lvert\, \begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}\right.$ | $\left\|\begin{array}{l} \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \end{array}\right\|$ |  |  | iw $1 \mathbf{1 w}$ iw iw |  |  |  |  |  | $\begin{aligned} & 75 / 3.3 \\ & 75 / 3.3 \\ & 82 / 3 \\ & 82 / 3 \end{aligned}$ | 10 5 20 10 |

## DIODE INTERCHANGEABILITY

| $\begin{gathered} \text { TYPE } \\ \text { NUMBER } \end{gathered}$ |  |  | $\underset{\text { REPLACEMENT }}{\text { n }}$ | $\begin{aligned} & \text { FOR } \\ & \text { NEW } \\ & \text { DESIGN } \end{aligned}$ | $P_{D}$ (mW) | ating <br> $V_{R}$ <br> (V) | I <br> (A) | $\begin{array}{ll} I_{R} & V_{R} \\ \mu_{A} & /(V) \end{array}$ | $\begin{array}{cc}  & \text { Characte } \\ \mathbf{v}_{\mathbf{F}} & \cdot \mathbf{I F}_{\mathbf{F}} \\ \text { (v) } & / \text { (mA) } \end{array}$ | ERISTIC <br> ${ }^{\boldsymbol{t r}}$ <br> (ns) | $\begin{array}{ccc} \mathbf{v}_{\mathbf{z}} & \cdot & \mathbf{z} \\ (\mathrm{v}) & /(\mathrm{mA}) \end{array}$ | TOL |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| $\begin{aligned} & \text { IN5585B } \\ & \text { IN5586 } \\ & \text { IN5586A } \\ & \text { IN5586B } \end{aligned}$ | $\begin{aligned} & \mathrm{s} \\ & \mathrm{~s} \\ & \mathrm{~s} \\ & \mathrm{~s} \end{aligned}$ | $\begin{aligned} & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \end{aligned}$ |  |  | $\begin{aligned} & 1 \mathrm{w} \\ & 1 \mathrm{w} \\ & 1 \mathrm{w} \\ & 1 \mathrm{w} \end{aligned}$ |  |  |  |  |  | 82/3 <br> 91/2.8 <br> 91/2.8 <br> 91/2.8 | 5 20 10 5 |
| $\begin{aligned} & \text { 1 N5587 } \\ & \text { 1N5587A } \\ & \text { 1N5587B } \\ & \text { 1N5588 } \end{aligned}$ | $\begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}$ | $\left\lvert\, \begin{aligned} & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \end{aligned}\right.$ |  |  | $\begin{aligned} & 1 w \\ & 1 w \\ & 1 w \\ & 1 w \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 100 / 2.5 \\ & 100 / 2.5 \\ & 100 / 2.5 \\ & 110 / 2.3 \end{aligned}$ | 20 10 5 20 |
| IN5588A 1N5588B 1N5589 1N5589A | $\left[\begin{array}{l} \mathbf{s} \\ \mathbf{s} \\ \mathbf{s} \\ \mathbf{s} \end{array}\right.$ | $\left\|\begin{array}{l} \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{ZD} \end{array}\right\|$ |  |  | $\begin{aligned} & 1 \mathrm{w} \\ & 1 \mathrm{w} \\ & 1 \mathrm{w} \\ & 1 \mathrm{w} \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 110 / 2.3 \\ & 110 / 2.3 \\ & 120 / 2 \\ & 120 / 2 \end{aligned}$ | 10 5 20 10 |
| 1N5589B 1N5590 1N5590A 1N5590B | s | $\left\|\begin{array}{l} \mathrm{ZD} \\ \mathrm{ZD} \\ \mathrm{ZD} \\ \mathrm{ZD} \end{array}\right\|$ |  |  | 10 10 10 16 |  |  |  |  |  | $\begin{aligned} & 120 / 2 \\ & 130 / 1.9 \\ & 130 / 1.9 \\ & 130 / 1.9 \end{aligned}$ | 5 20 10 5 |
|  | s s s s | $\left\|\begin{array}{l} \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \end{array}\right\|$ |  |  | $\begin{aligned} & \text { iw } \\ & \text { iw } \\ & i w \\ & i w \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 150 / 1.7 \\ & 150 / 1.7 \\ & 150 / 1.7 \\ & 160 / 1.6 \end{aligned}$ | 20 10 5 20 |
|  | s | $\left\|\begin{array}{l} \mathrm{zD} \\ \mathrm{ZD} \\ \mathrm{ZD} \\ \mathrm{ZD} \end{array}\right\|$ |  |  | $\begin{aligned} & 1 \mathrm{w} \\ & 1 \mathrm{w} \\ & 1 \mathrm{w} \\ & 1 \mathrm{w} \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 160 / 1.6 \\ & 160 / 1.6 \\ & 180 / 1.4 \\ & 180 / 1.4 \end{aligned}$ | 10 5 20 10 |
|  | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\left\|\begin{array}{l} \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \end{array}\right\|$ |  |  | $\begin{aligned} & \text { iw } \\ & \text { iw } \\ & \text { iw } \\ & \text { iw } \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 180 / 1.4 \\ & 200 / 1.2 \\ & 200 / 1.2 \\ & 200 / 1.2 \end{aligned}$ | 5 20 10 5 |
| 1N5595 <br> 1N5596 <br> 1N5597 <br> 1N5598 | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\begin{aligned} & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \end{aligned}$ |  |  |  | $\begin{array}{r} 5 K \\ 7.5 K \\ 10 K \\ 15 K \end{array}$ | $\begin{array}{r} 1.15 \\ .87 \\ .77 \\ .47 \end{array}$ | $\begin{aligned} & 300 / \\ & 300 / \\ & 300 / \\ & 300 / \end{aligned}$ | $\begin{aligned} & 7.41 \\ & 11 / \\ & 141 \\ & 23 / \end{aligned}$ |  |  |  |
| 1N5599 <br> 1N5600 <br> INS601 <br> IN5602 | $\left\lvert\, \begin{aligned} & \mathbf{s} \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\begin{array}{\|l\|} \hline \mathbf{R E} \\ \mathbf{R E} \\ \mathbf{R E} \\ \mathbf{R E} \\ \hline \end{array}$ |  |  |  | $\begin{gathered} 2.5 K \\ 5 K \\ 7.5 K \\ 2.5 K \end{gathered}$ | $\begin{aligned} & 2.1 \\ & 1.4 \\ & .92 \\ & 4.6 \end{aligned}$ | $\begin{gathered} 750 / \\ 750 / \\ 750 / \\ 1 \mathrm{M} / \end{gathered}$ | $\begin{gathered} 3.71 \\ 7.4 / \\ 11 / \\ 5 / \end{gathered}$ |  |  |  |
| IN5603 IN5604 1N5605 1N5606 | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\left\|\begin{array}{l} \mathrm{RE} \\ \mathrm{RE} \\ \mathrm{SD} \\ \mathrm{SD} \end{array}\right\|$ |  | $\begin{aligned} & \text { IN457 } \\ & \text { ind } 58 \end{aligned}$ |  | $\begin{array}{r} 5 K \\ 7.5 K \\ 70 \\ 150 \end{array}$ | $\begin{aligned} & 3.3 \\ & 2.3 \end{aligned}$ | $\begin{aligned} & 1 \mathrm{M} / 2 \\ & 1 \mathrm{M} / \\ & 25 \mathrm{~N} / \theta 0 \\ & 25 \mathrm{~N} / 125 \end{aligned}$ | $\begin{gathered} 91 \\ 121 \\ 1 / 20 \\ 1 / 7 \end{gathered}$ |  |  |  |

## DIODE INTERCHANGEABILITY

| TYPE NUMEER |  |  | $\pi$ REPLACEMENT | $\begin{aligned} & \text { FOR } \\ & \text { NiEW } \\ & \text { DESICN } \end{aligned}$ | Ratines |  |  | CHARACTERISTICS |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  |  | $\mathbf{V}_{\mathbf{R}}$ <br> (V) | I <br> (A) | $\begin{array}{ll} \mathbf{V R}_{\mathbf{R}} & \mathbf{V}_{\mathrm{R}} \\ \boldsymbol{\mu} \mathbf{A} & /(\mathbf{V}) \end{array}$ | $\mathbf{V F}_{F} \cdot \mathbf{I F}_{\mathbf{F}}$ <br> (V) $/$ (mA) | $\begin{aligned} & I_{T r} \\ & (n s) \end{aligned}$ | $\mathbf{V}_{\mathbf{z}} \cdot \mathbf{I z}_{\mathbf{z}}$ <br> (V) $/$ ( ma ) | $\begin{array}{r} \text { TOL } \\ \% \end{array}$ |
| 1N5607 <br> 1N5608 <br> 1N5609 <br> 1N5614 | $\begin{aligned} & \mathbf{s} \\ & \mathbf{S} \\ & \mathbf{S} \\ & \mathbf{S} \end{aligned}$ | $\begin{array}{\|l\|} \hline S D \\ S D \\ \text { SD } \\ \hline R E \end{array}$ |  | iN4938 1N4938 1 M4938 TID383 |  | 200 120 120 200 | 1 | $\begin{gathered} 25 N / 175 \\ 50 N / 50 \\ 5 / 100 \\ 2.5 / 200 \end{gathered}$ | $\begin{aligned} & 1 / 3 \\ & 1 / 100 \\ & 1 / 6 \\ & 1.2 / 1 \mathrm{~A} \end{aligned}$ | $\begin{array}{r} \hline 300 \\ 300 \\ 300 \\ 2 \mathrm{U} \end{array}$ |  |  |
| 1N5615 1N5616 1N5617 1N5618 | $\begin{aligned} & \mathbf{s} \\ & \mathbf{S} \\ & \mathbf{s} \\ & \mathbf{S} \end{aligned}$ | $\begin{aligned} & R E \\ & R E \\ & R E \\ & R E \end{aligned}$ |  | TID384 TID385 |  | 200 400 400 600 | 1 1 1 1 | $\begin{aligned} & 2.5 / \\ & 2.5 / 400 \\ & 2.5 / \\ & 2.5 / 600 \end{aligned}$ | $\begin{aligned} & 1.2 / \\ & 1.2 / 1 \mathrm{~A} \\ & 1.2 / \\ & 1.2 / 1 \mathrm{~A} \end{aligned}$ | $\begin{array}{r} 150 \\ 2 \mathrm{U} \\ 150 \\ 2 \mathrm{U} \end{array}$ |  |  |
| 1N5619 <br> 1N5620 <br> 1N5621 <br> 1NS622 | $\begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}$ | $\begin{aligned} & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{RE} \end{aligned}$ |  | 70386 <br> 710387 |  | 600 800 800 $1 K$ | 1 1 1 1 | $\begin{aligned} & 2.5 / \\ & 2.5 / 800 \\ & 2.5 / \\ & 2.5 / 1 \mathrm{~K} \end{aligned}$ | $\begin{aligned} & 1.2 / \\ & 1.2 / 1 \mathrm{~A} \\ & 1.2 / \\ & 1.2 / 1 \mathrm{~A} \end{aligned}$ | $\begin{array}{r} 250 \\ 20 \\ 350 \\ 20 \end{array}$ |  |  |
| 1N5623 <br> 1N5624 <br> 1N5625 <br> 1N5626 | S | RE RE RE RE |  |  |  | $\begin{array}{r} 1 K \\ 200 \\ 400 \\ 600 \end{array}$ | $\begin{aligned} & 1 \\ & 3 \\ & 3 \\ & 3 \end{aligned}$ | $\begin{aligned} & 2.5 / \\ & 300 / \\ & 300 / \\ & 300 / \end{aligned}$ | $\begin{aligned} & 1.2 / \\ & .95 / \\ & .95 / \\ & .95 / \end{aligned}$ | 500 |  |  |
| 1N5627 <br> 1N5667A <br> 1N5668A <br> 1N5669A | S | $\begin{aligned} & \mathrm{RE} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \end{aligned}$ |  |  | $\begin{aligned} & 250 \\ & 250 \\ & 250 \end{aligned}$ | 800 | 3 | 300/ | .951 |  | $\begin{array}{r} 2 / 1 \\ 2.2 / 1 \\ 2.4 / 1 \end{array}$ | 10 10 10 |
| 1N5670A <br> IN5671A <br> 1N5672A <br> 1N5673A | $\begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}$ | $\begin{aligned} & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \end{aligned}$ |  |  | $\begin{aligned} & 250 \\ & 250 \\ & 250 \\ & 250 \end{aligned}$ |  |  |  |  |  | $\begin{array}{r} 2.7 / 1 \\ 3 / 1 \\ 3.3 / 1 \\ 3.6 / 1 \end{array}$ | $\begin{aligned} & 10 \\ & 10 \\ & 10 \\ & 10 \end{aligned}$ |
| 1N5674A <br> 1N5675A <br> 1N5676A <br> 1N5677A | $\begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}$ | $\begin{aligned} & \mathrm{ZD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \end{aligned}$ |  |  | $\begin{aligned} & 250 \\ & 250 \\ & 250 \\ & 250 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 3.9 / 1 \\ & 4.3 / 1 \\ & 4.7 / 1 \\ & 5.1 / 1 \end{aligned}$ | $\begin{aligned} & 10 \\ & 10 \\ & 10 \\ & 10 \end{aligned}$ |
| 1N5678A <br> 1N5679 <br> 1N5680 <br> 1N5711 | S | $\begin{aligned} & \mathrm{ZD} \\ & \mathrm{RE} \\ & \mathrm{RE} \\ & \mathrm{SD} \end{aligned}$ |  | $\begin{aligned} & \text { TID381 } \\ & \text { TID382 } \\ & \text { IN4446 } \end{aligned}$ | 250 | $\begin{array}{r} 50 \\ 100 \\ 55 \\ \hline \end{array}$ | $\begin{aligned} & 1 \\ & 1 \end{aligned}$ | 10/50 10/100 .2/50 | $\begin{gathered} 1.1 / 1 A \\ 1.1 / 1 A \\ 1 / 15 \end{gathered}$ |  | 5.6/1 | 10 |
| 1N5712 <br> iN5713 <br> 1N5719 <br> IN5720 | S | $\begin{aligned} & \text { SD } \\ & \text { SD } \\ & \text { SD } \\ & S D \end{aligned}$ |  | IN4446 <br> 1N4446 IN484 1N4448 |  | 16 12 150 30 |  | $\begin{aligned} & .1 / 15 \\ & .1 / 8 \\ & 1 / 100 \\ & .5 / 20 \end{aligned}$ | $\begin{aligned} & 1 / 35 \\ & 1 / 20 \\ & 1 / 100 \\ & 1 / 50 \end{aligned}$ | 10 |  |  |
| 1N5721 <br> 1N5726 <br> 1N5727 <br> 1N5728B | S | SD SD SD ZD |  | IN4448 <br> IN4608 <br> IN4608 | 400 | 15 60 50 |  | $\begin{array}{r} .5 / 10 \\ .2 / 50 \\ 1 / 30 \end{array}$ | $1 / 50$ $1.1 / 500$ <br> $1.1 / 500$ | $\begin{aligned} & 10 \\ & 10 \\ & 10 \end{aligned}$ | 4.7/10 | 5 |

TEXAS INSTRUMENTS

## DIODE INTERCHANGEABILITY

| TYPE NUMEEA |  |  | $\pi$ | FOR NEW DESTON | $(\mathrm{mW})$ | $\mathbf{V}_{\mathbf{R}}$ <br> (V) | I <br> (A) | $\begin{array}{ll} L_{R} & \mathbf{V}_{\mathrm{R}} \\ \mu \mathrm{~A} & /(\mathbf{V}) \end{array}$ | $\mathbf{V F}_{F} \cdot \mathbf{I F}_{\mathbf{F}}$ <br> (V) $/(\mathrm{mA})$ | ERISTIC <br> Int <br> ( n ) | $\mathbf{V}_{\mathbf{z}}$ - $\mathbf{I z}_{\mathbf{z}}$ <br> (V) $/$ (mA) | TOL <br> \% |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 1N5728C <br> 1N5728D <br> 1N57290 <br> 1N5729C | $\left[\begin{array}{l} s \\ s \\ s \\ s \end{array}\right.$ | $\begin{aligned} & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \end{aligned}$ |  |  | $\begin{array}{r} 400 \\ 400 \\ 400 \\ 400 \end{array}$ |  |  |  |  |  | $\begin{aligned} & 4.7 / 10 \\ & 4.7 / 10 \\ & 5.1 / 10 \\ & 5.1 / 10 \end{aligned}$ | 2 1 5 2 |
| 1N5729D <br> IN57308 <br> 1N5730C <br> IN5730D | $\begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{S} \\ & \mathbf{s} \end{aligned}$ | $\begin{aligned} & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{ZD} \end{aligned}$ |  |  | $\begin{aligned} & 400 \\ & 400 \\ & 400 \\ & 400 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 5.1 / 10 \\ & 5.6 / 10 \\ & 5.6 / 10 \\ & 5.6 / 10 \end{aligned}$ | $\begin{aligned} & 1 \\ & 5 \\ & 2 \\ & 1 \end{aligned}$ |
| $\begin{array}{\|l} \text { 1N5731B } \\ \text { 1N5731C } \\ \text { 1N5731D } \\ \text { IN5732B } \end{array}$ | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\begin{aligned} & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{ZD} \end{aligned}$ |  |  | $\begin{aligned} & 400 \\ & 400 \\ & 400 \\ & 400 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 6.2 / 10 \\ & 6.2 / 10 \\ & 6.2 / 10 \\ & 6.8 / 10 \end{aligned}$ | 5 2 1 5 |
| $\begin{aligned} & \text { 1N5732C } \\ & \text { 1N5732D } \\ & \text { 1N5733B } \\ & \text { 1N5733C } \end{aligned}$ | $\begin{aligned} & \mathrm{s} \\ & \mathrm{~s} \\ & \mathrm{~s} \\ & \mathrm{~s} \end{aligned}$ | $\left\|\begin{array}{l} \mathrm{ZD} \\ \mathrm{ZD} \\ \mathrm{ZD} \\ \mathrm{ZD} \end{array}\right\|$ |  |  | $\begin{array}{r} 400 \\ 400 \\ 400 \\ 400 \end{array}$ |  |  |  |  |  | $\begin{aligned} & 6.8 / 10 \\ & 6.8 / 10 \\ & 7.5 / 10 \\ & 7.5 / 10 \end{aligned}$ | 2 1 5 2 |
| $\begin{aligned} & \text { 1N5733D } \\ & \text { 1N5734B } \\ & \text { 1N5734C } \\ & \text { 1N5734D } \end{aligned}$ | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\begin{aligned} & \mathrm{ZD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \\ & \mathrm{ZD} \end{aligned}$ |  |  | $\begin{aligned} & 400 \\ & 400 \\ & 400 \\ & 400 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 7.5 / 10 \\ & 8.2 / 10 \\ & 8.2 / 10 \\ & 8.2 / 10 \end{aligned}$ | 1 5 2 1 |
| $\begin{aligned} & \text { 1N5735B } \\ & \text { 1N5735C } \\ & \text { 1N5735D } \\ & \text { IN5736B } \end{aligned}$ | $\left\lvert\, \begin{aligned} & \mathbf{s} \\ & \mathbf{S} \\ & \mathbf{S} \\ & \mathbf{s} \end{aligned}\right.$ | $\begin{aligned} & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \end{aligned}$ |  |  | $\begin{array}{r} 400 \\ 400 \\ 400 \\ 400 \end{array}$ |  |  |  |  |  | $\begin{array}{r} 9.1 / 10 \\ 9.1 / 10 \\ 9.1 / 10 \\ 10 / 10 \end{array}$ | 5 2 1 5 |
| IN5736C <br> IN5736D <br> IN57378 <br> 1N5737C | $\begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}$ | $\left\|\begin{array}{l} z 0 \\ z D \\ z 0 \\ z 0 \end{array}\right\|$ |  |  | 400 400 400 400 |  |  |  |  |  | $\begin{aligned} & 10 / 10 \\ & 10 / 10 \\ & 11 / 5 \\ & 11 / 5 \end{aligned}$ | 2 1 5 2 |
| 1N57370 <br> 1N57388 <br> 1N5738C <br> IN57380 | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\begin{aligned} & \mathrm{zD} \\ & \mathrm{zo} \\ & \mathrm{zD} \\ & \mathrm{zo} \end{aligned}$ |  |  | $\begin{aligned} & 400 \\ & 400 \\ & 400 \\ & 400 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 11 / 5 \\ & 12 / 5 \\ & 12 / 5 \\ & 12 / 5 \end{aligned}$ | 1 5 2 1 |
| 1N57398 <br> 1N5739C <br> 1N5739D <br> 1N5740B | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\left.\begin{aligned} & z D \\ & Z D \\ & Z D \\ & Z D \end{aligned} \right\rvert\,$ |  |  | $\begin{array}{r} 400 \\ 400 \\ 400 \\ 400 \end{array}$ |  |  |  |  |  | $\begin{aligned} & 13 / 5 \\ & 13 / 5 \\ & 13 / 5 \\ & 15 / 5 \end{aligned}$ | 5 2 1 5 |
| 1N5740C <br> 1N5740D <br> 1N57418 <br> 1N5741C | $\begin{aligned} & 5 \\ & 5 \\ & 5 \\ & 5 \end{aligned}$ | $\left\|\begin{array}{l} \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \end{array}\right\|$ |  |  | $\begin{aligned} & 400 \\ & 400 \\ & 400 \\ & 400 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 15 / 5 \\ & 15 / 5 \\ & 16 / 5 \\ & 16 / 5 \end{aligned}$ | $\begin{aligned} & 2 \\ & 1 \\ & 5 \\ & 2 \end{aligned}$ |


| $\begin{gathered} \text { TYPE } \\ \text { Number } \end{gathered}$ |  |  | $\pi$ <br> replacemint | $\begin{gathered} \text { FOR } \\ \text { NEW } \\ \text { DESHON } \end{gathered}$ | ratines |  |  | CHARACTERISTICS |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  | $\begin{gathered} P_{D} \\ (m w) \end{gathered}$ | $\mathbf{V}_{\mathrm{R}}$ <br> (V) | (A) | $\begin{array}{ll} V_{R} & \bullet V_{R} \\ \mu_{\mathrm{A}} & /(\mathrm{V}) \end{array}$ | $\begin{array}{cc} \mathbf{v}_{\mathbf{F}} & \mathbf{i}_{\mathbf{F}} \\ \text { (V) } & 1 \text { (ma) } \end{array}$ | ${ }^{1 \pi}$ <br> (ns) | $\begin{array}{ccc} \mathbf{v}_{\mathbf{z}} & 0 & \mathbf{l z} \\ (\mathrm{v}) & 1 & (\mathrm{ma}) \end{array}$ | TOL \% |
| 1N5741D <br> 1N5742B <br> iN5742C <br> 1N5742D | $\begin{aligned} & \mathbf{s} \\ & s \\ & s \\ & s \\ & s \end{aligned}$ | $\left\|\begin{array}{l\|} \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \end{array}\right\|$ |  |  | $\begin{aligned} & 400 \\ & 400 \\ & 400 \\ & 400 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 16 / 5 \\ & 18 / 5 \\ & 18 / 5 \\ & 18 / 5 \end{aligned}$ | 1 5 2 1 |
| 1N57438 <br> 1N5743C <br> 1N5743D <br> 1N57448 | $\begin{array}{\|l} \hline s \\ s \\ s \\ s \end{array}$ | $\begin{aligned} & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \\ & \mathrm{zD} \end{aligned}$ |  |  | $\begin{aligned} & 400 \\ & 400 \\ & 400 \\ & 400 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 20 / 5 \\ & 20 / 5 \\ & 20 / 5 \\ & 22 / 5 \end{aligned}$ | 5 2 1 5 |
| IN5744C <br> 1N5744D <br> 1N57458 <br> IN5745C | $\left\lvert\, \begin{aligned} & \mathbf{s} \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\left\|\begin{array}{l} \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \end{array}\right\|$ |  |  | $\begin{aligned} & 400 \\ & 400 \\ & 400 \\ & 400 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 22 / 5 \\ & 22 / 5 \\ & 24 / 5 \\ & 24 / 5 \end{aligned}$ | 2 1 5 2 |
| 1N5745D 1N5746B 1N57LCC 1N57460 | $\left\lvert\, \begin{aligned} & \mathrm{s} \\ & \mathrm{~s} \\ & \mathrm{~s} \\ & \mathrm{~s} \end{aligned}\right.$ | $\left\|\begin{array}{l} \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \end{array}\right\|$ |  |  | $\begin{aligned} & 400 \\ & 400 \\ & 400 \\ & 400 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 24 / 5 \\ & 27 / 2 \\ & 27 / 2 \\ & 27 / 2 \end{aligned}$ | 1 5 2 1 |
| 1N57478 <br> 1N5747C <br> 1N57470 <br> 1N5748B | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\left\|\begin{array}{l} \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \end{array}\right\|$ |  |  | $\begin{aligned} & 400 \\ & 400 \\ & 400 \\ & 400 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 30 / 2 \\ & 30 / 2 \\ & 30 / 2 \\ & 33 / 2 \end{aligned}$ | 5 2 1 5 |
| 1N5748C <br> 1N5748D <br> 1N5749B <br> 1N5749C | $\begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}$ |  |  |  | $\begin{aligned} & 400 \\ & 400 \\ & 400 \\ & 400 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 33 / 2 \\ & 33 / 2 \\ & 36 / 2 \\ & 36 / 2 \end{aligned}$ | 2 1 5 2 |
| 1N57490 iN5750B IN5750C 1N5750D | $\begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathrm{s} \\ & \mathrm{~s} \end{aligned}$ | $\left\|\begin{array}{l} \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \end{array}\right\|$ |  |  | $\begin{aligned} & 400 \\ & 400 \\ & 400 \\ & 400 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 36 / 2 \\ & 39 / 2 \\ & 39 / 2 \\ & 39 / 2 \end{aligned}$ | 1 5 2 1 |
| iN5751B <br> IN5751C <br> 1N5751D <br> 1N5752B | $\left\lvert\, \begin{aligned} & s \\ & s \\ & s \\ & s \end{aligned}\right.$ | $\left\|\begin{array}{l} \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \end{array}\right\|$ |  |  | $\begin{aligned} & 400 \\ & 400 \\ & 400 \\ & 400 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 43 / 2 \\ & 43 / 2 \\ & 43 / 2 \\ & 47 / 2 \end{aligned}$ | 5 2 1 5 |
| 1N5752C <br> 1N5752D <br> 1N5753B <br> 1N5753C | $\left\lvert\, \begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}\right.$ | [ |  |  | 400 400 400 400 |  |  |  |  |  | $\begin{aligned} & 47 / 2 \\ & 47 / 2 \\ & 51 / 2 \\ & 51 / 2 \end{aligned}$ | 2 1 5 2 |
| 1N5753D 1N575AB IN5754C 1N5754D | $\left\lvert\, \begin{aligned} & \mathrm{s} \\ & \mathrm{~s} \\ & \mathrm{~s} \\ & \mathrm{~s} \end{aligned}\right.$ | $\left\|\begin{array}{l} \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \end{array}\right\|$ |  |  | 400 400 400 400 |  |  |  |  |  | $\begin{aligned} & 51 / 2 \\ & 56 / 2 \\ & 56 / 2 \\ & 56 / 2 \end{aligned}$ | 1 5 2 1 |

## DIODE INTERCHANGEABILITY

| $\begin{aligned} & \text { TYPE } \\ & \text { NUMBER } \end{aligned}$ |  |  | $\prod_{\text {REPLACEMENT }}$ | $\begin{aligned} & \text { FOR } \\ & \text { NEW } \\ & \text { DESIGN } \end{aligned}$ | PD (mW) | $\begin{aligned} & \text { TINES } \\ & \mathbf{V}_{\mathbf{R}} \\ & \text { (v) } \end{aligned}$ | (A) | $\begin{array}{cc} \mathbf{I}_{\mathbf{R}} & \mathbf{V}_{\mathbf{R}} \\ \mu \mathbf{A} & /(\mathbf{V}) \end{array}$ | $\left.\begin{array}{cc}  & \text { CHARACT } \\ \mathbf{v}_{\mathbf{F}} & \bullet \\ \mathbf{l}_{\mathbf{F}} \\ (\mathrm{v}) & /(\mathrm{ma}) \end{array} \right\rvert\,$ | $\begin{aligned} & \text { ERISTICS } \\ & \left\|\begin{array}{c} t_{\pi} \\ \text { (ns) } \end{array}\right\| \end{aligned}$ | $\begin{array}{ccc} \mathbf{v}_{\mathbf{z}} & \bullet & \mathbf{z} \\ (\mathrm{v}) & /(\mathrm{ma}) \end{array}$ | ral |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 1N5755B 1N5755C 1N5755D 1N5756B | $\begin{aligned} & \mathrm{s} \\ & \mathrm{~s} \\ & \mathrm{~s} \\ & \mathrm{~s} \end{aligned}$ | $\left\|\begin{array}{l} \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \end{array}\right\|$ |  |  | $\begin{aligned} & 400 \\ & 400 \\ & 400 \\ & 400 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 62 / 2 \\ & 62 / 2 \\ & 62 / 2 \\ & 68 / 2 \end{aligned}$ | 5 2 1 5 |
| 1N5756C 1N5756D 1N5757B 1N5757C | $\begin{aligned} & \mathrm{s} \\ & \mathrm{~s} \\ & \mathrm{~s} \\ & \mathrm{~s} \end{aligned}$ | $\left\|\begin{array}{l} \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \\ \mathrm{zD} \end{array}\right\|$ |  |  | $\begin{aligned} & 400 \\ & 400 \\ & 400 \\ & 400 \end{aligned}$ |  |  |  |  |  | 68/2 68/2 75/2 75/2 | 2 1 5 2 |
| 1N5757D 1N5766 IN5767 | $\begin{aligned} & \mathbf{s} \\ & \mathbf{s} \\ & \mathbf{s} \end{aligned}$ | $\left\|\begin{array}{c} \mathrm{zD} \\ \mathrm{sD} \\ \mathrm{sD} \end{array}\right\|$ |  |  | 400 | 110 100 |  | $\begin{gathered} 20 / 100 \\ 1 / 50 \end{gathered}$ | $\begin{gathered} 1.7 / 30 \mathrm{~A} \\ 1 / 100 \end{gathered}$ | 400 | 75/2 | 1 |
|  |  |  |  |  |  |  |  |  |  |  |  |  |

# Diode <br> Data Sheets 

## TYPE 1N251 <br> SILICON SWITCHING DIODE

## MEDIUM-SPEED SWITCHING DIODE

## - Rugged Double-Plug Construction

mechanical data
Double-plug construction affords integral positive contact by means of a thermal compression bond. Moisture-free stability is ensured through hermetic sealing. The coefficients of thermal expansion of the glass case and the dumet plugs are closely matched to allow extreme temperature excursions. Hot-solder-dipped leads are standard.


## *absolute maximum ratings


electrical characteristics at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

|  | PARAMETER | TEST CONDITIONS | MIN MAX | UNIT |
| :---: | :---: | :---: | :---: | :---: |
| $V_{\text {(10) }}$ | Reverse Breakdown Volitage | $i_{\mathrm{R}}=100 \mu \mathrm{~A}$ | 40 | V |
| ${ }^{*} I_{R}$ | Static Reverse Current | $V_{\mathrm{R}}=20 \mathrm{~V}$ | 20 | $\mu \mathrm{A}$ |
|  |  | $\mathrm{V}_{\mathrm{R}}=10 \mathrm{~V}$ | 0.1 | $\mu \mathrm{A}$ |
|  |  | $V_{R}=10 \mathrm{~V}, \mathrm{~T}_{A}=125^{\circ} \mathrm{C}$ | 10 | $\mu \mathrm{A}$ |
| ${ }^{*} V_{F}$ | Static Forward Voltage | $\mathrm{I}_{\mathrm{F}}=5 \mathrm{~mA}$ | 1 | V |

*switching characteristics at $25^{\circ} \mathrm{C}$ free-air temperature

| PARAMETER | TEST CONDITIONS | MIN | MAX | UNIT |
| :---: | :---: | :---: | :---: | :---: |
| Peverse Recovary Time | $256-\mathrm{JAN}, \mathrm{I}_{\mathrm{F}}=5 \mathrm{~mA}, \mathrm{~V}_{\mathrm{R}}=10 \mathrm{~V}$ <br> $\mathrm{R}_{\mathrm{L}}=1 \mathrm{k} \Omega, \mathrm{C}=10 \mathrm{pF}$, <br> $\mathrm{i}_{\mathrm{rr}}=0.5 \mathrm{~mA}$ | ms |  |  |

WOTES: 1. Thase values may be applited continuously under singla-phase $60-\mathrm{Hz}$ half-sine-wave operation with resistive lead.
2. Derate linearly to $\mathbf{3 0} \mathrm{mA}$ at $125^{\circ} \mathrm{C}$ free-air temperature.
3. Derate Incarly to 0 at $150^{\circ} \mathrm{C}$ free-air temperature.
4. These values apply for a one-second square-wave pelse with the device at nenapersting thermal equilibrium lamediately prion fo the swrge.
5. Derate linearly to $150^{\circ} \mathrm{C}$ free-alf temperalure of the rate of $1.2 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$.

- Indicates JEDEC ragisfored dato

VRM(wkg) . . 25 to 185 Volts<br>- Rugged Double-Plug Construction<br>- Low Reverse Current

## description and mechanical data

The glass-passivated silicon chip combines extremely low reverse current with a high degree of stability. True glass passivation and the absence of an organic coating ensure protection of the junction from contaminants and moisture.

Double-plug construction affords integral positive contacts by means of a thermal compression bond. Moisture-free stability is ensured through hermetic sealing. The coefficients of thermal expansion of the glass case and the dumet plugs are closely matched to allow extreme temperature excursions. Hot-solder-dipped leads are standard. Gold-plated leads are available on request.


[^181]
# TYPES 1N456 THRU 1N459, 1 N461 THRU 1N464, 1N482 THRU 1N485, AND SUFFIX VERSIONS SILICON GENERAL PURPOSE DIODES 

*absolute maximum ratings at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

| TYPE | $\mathbf{V}_{\mathbf{R M}}$ <br> Peak <br> Reverse <br> Voltage | $V_{\text {RM }}$ (wkg) <br> Working Peak Reverse Vottage | ${ }^{1} 0$ <br> Average Rectified Forward Current $e T_{A} \leqslant 25^{\circ} C$ <br> (See Notes 1 and 2) | $I_{F}$ <br> Steady State Forward Current $\text { e } T_{A} \leqslant 25^{\circ} C$ <br> (Sea Note 2) | IFM(surge) Peak Surge Current |  | P Continuous Power Dissipation $T_{A} \leqslant 25^{\circ} \mathrm{C}$ (See Note 5) | $T_{\text {stg }}$ <br> Storage <br> Temperature Range |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  | 1 s (See Note 3) | $\begin{gathered} 2 \mu \mathrm{~s} \\ \text { (See Note 4) } \end{gathered}$ |  |  |
| $\begin{aligned} & \text { 1N456 } \\ & \text { 1N456A } \end{aligned}$ | 30 V | 25 V | $\begin{array}{r} 90 \mathrm{~mA} \\ 200 \mathrm{~mA} \end{array}$ | 135 mA | $\begin{aligned} & 0.7 \mathrm{~A} \\ & 1.5 \mathrm{~A} \end{aligned}$ | 1.2 A | 200 mW 500 mW | $9$ |
| $\begin{aligned} & \text { 1N457 } \\ & \text { 1N457A } \\ & \hline \end{aligned}$ | 70 V | 60 V | $\begin{array}{r} 75 \mathrm{~mA} \\ 200 \mathrm{~mA} \end{array}$ | $110 \mathrm{~mA}$ $\qquad$ | $\begin{aligned} & \hline 0.6 \mathrm{~A} \\ & 1.5 \mathrm{~A} \end{aligned}$ | 1.0 A | $\begin{aligned} & 200 \mathrm{~mW} \\ & 500 \mathrm{~mW} \end{aligned}$ |  |
| $\begin{aligned} & \text { 1N458 } \\ & \text { 1N458A } \end{aligned}$ | 150 V | 125 V | $\begin{array}{r} 55 \mathrm{~mA} \\ 200 \mathrm{~mA} \\ \hline \end{array}$ | $80 \mathrm{~mA}$ | $\begin{aligned} & 0.5 \mathrm{~A} \\ & 1.5 \mathrm{~A} \end{aligned}$ | 0.8 A | $\begin{aligned} & 200 \mathrm{~mW} \\ & 500 \mathrm{~mW} \end{aligned}$ |  |
| $\begin{aligned} & \text { 1N459 } \\ & \text { 1N459A } \end{aligned}$ | 200 V | 175 V | $\begin{array}{r} 40 \mathrm{~mA} \\ 200 \mathrm{~mA} \\ \hline \end{array}$ | 60 mA | $\begin{aligned} & 0.4 \mathrm{~A} \\ & 1.5 \mathrm{~A} \end{aligned}$ | $\underline{0.7 ~ A}$ | $\begin{aligned} & 200 \mathrm{~mW} \\ & 500 \mathrm{~mW} \end{aligned}$ | $-80^{\circ} \mathrm{C}$ |
| $\begin{aligned} & \text { 1N461 } \\ & \text { 1N461A } \\ & \hline \end{aligned}$ | 30 V | 25 V | $\begin{array}{r} 60 \mathrm{~mA} \\ 200 \mathrm{~mA} \\ \hline \end{array}$ | 90 mA | $\begin{array}{r} \hline 0.55 \mathrm{~A} \\ 1.5 \mathrm{~A} \\ \hline \end{array}$ | 0.9 A - | $\begin{aligned} & 200 \mathrm{~mW} \\ & 500 \mathrm{~mW} \\ & \hline \end{aligned}$ | $200^{\circ} \mathrm{C}$ |
| $\begin{aligned} & \text { 1N462 } \\ & \text { 1N462A } \end{aligned}$ | 70 V | 60 V | $\begin{array}{r} 50 \mathrm{~mA} \\ 200 \mathrm{~mA} \\ \hline \end{array}$ | 75 mA - | $\begin{aligned} & 0.5 \mathrm{~A} \\ & 1.5 \mathrm{~A} \end{aligned}$ | 0.8 A | 200 mW <br> 500 mW |  |
| $\begin{aligned} & \text { 1N463 } \\ & \text { 1N463A } \end{aligned}$ | 200 V | 175 V | 30 mA 200 mA | 50 mA $\qquad$ | $\begin{aligned} & 0.4 \mathrm{~A} \\ & 1.5 \mathrm{~A} \end{aligned}$ | 0.7 A | 200 mW 500 mW |  |
| $\begin{aligned} & \text { 1N464 } \\ & \text { 1N464A } \end{aligned}$ | 150 V | 125 V | $\begin{array}{r} 40 \mathrm{~mA} \\ 200 \mathrm{~mA} \end{array}$ | $60 \mathrm{~mA}$ ـ | $\begin{aligned} & 0.4 \mathrm{~A} \\ & 1.5 \mathrm{~A} \end{aligned}$ | 0.7 A | 200 mW 500 mW | $d$ |

*absolute maximum ratings at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

| TYPE | VRM <br> Peak <br> Reverse <br> Voltage | $V_{\text {RM }}$ (wkg) <br> Working Peak Reverse Voltage | 10 <br> Average Rectified Forward Current e $T_{A}<25^{\circ} \mathrm{C}$ <br> (See Notes 1 and 2) | IFM(rep) <br> Repetitive Peak <br> Forward Current <br> (See Note 6) | IFM(surge) <br> Peak Surge Current (See Note 7) | $\bar{P}$ <br> Continuous Power Dissipation (See Note 5) | $\mathrm{T}_{\mathrm{stg}}$ <br> Storage <br> Temperature Range |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| $\begin{aligned} & \text { 1N482 } \\ & \text { 1N482A } \\ & \text { 1N482B } \end{aligned}$ | 40 V | 36 V | $\begin{aligned} & 100 \mathrm{~mA} \\ & 200 \mathrm{~mA} \\ & 200 \mathrm{~mA} \end{aligned}$ | $\begin{aligned} & 400 \mathrm{~mA} \\ & 650 \mathrm{~mA} \\ & 650 \mathrm{~mA} \end{aligned}$ | $\begin{aligned} & 1 \mathrm{~A} \\ & 2 \mathrm{~A} \\ & 2 \mathrm{~A} \end{aligned}$ |  |  |
| $\begin{array}{l\|} \hline \text { 1N483 } \\ \text { 1N483A } \\ \text { 1N48,3B } \\ \hline \end{array}$ | 80 V | 70 V | $\begin{aligned} & 100 \mathrm{~mA} \\ & 200 \mathrm{~mA} \\ & 200 \mathrm{~mA} \end{aligned}$ | $\begin{aligned} & 400 \mathrm{~mA} \\ & 650 \mathrm{~mA} \\ & 650 \mathrm{~mA} \end{aligned}$ | $\begin{aligned} & 1 A \\ & 2 A \\ & 2 A \end{aligned}$ | 1 | $-65^{\circ} \mathrm{C}$ |
| $\begin{aligned} & \text { 1N484 } \\ & \text { 1N484A } \\ & \text { 1N484B } \end{aligned}$ | 150 V | 130 V | $\begin{aligned} & 100 \mathrm{~mA} \\ & 200 \mathrm{~mA} \\ & 200 \mathrm{~mA} \\ & \hline \end{aligned}$ | $\begin{aligned} & \hline 400 \mathrm{~mA} \\ & 650 \mathrm{~mA} \\ & 650 \mathrm{~mA} \end{aligned}$ | $\begin{aligned} & 1 \mathrm{~A} \\ & 2 \mathrm{~A} \\ & 2 \mathrm{~A} \end{aligned}$ |  | $200^{\circ} \mathrm{C}$ |
| $\begin{aligned} & \text { 1N485 } \\ & \text { 1N485A } \\ & \text { 1N485B } \end{aligned}$ | 200 V | 180 V | $\begin{aligned} & 100 \mathrm{~mA} \\ & 200 \mathrm{~mA} \\ & 200 \mathrm{~mA} \\ & \hline \end{aligned}$ | $\begin{aligned} & 400 \mathrm{~mA} \\ & 650 \mathrm{~mA} \\ & 650 \mathrm{~mA} \end{aligned}$ | $\begin{aligned} & 1 \mathrm{~A} \\ & 2 \mathrm{~A} \\ & 2 \mathrm{~A} \end{aligned}$ |  |  |

NOTES: 1. These values may be applied continuously under single-phase $\mathbf{6 0 - H z}$ half-sine-wave operation with resistive load.
2. For operation above $25^{\circ} \mathrm{C}$ free-air temperature refer to Forward Current Derating Curve Figure 1.
3. These values apply for a one-second square-wave pulse with the device at nonoperating thermal equilibrium immediately prior to
the surge.
4. These values apply for $2-\mu$ s pulses, duty cycle $\leqslant 1 \%$, with the device at nonoperating thermal equilibrium immediately prior to the surge.
5. For operation above $25^{\circ} \mathrm{C}$ free-air temperature refer to Dissipation Derating Curve Figure 2.
6. These valuas apply for a 4 -ms square-wave pulse, duty cycle $\leqslant \mathbf{2 5 \%}$.
7. These values apply for a $1 / 10$-second square-wave pulse with the device at nonoperating thermal equilibrium immediately prior to the surge.

- JEDEC registered data


## TYPES 1 N456 THRU 1N459, $1 N 461$ THRU $1 N 464$, 1N482 THRU IN485, AND SUFFIX VERSIONS SILICON GENERAL PURPOSE DIODES

"electrical characteristics at $\mathbf{2 5}^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

| CHARACTERISTICS |  |  |  |  | TEST VOLTAGE AND CURRENT |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| PARAMETER | $V_{\text {(BR) }}$ <br> Reverse <br> Breakdown Voltage | $I_{R}$ <br> Static Reverse Current |  | $V_{F}$ <br> Static Forward Voltage |  |  |
| TEST CONDITIONS | $I_{R}=100 \mu A$ | $\mathrm{T}_{A}=25^{\circ} \mathrm{C}$ | $T_{A}=150^{\circ} \mathrm{C}$ |  | $\begin{gathered} \mathbf{V}_{\mathbf{R}} \\ \text { FOR TESTING } \end{gathered}$ | $\begin{gathered} \text { IF } \\ \text { FOR TESTING } \end{gathered}$ |
| LiMITS | MIN | MAX | MAX | MAX | $\mathrm{I}_{R}$ | $\mathbf{V F}_{F}$ |
| 1N456 <br> 1N456A | 30 V |  |  |  | 25 V | $\begin{array}{r} 40 \mathrm{~mA} \\ 100 \mathrm{~mA} \\ \hline \end{array}$ |
| 1N457 <br> 1N457A | 70 V |  |  |  | 60 V | $\begin{array}{r} 20 \mathrm{~mA} \\ 100 \mathrm{~mA} \end{array}$ |
| $\begin{aligned} & \text { 1N458 } \\ & \text { 1N458A } \end{aligned}$ | 150 V |  |  |  | 125 V | $\begin{array}{r} 7 \mathrm{~mA} \\ 100 \mathrm{~mA} \end{array}$ |
| 1N459 1N459A | 200 V |  |  |  | 175 V | $\begin{array}{r} 3 \mathrm{~mA} \\ 100 \mathrm{~mA} \\ \hline \end{array}$ |
| iN461 <br> 1N461A | 30 V |  |  |  | 25 V | $\begin{array}{r} 15 \mathrm{~mA} \\ 100 \mathrm{~mA} \end{array}$ |
| $\begin{aligned} & \text { 1N462 } \\ & \text { IN462A } \end{aligned}$ | 70 V |  |  |  | 60 V | $\begin{array}{r} 5 \mathrm{~mA} \\ 100 \mathrm{~mA} \end{array}$ |
| $\begin{aligned} & \text { 1N463 } \\ & \text { 1N463A } \end{aligned}$ | 200 V |  |  |  | 175 V | $\begin{array}{r} 1 \mathrm{~mA} \\ 100 \mathrm{~mA} \end{array}$ |
| $\begin{aligned} & \text { iN464 } \\ & \text { 1N464A } \end{aligned}$ | 150 V |  |  | $\sqrt{d}$ | 125 V | $\begin{array}{r} 3 \mathrm{~mA} \\ 100 \mathrm{~mA} \\ \hline \end{array}$ |
| $\begin{aligned} & \text { 1N482 } \\ & \text { 1N482A } \\ & \text { 1N482B } \end{aligned}$ | 40 V | $\begin{array}{r} 250 \mathrm{nA} \\ 25 \mathrm{nA} \\ 25 \mathrm{nA} \end{array}$ | $\begin{array}{r} 30 \mu \mathrm{~A} \\ 15 \mu \mathrm{~A} \\ 5 \mu \mathrm{~A} \\ \hline \end{array}$ | $\begin{aligned} & 1.1 \mathrm{~V} \\ & 1.0 \mathrm{~V} \\ & 1.0 \mathrm{~V} \\ & \hline \end{aligned}$ | 30 V | 100 mA |
| $\begin{aligned} & \text { 1N483 } \\ & \text { 1N483A } \\ & \text { 1N483B } \\ & \hline \end{aligned}$ | 80 V | $\begin{array}{r} 250 \mathrm{nA} \\ 25 \mathrm{nA} \\ 25 \mathrm{nA} \\ \hline \end{array}$ | $\begin{array}{r} 30 \mu A \\ 15 \mu A \\ 5 \mu A \end{array}$ | $\begin{aligned} & \hline 1.1 \mathrm{~V} \\ & 1.0 \mathrm{~V} \\ & 1.0 \mathrm{~V} \\ & \hline \end{aligned}$ | 60 V | 100 mA |
| $\begin{aligned} & \text { iN484 } \\ & \text { iN484A } \\ & \text { iN484B } \end{aligned}$ | 150 V | $\begin{array}{r} 250 \mathrm{nA} \\ 25 \mathrm{nA} \\ 25 \mathrm{nA} \\ \hline \end{array}$ | $\begin{array}{r} 30 \mu \mathrm{~A} \\ 15 \mu \mathrm{~A} \\ 5 \mu \mathrm{~A} \\ \hline \end{array}$ | $\begin{aligned} & 1.1 \mathrm{~V} \\ & 1.0 \mathrm{~V} \\ & 1.0 \mathrm{~V} \\ & \hline \end{aligned}$ | 125 V | 100 mA |
| 1N485 <br> 1N485A <br> 1N485B | 200 V | $\begin{array}{r} 250 \mathrm{nA} \\ 25 \mathrm{nA} \\ 25 \mathrm{nA} \end{array}$ | $\begin{array}{r} \hline 30 \mu \mathrm{~A} \\ 15 \mu \mathrm{~A} \\ 5 \mu \mathrm{~A} \end{array}$ | $\begin{aligned} & \hline 1.1 \mathrm{~V} \\ & 1.0 \mathrm{~V} \\ & 1.0 \mathrm{~V} \end{aligned}$ | 175 V | 100 mA |

THERMAL INFORMATION


DISSIPATION DERATING CURVE


# TYPES 1N625 THRU iN629 <br> SILICON SWITCHING DIODES 

## MEDIUM-SPEED SWITCHING DIODES

## - Rugged Double-Plug Construction

## mechanical dafa

Double-plug construction affords integral positive contact by means of a thermal compression bond. Moisture-free stability is ensured through hermetic sealing. The coefficients of thermal expansion of the glass case and the dumet plugs are closely matched to allow extreme temperature excursions. Hot-solder-dipped leads are standard.

absolute maximum ratings at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

|  |  | 1N625 | 1N626 | 1N627 | IN628 | IN629 | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| ${ }^{*} V_{\text {RM } M \text { [wkg] }}$ | Working Peak Reverse Voltage | 20 | 35 | 75 | 125 | 175 | $V$ |
| ${ }^{*}{ }_{0}$ | Average Rectified Forward Current at (or below) $25^{\circ} \mathrm{C}$ Free-Air Temperature (See Notes 1 and 2) | 20 |  |  |  |  | mA |
| ${ }^{1} 10$ | Average Rectified Forward Current of $100^{\circ} \mathrm{C}$ Free-Air Temperature (See Notes 1 and 3) | 5 |  |  |  |  | mA |
| $\mathrm{I}_{\text {PM(surgel }}$ | Peak Surge Current, One Second (See Note 4) | 300 |  |  |  |  | mA |
| * ${ }^{\text {P }}$ | Continuous Power Dissipation at (or below) $25^{\circ} \mathrm{C}$ Free-Air Temperature (See Note 5) | 200 |  |  |  |  | mW |
| ${ }^{*} \mathrm{~T}_{\text {Alopr }}$ | Operating Free-Air Temperalure Range | -80 to 150 |  |  |  |  | ${ }^{\circ} \mathrm{C}$ |
| $\mathrm{I}_{\text {stg }}$ | Storage Temperature Range | -80 to 200 |  |  |  |  | ${ }^{\circ} \mathrm{C}$ |

*electrical characteristics at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

| PARAMETER |  | TEST CONDITIONS | 1N625 | 1N626 | 1N627 | 1N628 | 1N629 | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | MIN MAX | MIN MAX | MIN MAX | MIN MAX |  |  |
| $V_{\text {(Ra) }}$ | Reverse Breakdown Voltage |  | $\mathrm{I}_{\mathrm{R}}=100 \mu \mathrm{~A}$ | 30 | 50 | 100 | 150 | 200 | V |
|  |  | $\mathrm{V}_{\mathrm{R}}=$ Rated $\mathrm{V}_{\mathrm{Rm}(\mathrm{wkg})}$ | 1 | 1 | 1 | 1 | 1 | $\mu \mathrm{A}$ |
| $\mathrm{I}_{\mathrm{R}}$ | Static Reverse Current | $\begin{aligned} & V_{R}=\operatorname{Rated} V_{R M M}{ }^{\text {KmqgI }}, \\ & T_{A}=100^{\circ} \mathrm{C} \end{aligned}$ | 30 | 30 | 30 | 30 | 30 | $\mu \mathrm{A}$ |
|  | Static Forward Vollage | $\mathrm{I}_{\mathrm{F}}=4 \mathrm{~mA}$ | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | $V$ |

*switching characteristics at $25^{\circ} \mathrm{C}$ free-air temperature

| PARAMETER | TEST CONDITIONS | 1N625 | 1N626 | 1N627 | 1N628 | 1N629 | UNIT | LIMIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| trr Reverse Recovery Time | $\begin{array}{ll} 256-\mathrm{JAN}, & l_{F}=30 \mathrm{~mA}, \\ V_{R}=35 \\ \text { Recovery to } & R_{L}=25 \mathrm{k} \Omega, \mathrm{C}_{\mathrm{L}}=20 \mathrm{pF}, \\ \end{array}$ | 1 | 1 | 1 | 1 | 1 | $\mu s$ | MAX |

WOTES: 1. These values may be applied cantinuously under single-phase $60-\mathrm{Hz}$ hali-sine-wove oparation with resistive load.
2. Berate lisearly to 5 mA at $100^{\circ} \mathrm{C}$ free-air temperaturs.
3. Derate Inearly to 0 at $150^{\circ} \mathrm{C}$ froe-air temperature.
4. This value applies for a ono-sceond squore-wove puise with the device at noneperating thermal equitibrium immediataly priot to the surge.
5. Derate linearly to $150^{\circ} \mathrm{C}$ frew-air temperature at the rate of $1.6 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$.
*indicates JEDEC registersad dala

## MEDIUM-SPEED SWITCHING DIODE

## - Rugged Double-Plug Construction

## mechanical data

Double-plug construction affords integral positive contact by means of a thermal compression bond. Moisture-free stability is ensured through hermetic sealing. The coefficients of thermal expansion of the glass case and the dumet plugs are closely matched to allow extreme temperature excursions. Hot-solder-dipped leads are standard.

absolute maximum ratings at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

| ${ }^{*} V_{\text {RMM }}$ wigl | Working Peak Reverse Voltage . . . . . . . . . . . . . . . . . . . 175 V |
| :---: | :---: |
| *。 | Average Rectified Forward Current at (or below) $25^{\circ} \mathrm{C}$ Free-Air Temperature (See Note I) 40 mA |
| $\boldsymbol{1}_{\text {FM(surge) }}$ | Peak Surge Current, One Second (See Note 2) . . . . . . . . . . . . . . 0.5 A |
| $\\|_{\text {fm(surge }}$ | Peak Surge Current, 0.3 Second (See Note 2) . . . . . . . . . . . . . . 1 A |
| $*_{\text {fm(pulse) }}$ | Peak Pulse Current (See Note 3) . . . . . . . . . . . . . . . . . . . 2 A |
| $P$ | Continuous Power Dissipation at (or below) $25^{\circ} \mathrm{C}$ Free-Air Temperature (See Note 4) . 250 mW |
| ${ }^{*} \mathrm{~T}_{\text {Alopr }\}}$ | Operating Free-Air Temperature Range . . . . . . . . . . . . $-65^{\circ} \mathrm{C}$ to $150^{\circ} \mathrm{C}$ |
| ${ }^{*} \mathrm{~T}_{\text {stg }}$ | Storage Temperature Range . . . . . . . . . . . . . . . . $-65^{\circ} \mathrm{C}$ to $150^{\circ} \mathrm{C}$ |

electrical characteristics at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

| PARAMETER |  | TEST CONDITIONS | MIN | MAX | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: |
| $V_{\text {(BRX }}$ | Reverse Breakdown Voltage | $\mathrm{I}_{\mathrm{R}}=100 \mu \mathrm{~A}$ | 200 |  | V |
| * $I_{\text {R }}$ | Static Reverse Current | $V_{R}=10 \mathrm{~V}$ |  | 0.025 | $\mu \mathrm{A}$ |
|  |  | $V_{R}=100 \mathrm{~V}$ |  | 1 | $\mu \mathrm{A}$ |
|  |  | $V_{\mathrm{R}}=10 \mathrm{~V}, \quad \mathrm{~T}_{\mathrm{A}}=100^{\circ} \mathrm{C}$ |  | 5 | $\mu \mathrm{A}$ |
|  |  | $\mathrm{V}_{\mathrm{R}}=100 \mathrm{~V}, \quad \mathrm{I}_{\mathrm{A}}=100^{\circ} \mathrm{C}$ |  | 15 | $\mu \mathrm{A}$ |
| * $V_{\text {F }}$ | Static Forword Voltage | $\mathrm{I}_{\mathrm{F}}=10 \mathrm{~mA}$ |  | 1 | $V$ |

*switching characteristics at $25^{\circ} \mathrm{C}$ free-air temperature

| PARAMETER | TEST CONDITIONS | MIN | MAX | UNIT |
| :---: | :---: | :---: | :---: | :---: |
| $t_{\text {rr }} \quad$ Reverse Recovery Time | $256 \mathrm{JAN}, \mathrm{I}_{\mathrm{F}}=5 \mathrm{~mA}, \mathrm{~V}_{\mathrm{R}}=40 \mathrm{~V}$, $R_{L}=2.3 \mathrm{k} \Omega, \mathrm{C}_{\mathrm{L}}=40 \mathrm{pF}$, Recovery to $200 \mathrm{k} \Omega$, See Note 5 |  | 0.3 | $\mu s$ |

NOTES: 1. These values may be applied continuously under single-phase $60-\mathrm{Hz}$ half-sine-wave operation with resistive load. Derate linearly to 0 at $150^{\circ} \mathrm{C}$ free-air temperature.
2. These volues apply for the specifiad square-wave pulse with the device at nonoperating thanmal equilibrium immediataly prior to the surge.
3. This volue applies for $t_{p} \leq 1 \mu s$, duty cycle $\leq 1 \%$.
4. Derate linearly to $150^{\circ} \mathrm{C}$ iree-air temperature at the rate af $2 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$,
5. Reverse recovery lime is measured using a forward current puise of $1-\mu \mathrm{s}$ duration, PRR $\leq 100 \mathrm{kHz}$. The waveform is monitored on an ascilloscope with a bandwidth of 30 MHz minimum.
*Indicates JEDEC registered data

## 225 V to 600 V - 400 mA AVERAGE

## - Rugged Double-Plug Construction

## mechanical data

Double-plug construction affords integral positive contact by means of a thermal compression bond. Moisture-free stability is ensured through hermetic sealing. The coefficients of thermal expansion of the glass case and the dumet plugs are closely matched to allow extreme temperature excursions. Hot-solder-dipped leads are standard.

*absolute maximum ratings at $\mathbf{2 5}^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

|  |  | 1N645 | 1N645A | IN646 | IN647 | 1N648 | 1N649 | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| $V_{\text {RM }}$ w(g) | Working Peak Reverse Voltage over Operating Free-Air Temperature Range | 225 | 225 | 300 | 400 | 500 | 600 | V |
| $\mathrm{I}_{0}$ | Average Reclified Forward Current at (or below) $25^{\circ} \mathrm{C}$ Free-Air Temperature (See Note 1) | 400 |  |  |  |  |  | mA |
| $\mathrm{I}_{0}$ | Average Rectified Forward Current of $150^{\circ} \mathrm{C}$ Free-Air Temperature | 150 |  |  |  |  |  | mA |
| $\mathrm{I}_{\text {FM(urgol }}$ | Peak Surge Current, One Second, at $25^{\circ} \mathrm{C}$ to $150^{\circ} \mathrm{C}$ Free-Air Temperature (See Note 2) | 3 |  |  |  |  |  | A |
| P | Continuous Power Dissipation at (or below) $25{ }^{\circ} \mathrm{C}$ Free-Air Temperature (See Note 3) | 600 |  |  |  |  |  | mW |
| $\mathrm{T}_{\text {Alopr) }}$ | Operating Free-Air Temperature Range | -65 to 150 |  |  |  |  |  | ${ }^{\circ} \mathrm{C}$ |
|  | Alfitude at Rated Working Peak Reverse Voltage | 100000 |  |  |  |  |  | $f$ |

*electrical characteristics at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

| PARAMETER |  | TEST CONDITIONS | $\begin{gathered} \text { IN645 } \\ \hline \text { MIN MAX } \end{gathered}$ | IN645A | 1N646 | $\begin{array}{\|c\|} \hline \text { IN647 } \\ \hline \text { MIN MAX } \\ \hline \end{array}$ | IN648 <br> MIN MAX | $\begin{array}{\|c\|} \hline \text { IN649 } \\ \hline \text { MIN MAX } \end{array}$ | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | MIN MAX |  | MIN MAX |  |  |  |  |
| $V_{\text {(BR) }}$ | Reverse <br> Breakdown Voltage |  | $\begin{aligned} & I_{R}=100 \mu \mathrm{~A}, \\ & \mathrm{~T}_{\mathrm{A}}=100^{\circ} \mathrm{C} \end{aligned}$ | 275 | 275 | 360 | 480 | 600 | 720 | $v$ |
| $I_{\text {R }}$ | Stutic Reverse Current | $V_{R}=$ Rated $V_{\text {RM }}(\mathrm{mkg}]$ | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | $\mu \mathrm{A}$ |
|  |  | $\begin{aligned} & V_{R}=\text { Rated } V_{R M}(\omega \mathrm{wgl\mid} . \\ & \mathrm{T}_{\mathrm{A}}=100^{\circ} \mathrm{C} \\ & \hline \end{aligned}$ | 15 | 15 | 15 | 20 | 20 | 25 | $\mu \mathrm{A}$ |
|  |  | $\mathrm{V}_{\mathrm{R}}=60 \mathrm{~V}$ |  | 0.05 |  |  |  |  | $\mu \mathrm{A}$ |
|  |  | $\begin{aligned} & V_{\mathrm{R}}=60 \mathrm{~V} \\ & \mathrm{~T}_{\mathrm{A}}=125^{\circ} \mathrm{C} \end{aligned}$ |  | 10 |  |  |  |  | $\mu \mathrm{A}$ |
| $V_{F}$ | Static Forward Voltage | $\mathrm{I}_{\mathrm{F}}=400 \mathrm{~mA}$ | 1 | 1 | 1 | 1 | 1 | 1 | V |
| $C_{1}$ | Total Capacitante | $\begin{aligned} & V_{R}=12 \mathrm{~V}, \\ & f=1 \mathrm{mHz} \end{aligned}$ | 6 typ | 6 typ | 6 typ | 6 typ | 6 typ | 6 typ | pF |

NOTES: 1. These values may be applied continuously under single-phase $60-\mathrm{Hz}$ half-sine-wave operation with resistive load. Derate linearly to 150 mA at $150^{\circ} \mathrm{C}$ free-air temperature at the rate of $2 \mathrm{~mA} /^{\circ} \mathrm{C}$.
2. These values apply for a one-second square-wave pulse with the device at nonoperating thermal equilibrium immediately prior to the surge.
3. Derate linearly to 200 mW at $150^{\circ} \mathrm{C}$ free-air temperature at the rate of $3.2 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$.

- JEDEC registered data.


## MEDIUM-SPEED SWITCHING DIODES

## - Rugged Double-Plug Construction

mechanical data
Double-plug construction affords integral positive contact by means of a thermal compression bond. Moisture-free stability is ensured through hermetic sealing. The coefficients of thermal expansion of the glass case and the dumet plugs are closely matched to allow extreme temperature excursions. Hot-solder-dipped leads are standard.

absolute maximum ratings at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

|  |  | 1N659 | 1N660 | 1N661 | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: |
| ${ }^{*} \mathrm{~V}_{\text {RM }}$ (wisg) | Working Peak Reverse Voltage over Operating Free-Air Temperature Range | 50 | 100 | 200 | V |
| * 0 | Average Rectified Forward Current at (or below) $25^{\circ} \mathrm{C}$ Free-Air Temperature (See Note 1) | 100 |  |  | mA |
| * ${ }^{\text {o }}$ | Average Rectified Forward Current at $100^{\circ} \mathrm{C}$ Free-Air Temperature (See Note 1) | 40 |  |  | mA |
| $\mathrm{I}_{\text {FM(surgal }}$ | Peak Surge Current at $25^{\circ} \mathrm{C}$ Free-Air Temperature (See Note 2) | 500 |  |  | mA |
| P | Continuous Power Dissipation of (or below) $25^{\circ} \mathrm{C}$ Free-Air Temperature (See Note 3) | 250 |  |  | mW |
| ${ }^{*} \mathrm{~T}_{\text {A }}$ (opr) | Operating Free-Air Temperature Range | -65 to 150 |  |  | ${ }^{\circ} \mathrm{C}$ |
| $\mathrm{T}_{\text {stg }}$ | Storage Temperature Range | -65 to 150 |  |  | ${ }^{\circ} \mathrm{C}$ |
|  | Altitude at Rated Working Peak Reverse Voltage | 100000 |  |  | $f$ |

*electrical characteristics at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

| PARAMETER | TEST CONDITIONS | 1N659 | IN660 | 1N661 | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | MIN MAX | MIN MAX | MIN MAX |  |
| $V_{\text {(图) }}$ Reverse Braakdown Voltage | $\mathrm{I}_{\mathrm{R}}=100 \mu \mathrm{~A}, \mathrm{I}_{\mathrm{A}}=100^{\circ} \mathrm{C}$ | 60 | 120 | 240 | $V$ |
|  |  | 5 | 5 | 10 | $\mu A$ |
| IR Static Reverse Current | $\begin{aligned} & V_{R}=\text { Roted } V_{R M(w k g)} \\ & T_{A}=100^{\circ} \mathrm{C} \\ & \hline \end{aligned}$ | 25 | 50 | 100 | $\mu \mathrm{A}$ |
| $\overline{V_{F}}$ Static Forward Voltage | $\mathrm{I}_{\mathrm{F}}=6 \mathrm{~mA}$ | 1 | 1 | 1 | $V$ |

*switching characteristics at $25^{\circ} \mathrm{C}$ free-air temperature

|  |  | 1N659 | $1 \times 660$ | 1N661 |  |
| :---: | :---: | :---: | :---: | :---: | :---: |
| PARAMETER | TEST CONDITIONS | MIN MAX | MIN MAX | MIN MAX | UNIT |
| $t_{\text {rr }}$ Reverse Recovery Time | $\begin{array}{ll} \hline 256-\mathrm{JA} N_{,}, & l_{F}=30 \mathrm{~mA}, \\ V_{R}=35 \mathrm{~V}, & R_{L}=2 \mathrm{k} \Omega, \\ \mathrm{C}_{\mathrm{L}}=20 \mathrm{pF}, & \text { Recovery }^{2} \text { to } 400 \mathrm{k} \Omega \\ \hline \end{array}$ | 0.3 | 0.3 | 0.3 | $\mu s$ |

MOTES: 1. These valuss may be appliad continuously under single-phase $60-\mathrm{Hz}$ half-sine-wave operation with resistive load. Derate linearly to 0 at $150^{\circ} \mathrm{C}$ troc-alr temperaturn.
2. This value appliss for a one-secend square-wave pulse with the device at nonoparating thermal equilibrium immediately prior to the surge.
3. Derate Ilinuasty to $150^{\circ} \mathrm{C}$ froo-alr temperature at the rate of $2 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$.
*JEDEC ingistrod data.

## TYPES 1N662, 1N663 <br> SILICON SWITCHING DIODES

BULLETIN NO. DL-S 739122, SEPTEMBER 1966-REVISED MARCH 1973

## MEDIUM-SPEED SWITCHING DIODE

## - Rugged Double-Plug Construction

## *mechanical data

Double-plug construction affords integral positive contact by means of a thermal compression bond. Moisture-free stability is ensured through hermetic sealing. The coefficients of thermal expansion of the glass case and the dumet plugs are closely matched to allow extreme temperature excursions. Hot-solder-dipped leads are standard. 1

absolute maximum ratings at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

|  |  | 1 N662 | IN663 | UNIT |
| :---: | :---: | :---: | :---: | :---: |
| ${ }^{*} \mathrm{~V}_{\text {RMM }}$ ( mkg | Working Peak Reverse Voltage | 80 | 80 | V |
| ** | Average Rectified Forward Current at (or below) $25^{\circ} \mathrm{C}$ Free-Air Temperature (See Note 1) | 40 | 60 | mA |
| * $I_{\text {FM M }}$ (surgel | Peak Surge Current, One Second (See Note 2) | 0.5 |  | A |
| ${ }^{*} I_{\text {EMM }}$ (urgel | Peak Surge Current, 0.3 Second (See Note 2) | 1 |  | A |
| ${ }^{*} I_{\text {FMMIpulsol }}$ | Peak Pulse Current (See Note 3) | 2 |  | A |
| P | Continuous Power Dissipation at (or below) $25^{\circ} \mathrm{C}$ Free-Air Temperature (See Note 4) | 250 |  | mW |
| ${ }^{*} \mathrm{~T}_{\text {A (00p) }}$ | Operating Free-Air Temperature Range | -65 to 150 |  | ${ }^{\circ} \mathrm{C}$ |
| ${ }^{*} \mathrm{~T}_{\text {stg }}$ | Storage Temperature Range | -65 to 150 |  | ${ }^{\circ} \mathrm{C}$ |

*electrical characteristics at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

| PARAMETER | TEST CONDITIONS | 1 N662 | IN663 | UNIT |
| :---: | :---: | :---: | :---: | :---: |
|  |  | MIN MAX | MIN MAX |  |
| $V_{\text {(ER) }}$ Reverse Breakdown Voltage | $\mathrm{I}_{\mathrm{R}}=100 \mu \mathrm{~A}$ | 100 | 100 | V |
| $\mathrm{I}_{\mathrm{R}} \quad$ Static Reverse Current | $V_{\mathrm{R}}=10 \mathrm{~V}$ | 1 |  | $\mu \mathrm{A}$ |
|  | $V_{R}=50 \mathrm{~V}$ | 20 |  | $\mu \mathrm{A}$ |
|  | $V_{R}=75 \mathrm{~V}$ |  | 5 | $\mu \mathrm{A}$ |
|  | $\mathrm{V}_{\mathrm{R}}=10 \mathrm{~V}, \mathrm{~T}_{\mathrm{A}}=100^{\circ} \mathrm{C}$ | 20 |  | $\mu \mathrm{A}$ |
|  | $\mathrm{V}_{\mathrm{R}}=50 \mathrm{~V}, \mathrm{~T}_{\mathrm{A}}=100^{\circ} \mathrm{C}$ | 100 |  | $\mu \mathrm{A}$ |
|  | $\mathrm{V}_{\mathrm{R}}=75 \mathrm{~V}, \mathrm{~T}_{\mathrm{A}}=100^{\circ} \mathrm{C}$ |  | 50 | $\mu \mathrm{A}$ |
| $\mathrm{V}_{\mathrm{F}} \quad$ Static Forward Voitage | $\mathrm{I}_{\mathrm{F}}=10 \mathrm{~mA}$ | 1 |  | V |
|  | $\mathrm{I}_{\mathrm{F}}=100 \mathrm{~mA}$ |  | 1 | V |

*switching characteristics ot $25^{\circ} \mathrm{C}$ free-air temperature

| PARAMETER |  | TEST CONDITIONS | 1 N662 |  | 1N663 |  | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | MIN | MAX | MIN | MAX |  |
| $\mathrm{t}_{\text {tr }}$ | Reverse Recovery Time |  | $\begin{aligned} & 256-\mathrm{JAN}, \mathrm{I}_{\mathrm{F}}=5 \mathrm{~mA}, \mathrm{~V}_{\mathrm{R}}=40 \mathrm{~V}, \\ & \mathrm{R}_{\mathrm{L}}=2.3 \mathrm{k}, \mathrm{C}_{\mathrm{L}}=40 \mathrm{pF}, \\ & \text { Recovery to } 100 \mathrm{k} \Omega \end{aligned}$ |  | 0.5 |  |  | $\mu s$ |
|  |  | $\begin{aligned} & 256-\mathrm{JAN}, \mathrm{I}_{F}=5 \mathrm{~mA}, \mathrm{~V}_{\mathrm{R}}=40 \mathrm{~V}, \\ & R_{\mathrm{L}}=2.3 \mathrm{k} \Omega, \mathrm{C}_{\mathrm{L}}=40 \mathrm{pF}, \\ & \text { Recovery to } 200 \mathrm{k} \Omega \end{aligned}$ |  |  |  | 0.5 | $\mu s$ |

NOTES: 1. These values may be applied continuously under single-phase $60-\mathrm{Hz}$ hall-sine-wave operation with resistive load. Derate linearly to 0 at $150^{\circ} \mathrm{C}$ free-air temperature.
2. Thase values apply for the specified square-wave pulse with the device at nonoperating thermal equilibrium immediately prior to the surge.
3. This value applies for $t_{p} \leq 1 \mu s$, duly cycle $\leq 1 \%$.
4. Derate linearly to $150^{\circ} \mathrm{C}$ free-air temperature af the rate of $2 \mathrm{~mW} / \mathrm{C}^{\circ}$.

* JEDEC registered dala

$$
\begin{aligned}
& \text { VZ } \ldots 2.6 \mathrm{~V} \text { to } 7.1 \mathrm{~V} \\
& \text { PD } \ldots 400 \mathrm{~mW}
\end{aligned}
$$

- Available in 5\% and 10\% Tolerances
- Rugged Double-Plug Construction


## mechanical data

Double-plug construction affords integral positive contact by means of a thermal compression bond. Moisture-free stability is ensured through hermetic sealing. The coefficients of thermal expansion of the glass case and the dumet plugs are closely matched to allow extreme temperature excursions. Hot-solder-dipped leads are standard.


## absolute maximum ratings

| TYPE | $l_{\text {IM }}$ Steady-State Regulator Current, $\mathrm{T}_{\mathrm{A}} \leq 25^{\circ} \mathrm{C}$ |  | P Dissipation, $\mathrm{T}_{\mathrm{A}} \leq 25^{\circ} \mathrm{C}$ | $\mathrm{T}_{\text {stg }}$ Storage Ternperature Ronge | $\mathrm{I}_{\mathrm{L}}$ Lead Temperaturo |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  | $\overbrace{\text { Nominalt }}^{\text {II }}$ | $\begin{aligned} & \text { JEDEC } \\ & \text { Value** } \end{aligned}$ | (See Note 1) |  | (See Note 2) |
| 1 1702 | 125 mA |  | $\begin{aligned} & 400 \mathrm{~mW} \dagger \\ & 250 \mathrm{~m} \mathrm{~W}^{*} \end{aligned}$ | $-65^{\circ} \mathrm{C}$ | $230^{\circ} \mathrm{C}$ |
| 11702a | 138 mA | 87 mA |  |  |  |
| 11703 | 103 mA |  |  |  |  |
| 117703A | 109 mA | 66 mA |  |  |  |
| 11704 | 89 mA |  |  |  |  |
| 11704A | 93 mA | 58 mA |  | to |  |
| 11705 | 74 mA |  |  | $200^{\circ} \mathrm{C}$ * |  |
| 14705A | 78 mA | 48 mA |  |  |  |
| 11706 | 62 mA |  |  |  |  |
| 13706A | 65 mA | 41 mA |  |  |  |
| 114707 | 50 mA |  |  |  |  |
| 1W707A | 53 mA | 33 mA |  |  |  |

mOTES: 1. For operatien above $25^{\circ} \mathrm{C}$ free-air temperatura, refor to Dissipation Derating Curve, figure 1.
2. This value applies $1 / 6$ inch from the case for 10 secends.
*Imelicates JEDEC remistered dete
The neminal $\mathrm{I}_{\mathrm{ZM}}$ ewrents shown are applicable to devices having neyplator voltages at the upper limit of the renge specifiod for eech type. Thase velues do net ropresent absolute limits. The ectual steedy-state current-voltage product must not exceed $\mathbf{4 0 0} \mathrm{mW}$.
*This value is gearantoed by Texas Instroments in addition to the JEDEC registered value which is alse shewn.

## TYPES 1N702 THRU 1N707, 1N702A THRU 1N707A <br> SILICON VOLTAGE-REGULATOR DIODES

*electrical characteristics ar $25^{\circ} \mathrm{C}$ free-cir temperature (unless otherwise noted)

|  | CHARACTERISTICS |  |  |  |  |  |  | $\begin{gathered} \text { TEST } \\ \text { VOITAGE } \end{gathered}$ |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| PARAMETER | $V_{z}$ Zener Breakdown Voltage |  |  | $\mathbf{I}_{2}$ <br> Small-Signal Breakdown Impedance | $I_{R}$ Slatic Roverse Current |  | $V_{F}$ <br> Static <br> Forward <br> Voltage |  |
| $\begin{array}{\|c\|} \text { TEST } \\ \text { CONDITIONS } \end{array}$ | $\mathrm{I}_{\mathbf{z t}}=\mathbf{5 m A}$ |  |  | $\begin{aligned} & \mathrm{I}_{\mathrm{zT}}=10 \mathrm{~mA} \\ & \mathrm{I}_{\mathrm{xt}}=1 \mathrm{~mA} \\ & \mathrm{f}=60 \mathrm{~Hz} \end{aligned}$ | $\begin{aligned} & V_{R}=V_{R(1)} \\ & r_{A}=25^{\circ} C \end{aligned}$ | $\begin{aligned} & V_{R}=V_{R(1)} \\ & T_{A}=100^{\circ} \mathrm{C} \end{aligned}$ | $\mathrm{I}_{\mathrm{F}}=200 \mathrm{~mA}$ | $V_{\text {R(1) }}$ |
| Llwils | MIM | NOM | max | max | max | max | max |  |
| UNIT | V |  |  | $\boldsymbol{\Omega}$ | $\mu \mathrm{A}$ | $\mu \mathrm{h}$ | V | V |
| 11702 | 2.00 | 2.60 | 3.20 | 60 | 75 | 100 |  | 1 |
| 1N702A | 2.30 | 2.60 | 2.90 | 60 | 75 | 100 | 1 | 1 |
| 1 17703 | 3.00 | 3.45 | 3.90 | 55 | 50 | 100 |  | 1 |
| 1W703A | 3.23 | 3.45 | 3.67 | 55 | 50 | 100 | 1 | 1 |
| 119704 | 3.70 | 4.10 | 4.50 | 45 | 5 | 100 |  | 1 |
| 197041 | 3.90 | 4.10 | 4.30 | 45 | 5 | 100 | 1 | 1 |
| 117705 | 4.30 | 4.85 | 5.40 | 35 | 5 | 100 |  | 1.5 |
| 1W705A | 4.58 | 4.85 | 5.12 | 35 | 5 | 100 | 1 | 1.5 |
| 111706 | 5.20 | 5.80 | 6.40 | 20 | 5 | 100 |  | 1.5 |
| 11706A | 5.50 | 5.80 | 6.10 | 20 | 5 | 100 | 1 | 1.5 |
| IH707 | 6.20 | 7.10 | 8.00 | 10 | 5 | 50 |  | 3.5 |
| 117007A | 6.65 | 7.10 | 7.55 | 10 | 5 | 50 | 1 | 3.5 |

## ${ }^{-1}$ Jadicafes JEDEC ragitoned data

## THERMAL INFORMATION

DISSIPATION DERATING CURVE


TYPES $1 N 708$ THRU 1N726, 1N708A THRU 1 N 72 SA SILICON VOLTAGE-REGULATOR DIODES

## Vz... 5.6 V to 33 V <br> PD ... 400 mW

- Available in 5\% and 10\% Tolerances
- Rugged Double-Plug Construction


## mechanical data

Double-plug construction affords integral positive contacts by means of a thermal compression bond. Moisture-free stability is ensured through hermetic sealing. The coefficients of thermal expansion of the glass case and the dumet plugs are closely matched to allow extreme temperature excursions. Hot-solder-dipped leads are standard.


## absolute maximum ratings



NOTE 1: For operation above $50^{\circ} \mathrm{C}$ free-air temperature refer to Dissipation Derating Curve, Figure 1.
${ }^{\dagger}$ This value is guaranteed by Texas Instruments in addition to the JEDEC registered value which is also shown.
*JEDEC registered date. This date sheet contains all applicable registered data in effect at the time of publication.

## TYPES 1 N708 THRU 1N726, 1W708A THRU 1N726A SILICON VOLTAGE-REGULATOR DIODES

*electrical characteristics at $\mathbf{2 5}{ }^{\circ} \mathrm{C}$ free-air temperature

| CHARACTERISTICS |  |  |  |  |  |  | TEST CURRENT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| PARAMETER | $v_{z}$ <br> Regulator Voltage |  |  |  |  | $z_{2}$ <br> Small-Signal Regulator Impedance |  |
| TEST CONDITIONS | $I_{R}=I_{Z}(T)$ |  |  |  |  | $\begin{gathered} I_{R}=I_{Z}(T), \\ I_{r}=10 \% I_{Z}(T) . \\ f=60 \mathrm{~Hz} \end{gathered}$ | Iz(T) |
| LIMIT | NOMINAL $\ddagger$ | 1N708-1N726 |  | 1N708A-1N726A |  | MAX |  |
| UNIT | V | V | V | V | V | $\Omega$ | mA |
| 1N708, A | 5.6 | 5.04 | 6.16 | 5.32 | 5.88 | 3.6 | 25 |
| 1N709, A | 6.2 | 5.58 | 6.82 | 5.89 | 6.51 | 4.1 | 25 |
| 1N710, A | 6.8 | 6.12 | 7.48 | 6.46 | 7.14 | 4.7 | 25 |
| 1N711, A | 7.5 | 6.75 | 8.25 | 7.13 | 7.87 | 5.3 | 25 |
| 1N712, A | 8.2 | 7.38 | 9.02 | 7.79 | 8.61 | 6 | 25 |
| 1N713, A | 9.1 | 8.19 | 10.01 | 8.65 | 9.55 | 7 | 12 |
| 1N714, A | 10 | 9.00 | 11.00 | 9.50 | 10.50 | 8 | 12 |
| 1N715, A | 11 | 9.90 | 12.10 | 10.45 | 11.55 | 9 | 12 |
| 1N716, A | 12 | 10.80 | 13.20 | 11.40 | 12.60 | 10 | 12 |
| 1N717, A | 13 | 11.70 | 14.30 | 12.35 | 13.65 | 11 | 12 |
| 1N718, A | 15 | 13.50 | 16.50 | 14.25 | 15.75 | 13 | 12 |
| 1N719, A | 16 | 14.40 | 17.60 | 15.20 | 16.80 | 15 | 12 |
| 1N720, A | 18 | 16.20 | 19.80 | 17.10 | 18.90 | 17 | 12 |
| 1N721, A | 20 | 18.00 | 22.00 | 19.00 | 21.00 | 20 | 4 |
| 1N722, A | 22 | 19.80 | 24.20 | 20.90 | 23.10 | 24 | 4 |
| 1N723, A | 24 | 21.60 | 26.40 | 22.80 | 25.20 | 28 | 4 |
| 1N724, A | 27 | 24.30 | 29.70 | 25.65 | 28.35 | 35 | 4 |
| 1N725, A | 30 | 27.00 | 33.00 | 28.50 | 31.50 | 42 | 4 |
| 1N726, A | 33 | 29.70 | 36.30 | 31.35 | 34.65 | 50 | 4 |

*JEDEC registered data
Tolerance is $\pm 10 \%$ for the 1 N708 through 1 N726 series, $\pm 5 \%$ for the $1 N 708 A$ through $1 N 726 A$ series.
THERMAL INFORMATION
dissipation derating curve


FIGURE 1

# $V_{Z} \ldots 3.3 \mathrm{~V}$ to $12 \mathrm{~V}, \mathrm{PD} \ldots 400 \mathrm{~mW}$ 

- Available in 5\% and 10\% Tolerances
- Rugged Double-Plug Construction


## description and mechanical data

These voltage regulator diodes have been designed using the best of both silicon material processing and packaging technologies. The silicon die is a planar oxide-passivated structure which has additional true-glass passivation over the junction. The double-plug package, proven by vears of volume production, ensures the best in mechanical integrity and the lowest possible junction temperature when compared to the thermal characteristics of whisker packages. Because of this rugged double-plug (heat-sink) package, these devices offer very conservatively rated power dissipation capabilities.

*absolute maximum ratings
Average Rectified Forward Current at (or below) $\mathbf{2 5}{ }^{\circ} \mathrm{C}$ Free-Air Temperature . . . . . . . . . . . . 230 mA
Average Rectified Forward Current at $150^{\circ} \mathrm{C}$ Free-Air Temperature . . . . . . . . . . . . . . . . 85 mA
Peak Reverse Surge Current . . . . . . . . . . . . . . . . . . . . . . . . . . . . . See Table 1
Peak Forward Surge Current . . . . . . . . . . . . . . . . . . . . . . . . . . . . . See Figure 1
Continuous Power Dissipation at (or below) $75^{\circ} \mathrm{C}$ Free-Air Temperature (See Figure 2) . . . . . . . . . 400 mW
Continuous Power Dissipation at $150^{\circ} \mathrm{C}$ Free-Air Temperature . . . . . . . . . . . . . . . . . . 100 mW
Operating Free-Air Temperature Range . . . . . . . . . . . . . . . . . . . . . . . $-65^{\circ} \mathrm{C}$ to $175^{\circ} \mathrm{C}$
Storage Temperature Range . . . . . . . . . . . . . . . . . . . . . . . . . . . $-65^{\circ} \mathrm{C}$ to $175^{\circ} \mathrm{C}$
TABLE 1-PEAK REVERSE SURGE CURRENT

| TYPE | IRSM <br> Nonrepetitive Reverse Surge Current |  |  |  | 'RRM <br> Repetitive Peak Reverse Current (Max Rep Rate $=1 \mathrm{kHz})$ |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | $\begin{aligned} t & =1 \mathrm{~s}, \\ \mathrm{~T}_{\mathrm{A}} & =25^{\circ} \mathrm{C} \end{aligned}$ | $\begin{aligned} & t=0.001 \mathrm{~s}, \\ & T_{A}=25^{\circ} \mathrm{C} \end{aligned}$ | $\begin{aligned} t & =1 \mathrm{~s} \\ T_{A} & =150^{\circ} \mathrm{C} \end{aligned}$ | $\begin{gathered} t=0.001 \mathrm{~s} \\ T_{A}=150^{\circ} \mathrm{C} \end{gathered}$ |  |  |
|  |  |  |  |  | $\mathrm{T}_{\mathrm{A}}=25^{\circ} \mathrm{C}$ | $T_{A}=150^{\circ} \mathrm{C}$ |
|  | mA | A | mA | mA | mA | mA |
| 1N746, A | 400 | 4.0 | 24 | 70 | 1000 | 250 |
| 1N747, A | 390 | 4.0 | 23 | 69 | 1000 | 250 |
| 1N748, A | 370 | 4.0 | 22 | 67 | 1000 | 250 |
| 1N749, A | 350 | 4.0 | 21 | 63 | 1000 | 250 |
| 1N750, A | 330 | 3.9 | 20 | 58 | 980 | 250 |
| 1N751, A | 310 | 3.7 | 19 | 53 | 960 | 250 |
| 1N752, A | 280 | 3.5 | 18 | 48 | 940 | 240 |
| 1N753, A | 250 | 3.2 | 17 | 45 | 910 | 230 |
| 1N754, A | 220 | 2.8 | 16 | 42 | 860 | 220 |
| 1N755, A | 190 | 2.5 | 15 | 39 | 800 | 200 |
| 1N756, A | 170 | 2.1 | 14 | 36 | 730 | 180 |
| 1N757, A | 150 | 1.8 | 13 | 33 | 650 | 150 |
| 1N758, A | 130 | 1.5 | 13 | 30 | 530 | 130 |
| 1N759, A | 120 | 1.3 | 12 | 28 | 400 | 100 |

[^182]
## TYPES 1N746 THRU 1N759, 1N746A THRU 1N759A SILICON VOLTAGE-REGULATOR DIODES

*electrical characteristics at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

| PARAMETER | $\mathbf{V}_{\mathbf{Z}}$Requalator Voltage |  |  |  |  | $a \mathrm{VZ}$ <br> Temperature Coefficient <br> of Regulator Voltage <br> $\mathrm{I}_{\mathbf{Z T}}=\mathbf{2 0} \mathrm{mA}$ | $\mathbf{z}_{\mathbf{z}}$ <br> Small-Signal <br> Regulator Impedance <br> $\mathbf{I Z T}_{\mathbf{Z T}}=\mathbf{2 0} \mathbf{~ m A}$, <br> $\mathbf{I}_{\mathbf{z t}}=1 \mathbf{~ m A}$ | $\mathbf{I}_{\mathbf{R}}$ <br> Static Reverse Current |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| TEST CONDITIONS | $\mathrm{I}_{\mathrm{ZT}}=20 \mathrm{~mA}$ |  |  |  |  |  |  | $V_{R}=1 \mathrm{~V}$ | $\begin{gathered} V_{R}=1 \mathrm{~V}, \\ T_{A}=150^{\circ} \mathrm{C} \end{gathered}$ |
| LIMIT | NOM | $\begin{aligned} & \text { 1N74 } \\ & \text { MIN } \end{aligned}$ | N759 MAX | 1N746A MIN | N759A <br> MAX | TYP | MAX | MAX | MAX |
| UNHT | V | V | V | V | V | \%/ ${ }^{\circ} \mathrm{C}$ | $\Omega$ | $\mu \mathrm{A}$ | $\mu \mathrm{A}$ |
| 1N746, A | 3.3 | 2.97 | 3.63 | 3.135 | 3.465 | -0.062 | 28 | 10 | 30 |
| 1N747, A | 3.6 | 3.24 | 3.96 | 3.420 | 3.780 | -0.055 | 24 | 10 | 30 |
| IN748, A | 3.9 | 3.51 | 4.29 | 3.705 | 4.095 | -0.049 | 23 | 10 | 30 |
| 1N749, A | 4.3 | 3.87 | 4.73 | 4.085 | 4.515 | -0.036 | 22 | 2 | 30 |
| 1N750, A | 4.7 | 4.23 | 5.17 | 4.465 | 4.935 | -0.018 | 19 | 2 | 30 |
| 1N751, A | 5.1 | 4.59 | 5.61 | 4.845 | 5.355 | -0.008 | 17 | 1 | 20 |
| 1N752, A | 5.6 | 5.04 | 6.16 | 5.320 | 5.880 | +0.006 | 11 | 1 | 20 |
| 1N753, A | 6.2 | 5.58 | 6.82 | 5.890 | 6.510 | +0.022 | 7 | 0.1 | 20 |
| 1N754, A | 6.8 | 6.12 | 7.48 | 6.460 | 7.140 | +0.035 | 5 | 0.1 | 20 |
| 1N755, A | 7.5 | 6.75 | 8.25 | 7.125 | 7.875 | +0.045 | 6 | 0.1 | 20 |
| 1N756, A | 8.2 | 7.38 | 9.02 | 7.790 | 8.610 | +0.052 | 8 | 0.1 | 20 |
| 1N757, A | 9.1 | 8.19 | 10.01 | 8.645 | 9.555 | +0.056 | 10 | 0.1 | 20 |
| 1N758, A | 10.0 | 9.00 | 11.00 | 9.500 | 10.500 | +0.060 | 17 | 0.1 | 20 |
| 1N759, A | 12.0 | 10.80 | 13.20 | 11.400 | 12.600 | +0.060 | 30 | 0.1 | 20 |

-JEDEC registered data
THERMAL INFORMATION

## MAXIMUM PEAK FORWARD NONREPETITIVE SURGE CURRENT <br> vs

PULSE WIDTH


FIGURE 1

DISSIPATION DERATING CURVE


## TYPES 1 N761 THRU $1 N 769$ <br> SILICON VOLTAGE-REGULATOR DIODES

## VZ... 4.85 V to 23.5 V

$$
\text { PD . . . } 400 \mathrm{~mW}
$$

- Tolerances Range from 9\% to 15\%
- Rugged Double-Plug Construction


## mechanical data

Double-plug construction affords integral positive contacts by means of a thermal compression bond. Moisture-free stability is ensured through hermetic sealing. The coefficients of thermal expansion of the glass case and the dumet plugs are closely matched to allow extreme temperature excursions. Hot-solder-dipped leads are standard.

absolute maximum ratings

| TYPE | $\mathrm{IZM}$ <br> Steady-State <br> Regulator Current $T_{A} \leqslant 25^{\circ} C$ |  | $\mathrm{I}_{\mathrm{ZM}}$ <br> Steady-State <br> Regulator Current $T_{A}=125^{\circ} \mathrm{C}$ |  | P <br> Dissipation $T_{A} \leqslant 25^{\circ} C$ <br> (See Note 1) | $\mathrm{T}_{\text {stg }}$ <br> Storage Temperature Range |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | II <br> Nominal ${ }^{\dagger}$ | JEDEC <br> Value* | TI Nominal ${ }^{\dagger}$ | JEDEC <br> Value* |  | TI <br> Value $\ddagger$ | JEDEC <br> Value* |  |
| 1N761 | 74 mA | 50 mA | 24 mA | 10 mA | $\begin{aligned} & 400 \mathrm{~mW} \ddagger \\ & 250 \mathrm{~mW} * \end{aligned}$ | $\begin{gathered} -65^{\circ} \mathrm{C} \\ \text { to } \\ 175^{\circ} \mathrm{C} \end{gathered}$ | $\begin{gathered} -65^{\circ} \mathrm{C} \\ \text { to } \\ 150^{\circ} \mathrm{C} \end{gathered}$ | $230^{\circ} \mathrm{C}$ |
| 1N762 | 62 mA | 40 mA | 20 mA | 8 mA |  |  |  |  |
| 1N763 | 50 mA | 30 mA | 16 mA | 6 mA |  |  |  |  |
| 1N764 | 40 mA | 25 mA | 13 mA | 5 mA |  |  |  |  |
| 1N765 | 33 mA | 20 mA | 11 mA | 4 mA |  |  |  |  |
| 1N766 | 27 mA | 17 mA | 9 mA | 3.5 mA |  |  |  |  |
| 1N767 | 22 mA | 14 mA | 7 mA | 3 mA |  |  |  |  |
| 1N768 | 19 mA | 12 mA | 6 mA | 2.5 mA |  |  |  |  |
| 1N769 | 15 mA | 10 mA | 5 mA | 2 mA |  |  |  |  |

NOTES: 1. For operation above $25^{\circ} \mathrm{C}$ free-air temperature, refer to Dissipation Derating Curve, Figure 1.
2. This value applies $1 / 8$ inch from the cose for 8 seconds.

- JEDEC registered data. This dsta sheet contains all applicable reglstered data in effect at the time of publication.

The nominal $I_{Z M}$ currents shown are applicable to devicas having regulator voltages at the upper limit of the range specified for each type.
These values do not represant absalute limits. The actual steady-state current-voltage product must not exceed the power rating shown in
Flgure 1.
¥This value is gutaranteed by Texas Instruments In addition to the JEDEC registered value which is also shown.
*electrical characteristics at $25^{\circ} \mathrm{C}$ free-air temperature

| CHARACTERISTICS |  |  |  |  | TEST CURRENT |
| :---: | :---: | :---: | :---: | :---: | :---: |
| PARAMETER | $V_{\mathbf{Z}}$ <br> Regulator Voltage |  |  | $Z_{z}$ <br> Small-Signal Regulator Impedance |  |
| TEST CONDITIONS |  | R $=1 \mathrm{I}_{\mathbf{L}}$ |  | $\begin{gathered} I_{R}=I_{Z(T)}, \\ I_{r}=10 \% I_{Z(T)}, \\ f=60 \mathrm{~Hz} \end{gathered}$ | ' $\mathrm{Z}(\mathrm{T}$ ) |
| LIMIT | MIN | NOM | MAX | MAX |  |
| UNIT | V | V | V | $\Omega$ | mA |
| 1N761 | 4.3 | 4.85 | 5.4 | 40 | 10 |
| 1N762 | 5.2 | 5.80 | 6.4 | 18 | 10 |
| 1N763 | 6.2 | 7.10 | 8.0 | 7 | 10 |
| 1N764 | 7.5 | 8.75 | 10.0 | 12 | 10 |
| 1N765 | 9.0 | 10.50 | 12.0 | 45 | 5 |
| 1N766 | 11.0 | 12.75 | 14.5 | 55 | 5 |
| 1N767 | 13.5 | 15.75 | 18.0 | 70 | 5 |
| 1N768 | 17.0 | 19.00 | 21.0 | 100 | 5 |
| 1N769 | 20.0 | 23.50 | 27.0 | 150 | 5 |

[^183]THERMAL CHARACTERISTICS


## TYPES 1N914, 1N914A, iN914B, iN915, 1N916, 1 N916A, $1 N 916 B, 1 N 917$ SILICON SWITCHING DIODES

BULLETIN NO. DL-S 7311954, MARCH 1973

## FAST SWITCHING DIODES

## - Rugged Double-Plug Construction <br> Electrical Equivalents <br> 1N914 . . . 1N4148 . . . 1N4531 <br> 1N914A... 1N4446 <br> 1N914B . . . 1 N4448 <br> 1N916 . . . 1N4149 <br> 1N916A . . . $1 N 4447$ <br> 1N916B . . . 1N4449

mechanical data
Double-plug construction affords integral positive contacts by means of a thermal compression bond. Moisture-free stability is ensured through hermetic sealing. The coefficients of thermal expansion of the glass case and the dumet plugs are closely matched to allow extreme temperature excursions. Hot-solder-dipped leads are standard.

absolute maximum ratings at specified free-air temperature

|  | 1N914 1N914A 1N914B | 1N915 | 1N916 1N916A 1N916B | 1N917 | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: |
| Working Peak Reverse Voltage from $-65^{\circ} \mathrm{C}$ to $150^{\circ} \mathrm{C}$ | 75* | 50* | 75* | 30* | V |
|  | 75* | 75* | 75* | 50* | mA |
| Average Rectified Forward Current (See Note 1) at $150^{\circ} \mathrm{C}$ | 10* | 10* | 10* | 10* |  |
| Peak Surge Current, 1 Second at $25^{\circ} \mathrm{C}$ (See Note 2) | 500* | 500 | 500* | 300 | mA |
| Continuous Power Dissipation at (or below) $25^{\circ} \mathrm{C}$ (See Note 3) | 250* | 250 | 250* | 250 | mW |
| Operating Free-Air Temperature Range | -65 to 175 |  |  |  | C |
| Storage Temperature Range | -65 to 200* |  |  |  | C |
| Lead Temperature 1/16 Inch from Case for 10 Seconds | 300 |  |  |  | C |

NOTES: 1. Thase values may be applied continuously under a single-phase $60-\mathrm{Hz}$ half-sine-wave operation with resistive load.
2. These values apply for a one-second square-wave pulse with the devices at nonoperating thermal equilibrium immediatelv prior to the surge.
3. Derete linearly to $175^{\circ} \mathrm{C}$ free-air temperature at the rate of $1.67 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$.

[^184] SILICON SWITCHING DIODES

## 1N914 SERIES AND 1N915

*electrical characteristics at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)


## 1N916 SERIES AND 1N917

"electrical characteristics at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)


NOTE 4: These parameters must be measured using pulse techniques. $\mathbf{t}_{\mathbf{w}}=\mathbf{3 0 0} \mu \mathrm{s}$, duty cycle $<\mathbf{2 \%}$.

## operating characteristics at $25^{\circ} \mathrm{C}$ free-air temperature

| PARAMETER |  | TEST CONDITIONS |  |  | 1N914 <br> 1N914A <br> 1N914B <br> tN916 <br> 1N916A <br> 1N916B |  | 1N915 |  | 1N917 |  | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | MIN | MAX | MIN | MAX | MIN | MAX |  |
| $t_{\text {rr }}$ | Reverse Recovery Time |  |  |  | $\begin{aligned} & I_{F}=10 \mathrm{~mA}, \\ & R_{L}=100 \Omega, \end{aligned}$ | $I_{R M}=10 \mathrm{~mA}$ <br> See Figure 1 | $i_{r r}=1 \mathrm{~mA},$ <br> ondition 11 |  | 8 |  | 10* |  | 3* | ns |
|  |  | $\begin{aligned} & I_{F}=10 \mathrm{~mA}, \\ & R_{L}=100 \Omega, \end{aligned}$ | $V_{R}=6 \mathrm{~V},$ <br> See Figure 1 | $i_{r r}=1 \mathrm{~mA},$ <br> ondition 2) |  | 4* |  |  |  |  | ns |
| $V_{\text {FM }}$ (rec) | Forward Recovery Voltage | $\mathrm{I}_{\mathrm{F}}=50 \mathrm{~mA}$, | $\mathrm{R}_{\mathrm{L}}=50 \Omega$, | See Figure 2 | 2.5* |  |  |  |  |  | V |
| $\eta_{r}$ | Rectification Efficiency | $\begin{aligned} & V_{r}=2 V, \\ & Z_{\text {source }}=50 \end{aligned}$ | $\begin{aligned} & R_{L}=5 \mathrm{k} \Omega, \\ & f=100 \mathrm{MHz} \end{aligned}$ | $\mathrm{C}_{\mathrm{L}}=20 \mathrm{pF}$ | 45* |  |  |  |  |  | \% |

PARAMETER MEASUREMENT INFORMATION

figure 1 - reverse recovery time

b. Oulput woveforms ore menitered on on oscillescope with the following charecteristics: $\mathrm{I}_{\mathrm{r}} \leq 0.6 \mathrm{~ms}, \mathrm{I}_{\mathrm{in}}=50 \Omega$.


FIGURE 2 - FORWARD RECOVERY VOLTAGE
MOTES: c . The input pulse is supplied by a generator with the following characteristics: $z_{\text {out }}=50 \Omega, \mathrm{t}_{\mathrm{r}} \leq 30 \mathrm{~ns}, \mathrm{t}_{\mathrm{w}}=100 \mathrm{~ms}$, PRR $=5$ to 100 kHz .
d. The output waveform is monilered on on oscilloscope with the following characteristics: $\mathrm{t}_{\mathrm{r}} \leq 15 \mathrm{~ns}, \mathrm{R}_{\mathrm{in}} \geq 1 \mathrm{~m} \mathrm{\Omega}, \mathrm{c}_{\mathrm{in}} \leq \mathbf{s} \mathbf{p f}$.

* JEDES ragistored data


## TYPES 1N957 THRU 1N973, 1N957A THRU 1N973A, 1N957B THRU 1N973B SILICON VOLTAGE-REGULATOR DIODES

$V_{Z} \ldots 6.8 \mathrm{~V}$ to 33 V
$\mathrm{PD}_{\mathrm{D}} \ldots 400 \mathrm{~mW}$

- Available in 5\%, 10\% and 20\% Tolerances
- Rugged Double-Plug Construction


## description and mechanical data

These voltage regulator diodes have been designed using the best of both silicon material processing and packaging technologies. The silicon die is a planar oxide-passivated structure which has additional true-glass passivation over the junction. The double-plug package, proven by years of volume production, ensures the best in mechanical integrity and the lowest possible junction temperature when compared to the thermal characteristics of whisker packages. Because of this rugged double-plug (heat-sink) package, these devices offer very conservatively rated power dissipation capabilities.

absolute maximum ratings at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

| TYPE | ${ }^{*}$ IZM <br> Steady-State <br> Regulator Current (See Note 1) | ${ }^{*}$ IRSM <br> Nonrepetitive Reverse Surge Current (See Note 2) | *PD Continuous Power Dissipation $\left(\mathrm{T}_{\mathrm{A}} \leqslant \mathbf{2 5}{ }^{\circ} \mathrm{C}\right.$, See Note 3) | $\mathrm{T}_{\text {stg }}$ Storage Temperature Range |
| :---: | :---: | :---: | :---: | :---: |
|  | mA | mA | mW | ${ }^{\circ} \mathrm{C}$ |
| 1N957, A, B | 55 | 300 | 4 | 4 |
| 1N958, A, B | 50 | 275 |  |  |
| 1N959, $A, B$ | 45 | 250 |  |  |
| 1N960, A, B | 41 | 225 |  |  |
| 1N961, A, B | 38 | 200 |  |  |
| 1N962, A, B | 32 | 175 |  |  |
| 1N963, A, B | 31 | 160 |  |  |
| 1 N964, A, B | 28 | 150 | 1 |  |
| 1N965, A, B | 25 | 130 | 400 | -65 to 175 |
| 1N966, A, B | 24 | 120 |  |  |
| 1N967, A, B | 20 | 110 |  |  |
| 1N968, A, B | 18 | 100 |  |  |
| 1N969, A, B | 16 | 90 |  |  |
| 1N970, A, B | 15 | 80 |  |  |
| 1N971, A, B | 13 | 70 |  |  |
| 1N972, A, B | 12 | 65 | , |  |
| 1N973, A, 8 | 11 | 60 | $\downarrow$ | $\dagger$ |

NOTES: 1. The nominal $I_{Z M}$ currents shown are applicable for devices having regulator voltages approximately $10 \%$ above the nominal $V_{Z}$ values shown under electrical characteristics. These values do not represent absolute limits. The actual steady-state current-voltage product must not exceed the power rating in Figure 1.
2. These values apply for an $8.3-\mathrm{ms}$ square-wave pulse with the device at nonoperating thermal equilibrium immediately prior to the surge.
3. Derate linearly to $175^{\circ} \mathrm{C}$ free-air temperature at the rate of $2.67 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$. See Dissipation Derating Curve, Figure 1 .

TYPES 1N957 THRU 1N973. 1N957A THRU 1N973A, 1N957B THRU 1N973B SILICON VOLTAGE-REGULATOR DIODES
electrical characteristics at $25^{\circ} \mathrm{C}$ free-air temperature

| CHARACTERISTICS |  |  |  |  |  |  |  | TEST CURRENT and voltage |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| PARAMETER | ${ }^{*} V_{z}$ <br> Regulator Voltage | ${ }^{*} \Delta \mathbf{V}_{\mathbf{Z}}\left(\Delta \mathbf{I}_{\mathbf{R}}\right)$ <br> Voltaga Regulation | ${ }^{*} z_{z}$ <br> Small-Signal <br> Regulator <br> Impedance | ${ }^{*} \mathbf{z}_{\text {zk }}$ <br> Small-Signal <br> Regulator Knee Impedance | $\mathbf{I R}_{\mathbf{R}^{\ddagger}}$ Static <br> Reverse Current | ${ }^{*} V_{F}$ <br> Static <br> Forward Voltage |  |  |  |  |
|  |  | $\begin{gathered} I_{R(1)}=10 \% \\ \text { rated } I_{R} . \end{gathered}$ | $I_{R}=I_{Z}(T)$. | $I_{R}=1 \mathbf{z K}$, |  |  |  |  | $\mathbf{V}_{\mathbf{R}(1)}$ |  |
| CONDITIONS |  | rated $I_{R}$. $t=90 \mathrm{~s}$ | $f=60 \mathrm{~Hz}$ | $f=60 \mathrm{~Hz}$ | V | $I_{F}$ | IZ(T) | IzK | 1N957A thru | 1N957B <br> thru |
| LIMIT | NOM ${ }^{+}$ | MAX | MAX | MAX | MAX | MAX |  |  | 1N973A | 1N973B |
| UNIT | V | V | $\Omega$ | $\Omega$ | $\mu \mathbf{A}$ | V | mA | mA | V | V |
| 1N957, A, B | 6.8 | 0.25 | 4.5 | 700 | 150 | 1.5 | 18.5 | 1.0 | 4.9 | 5.2 |
| 1N958, A, B | 7.5 | 0.30 | 5.5 | 700 | 75 | 1.5 | 16.5 | 0.5 | 5.4 | 5.7 |
| 1 N959, A, B | 8.2 | 0.35 | 6.5 | 700 | 50 | 1.5 | 15.0 | 0.5 | 5.9 | 6.2 |
| 1N960, A, B | 9.1 | 0.40 | 7.5 | 700 | 25 | 1.5 | 14.0 | 0.5 | 6.6 | 6.9 |
| 1N961, A, B | 10 | 0.45 | 8.5 | 700 | 10 | 1.5 | 12.5 | 0.25 | 7.2 | 7.6 |
| 1N962, A, B | 11 | 0.50 | 9.5 | 700 | 5 | 1.5 | 11.5 | 0.25 | 8.0 | 8.4 |
| 1N963, A, B | 12 | 0.55 | 11.5 | 700 | 5 | 1.5 | 10.5 | 0.25 | 8.6 | 9.1 |
| 1 N964, A, B | 13 | 0.60 | 13 | 700 | 5 | 1.5 | 9.5 | 0.25 | 9.4 | 9.9 |
| 1N965, A, B | 15 | 0.70 | 16 | 700 | 5 | 1.5 | 8.5 | 0.25 | 10.8 | 11.4 |
| 1 N966, A, B | 16 | 0.75 | 17 | 700 | 5 | 1.5 | 7.8 | 0.25 | 11.5 | 12.2 |
| 1N967, A, B | 18 | 0.85 | 21 | 750 | 5 | 1.5 | 7.0 | 0.25 | 13.0 | 13.7 |
| 1 N968, A, B | 20 | 0.95 | 25 | 750 | 5 | 1.5 | 6.2 | 0.25 | 14.4 | 15.2 |
| 1N969, A, B | 22 | 1.05 | 29 | 750 | 5 | 1.5 | 5.6 | 0.25 | 15.8 | 16.7 |
| 1N970, A, 8 | 24 | 1.15 | 33 | 750 | 5 | 1.5 | 5.2 | 0.25 | 17.3 | 18.2 |
| 1N971, A, B | 27 | 1.30 | 41 | 750 | 5 | 1.5 | 4.6 | 0.25 | 19.4 | 20.6 |
| 1N972, A, B | 30 | 1.45 | 49 | 1000 | 5 | 1.5 | 4.2 | 0.25 | 21.6 | 22.8 |
| 1N973, A, B | 33 | 1.60 | 58 | 1000 | 5 | 1.5 | 3.8 | 0.25 | 23.8 | 25.1 |

${ }^{\dagger} V_{Z}$ tolerance is $\pm \mathbf{2 0 \%}$ for 1 N957 thru 1 N973, $\pm 10 \%$ for 1 N957A thru 1 N973A, and $\pm 5 \%$ for 1 N957B thru 1 N973B.
$\ddagger$ These limits apply for $A$ and $B$ suffix types only. There is no reverse current specification for 1N957 through 1 N973.
*JEDEC registered data


# TYPES IN2069, 1N2070, 1N2071, 1N2069A, 1N2070A, 1N2071A <br> SILICON RECTIFIERS 

BULLETIN NO. DL-S 7211697 , NOVEMBER 1972

## 200-600 VOLTS • 750 mA AVERAGE

- Rugged Double-Plug Construction
- Hermetic Case
- Small Size
description and mechanical data
These rectifier diodes are the product of combining the best of both silicon material processing and packaging technologies. The silicon die is a mesa oxide-passivated structure which has additional nitride passivation and glass passivation over the junction. Years of volume production have shown the double-plug package to have the highest inherent mechanical integrity of all hermetic-case diodes.

*absolute maximum ratings at specified ambient ${ }^{\dagger}$ temperature (unless otherwise noted)

|  | 1N2069 | 1N2070 | 1N2071 | 1N2069A | IN2070A | 1N2071A | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|   <br> $V_{\text {RM }}$ Peak Reverse Voitage <br> at (or below) $100^{\circ} \mathrm{C}$ (See Note 1)  | 200 | 400 | 600 | 200 | 400 | 600 | V |
| $V_{R} \quad$ Steady State Reverse Voltage at (or below) $100^{\circ} \mathrm{C}$ | 200 | 400 | 600 | 200 | 400 | 600 | V |
| $10 \quad$Average Rectified Forward Current <br> at (or below) $25^{\circ} \mathrm{C}$ (See Notes 1 and 2) | 750 |  |  |  |  |  | mA |
| IOAverage Rectified Forward Current <br> at $100^{\circ} \mathrm{C}$ (See Notes 1 and 2) | 500 |  |  |  |  |  | mA |
| IFRM Repetitive Peak Forward Current, 10 Cycles, <br> at (or below) $25^{\circ} \mathrm{C}$ (See Notes 3 and 4 )  | 6 |  |  |  |  |  | A |
| IFSM Peak Surge Current, One Cycle, <br> at (or below) $100^{\circ} \mathrm{C}$ (See Note 3)  | 22 |  |  |  |  |  | A |
| TA(opr) Operating Ambient Temperature Range | -30 to 100 |  |  | -35 to 100 |  |  | ${ }^{\circ} \mathrm{C}$ |
| $\mathrm{T}_{\text {stg }}$ Storage Temperature Range | -30 to 100 |  |  |  | -35 to 100 |  | ${ }^{\circ}$ |
| Lead Temperature 1/2 Inch from Case for 5 Seconds | 240 |  |  |  |  |  | C |

NOTES: 1. These values may be applied continuously under single-phase, 60-Hz, hatt-sine-wave oparation with resistive load. Above $25^{\circ} \mathrm{C}$ derate $l_{0}$ according to Figure 1.
2. This rectifier is a lead-conduction-cooled device. At (or above) ambient temparatures of $25^{\circ} \mathrm{C}$, the lead tempereture $\mathbf{3 / 8}$ inch from case must be no higher than $5^{\circ} \mathrm{C}$ above the ambient temparsture for these ratinge to apply.
3. These values apply for $60-\mathrm{Hz}$ half sine waves when the device is operating at (or below) rated values of peak reverse voitage and everage rectified forward current. Surge may be repested after the device has returned to ortginal thermal equilibrium.
4. Derate linearly to 4 A at $100^{\circ} \mathrm{C}$.

- JEDEC repistered dats. This dats shest contains sll spplicsble registered dete in effect et the time of publication.
t The ambiant temperature is measured the point 2 inches below the device. Natural air cooling is uted.


## TYPES 1N2069, 1N2070, 1N2071, 1N2069A, 1N2070A, 1N2071A SILICON RECTIFIERS

${ }^{*}$ electrical characteristics at specified ambient ${ }^{\dagger}$ temperature

| PARAMETER |  | TEST CONDITIONS | $\begin{aligned} & \text { 1N2069 } \\ & \text { 1N2070 } \\ & \text { 1N2071 } \end{aligned}$ | $\begin{array}{\|l\|} \hline \text { 1N2069A } \\ \text { 1N2070A } \\ \text { 1N2071A } \\ \hline \end{array}$ | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | MAX | MAX |  |
| ${ }_{1}{ }^{1}$ | Static Reverse Current |  | $\mathrm{V}_{\mathrm{R}}=$ Rated $\mathrm{V}_{\mathrm{R}}, \quad \mathrm{T}_{\mathrm{A}}=25^{\circ} \mathrm{C}$ | 10 | 5 | $\mu \mathrm{A}$ |
| $I_{\text {R (av) }}$ | Average Reverse Current | $\begin{array}{ll} \hline V_{R M}=\text { Rated } V_{R M}, & T_{O}=500 \mathrm{~mA}, \\ f=60 \mathrm{~Hz}, & T_{A}=100^{\circ} \mathrm{C} \\ \hline \end{array}$ | 200 | 50 | $\mu \mathrm{A}$ |
| $V_{F}$ | Static Forward Voltage | $\mathrm{I}_{\mathrm{F}}=500 \mathrm{~mA}, \quad \mathrm{~T}_{\text {A }}=25^{\circ} \mathrm{C}$ | 1.2 | 1 | $V$ |
| $V_{\text {F (av) }}$ | Average Forward Voltage | $\begin{array}{ll} \hline V_{R M}=\text { Rated } V_{R M}, & I_{O}=500 \mathrm{~mA}, \\ f=60 \mathrm{~Hz} . & T_{A}=100^{\circ} \mathrm{C} \\ \hline \end{array}$ | 0.6 | 0.5 | V |

## *JEDEC registered data

## THERMAL INFORMATION



FIGURE 1


NOTE 2: This rectifitr is a lead-conduction-cooled device. At (or above) armbient temperatures of $25^{\circ} \mathrm{C}$, the lead temperature $3 / 8$ inch from case must be no higher than $5^{\circ} \mathrm{C}$ above the ambient temperature for these ratings to apply.
The ambient temperature is measured at a point 2 inchea below the device. Natural air cooling is used.

# TYPE 1N3064 <br> SILICON SWITCHING DIODE 

BULLETIN NO. DL-S 739114, SEPTEMBER 1966-REVISED MARCH 1973

## FAST SWITCHING DIODE

- Rugged Double-Plug Construction
- Electrically Equivalent to 1N4454 (DO-35) and 1N4532 (DO-34)
mechanical data
Double-plug construction affords integral positive contact by means of a thermal compression bond. Moisture-free stability is ensured through hermetic sealing. The coefficients of thermal expansion of the glass case and the dumet plugs are closely matched to allow extreme temperature excursions. Hot-solder-dipped leads are standard.

absolute maximum ratings at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

| M | Peak Reverse Voltage . . $\cdot \dot{0}$ (or below) $25^{\circ}{ }^{\circ} \mathrm{C}$ Free-Air Temperature (See Note 1). . 115 mA |
| :---: | :---: |
|  | Peak Surge Current, One Second (See Note 2) . . . . . . . . . . . . . . 500 mA |
|  | Peak Surge Current, One Microsecond (See Note 2) . . . . . . . . . . . . 2 A |
|  | Continuous Power Dissipation at (or below) $25^{\circ} \mathrm{C}$ Free-Air Temperature (See Note 3). 250 mW |
| * ${ }^{\text {r }}$ | Storage Temperature Range . . . . . . . . . . . . . . . . $-65^{\circ} \mathrm{C}$ to $200^{\circ} \mathrm{C}$ |
|  | Lead Temperature $\mathrm{K}_{6}$ Inch from Case for 2 Seconds . . . . . . . . . . . . $250^{\circ} \mathrm{C}$ |

*electrical characteristics at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

|  | PARAMETER | TEST CONDITIONS | MIN MAX | UNIT |
| :---: | :---: | :---: | :---: | :---: |
| $V_{\text {(30) }}$ | Reverse Breakdown Voltage | $\mathrm{I}_{\mathrm{R}}=5 \mu \mathrm{~A}$ | 75 | V |
| $\mathrm{I}_{\mathrm{R}}$ | Static Reverse Current | $\mathrm{V}_{\mathrm{R}}=50 \mathrm{~V}$ | 0.1 | $\mu \mathrm{A}$ |
|  |  | $\mathrm{V}_{\mathrm{R}}=50 \mathrm{~V}, \mathrm{~T}_{\mathrm{A}}=150^{\circ} \mathrm{C}$ | 100 | $\mu \mathrm{A}$ |
|  | Static Forward Voltage | $\mathrm{I}_{\mathrm{F}}=10 \mathrm{~mA}$ | 1 | V |
| $\alpha_{\text {VF }}$ | Temperature Coefficient of Static Forward Voltage | $\mathrm{I}_{\mathrm{F}}=10 \mathrm{~mA}$, See Note 4 | 3 | $\mathrm{mV} /{ }^{\circ} \mathrm{C}$ |
| $C_{T}$ | Total Capacitance | $\mathrm{V}_{\mathrm{R}}=0, \quad \mathrm{f}=1 \mathrm{MHz}$ | 2 | pF |

*operating characteristics at $25^{\circ} \mathrm{C}$ free-air temperature

| PARAMETER | TEST CONDITIONS | MIN MAX | UNIT |
| :---: | :---: | :---: | :---: |
| $\dagger_{\text {rr }} \quad$ Reverse Recovery Time | $\begin{array}{ll} l_{F}=10 \mathrm{~mA}, & I_{R M}=10 \mathrm{~mA}, R_{L}=100 \Omega, \\ C_{G}=10 \mathrm{pF}, & i_{r r}=1 \mathrm{~mA}, \quad \text { See Figure } 1 \end{array}$ | 4 | ns |
| $\mathrm{V}_{\text {FMYract }}$ Forward Recovery Voltage | $\mathrm{I}_{\mathrm{F}}=100 \mathrm{~mA}, \quad \mathrm{R}_{\mathrm{L}}=50 \Omega, \quad$ See Figure 2 | 3 | V |
| $\eta_{\mathrm{r}} \quad$ Rectification Efficiency | $\begin{aligned} & V_{r}=2 \mathrm{~V}, \quad R_{1}=5 \mathrm{k} \Omega_{r} C_{L}=20 \mathrm{pF}, \\ & Z_{\text {source }}=50 \Omega, f=100 \mathrm{MHz} \end{aligned}$ | $45 \%$ |  |

MOTES: 1. These values may be applied continuously under single-phose $60-\mathrm{Hz}$ halt-sine-wave operation with resistive load. Derate linearly to 0 at $150^{\circ} \mathrm{C}$ free-air temperature.
2. These volues apply for the specifiad square-wave pulse with the device at nonoparating themual equilibrium immediately prior to the surge.
3. Derate linearly at the rale of $1.5 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$.
4. Temperature coefficient, $\alpha_{\text {VF }}$, is detarminad by the following formula:

$$
\alpha \mathrm{VF}=\frac{v_{F} @ 150^{\circ} \mathrm{C}-\mathbf{v}_{\mathrm{F}} @-55^{\circ} \mathrm{C}}{150^{\circ} \mathrm{C}-\left(-55^{\circ} \mathrm{C}\right)}
$$

[^185]
# TYPE 1N3064 SILICON SWITCHING DIODE 

## PARAMETER MEASUREMENT INFORMATION



FIGURE I - REVERSE RECOVERY TIME
MOTES: a. The input pulse is supplied by a generater with the following characteristics: $z_{\text {out }}=50 \Omega, \mathrm{i}_{\mathrm{r}} \leq 0.25 \mathrm{~ns}, \mathrm{t}_{\mathrm{p}}=100 \mathrm{~ns}$.
b. Output woveterm is menitored on an ascilloscope with the following cheracteristics: $\boldsymbol{t}_{\mathrm{r}} \leq \mathbf{0 . 3 5} \mathrm{ms}, \mathbf{z}_{\mathrm{in}}=50 \Omega$.


FIGURE 2 - FORWARD RECOVERY VOLTAGE
NOTES: c. The input pulse is supplied by a generator with the following characteristics: $z_{\text {out }}=50 \Omega, \mathrm{t}_{\mathrm{r}} \leq 20 \mathrm{~ns}, \mathrm{t}_{\mathrm{p}}=100 \mathrm{~ns}, \mathrm{PRR} \leq 100 \mathrm{kHz}$.
d. Output woveform is monitored on an ossilloseope with the following charocteristics: $\mathrm{t}_{\mathrm{r}} \leq 0.4 \mathrm{~ns}, \mathbf{R}_{\mathrm{in}} \geq 1 \mathrm{M} \Omega, \mathrm{C}_{\mathrm{in}} \leq \mathbf{5 p}$.

## TYPE 1 N3070 <br> SILICON SWITCHING DIODE

BULLETIN NO. DL-S 739370, NOVEMBER 1966-REVISED MARCH 1973

## HIGH-VOLTAGE SWITCHING DIODE

- Rugged Double-Plug Construction
- Electrically Equivalent to 1N4938 (DO-35)


## *mechanical data

Double-plug construction affords integral positive contact by means of a thermal compression bond. Moisture-free stability is ensured through hermetic sealing. The coefficients of thermal expansion of the glass case and the dumet plugs are closely matched to allow extreme temperature excursions. Hot-solder-dipped leads are standard.

absolute maximum ratings at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

*electrical characteristics at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

| PARAMETER |  | TEST CONDITIONS | MIN MAX | UNIT |
| :---: | :---: | :---: | :---: | :---: |
| $V_{\text {(ax) }}$ | Reverse Breakdown Voltage | $\mathrm{I}_{\mathrm{R}}=0.1 \mathrm{~mA}$ | 200 | V |
| $\mathrm{I}_{\mathrm{R}}$ | Static Reverse Current | $\mathrm{V}_{\mathrm{R}}=175 \mathrm{~V}$ | 0.1 | $\mu \mathrm{A}$ |
|  |  | $\mathrm{V}_{\mathrm{R}}=175 \mathrm{~V}, \mathrm{~T}_{\mathrm{A}}=150^{\circ} \mathrm{C}$ | 100 | $\mu \mathrm{A}$ |
| $V_{F}$ | Static Forward Voltage | $\mathrm{I}_{F}=100 \mathrm{~mA}$ | 1 | $V$ |
| $\alpha_{\text {VF }}$ | Temperature Coefficient of Static Forward Voltage | $\mathrm{I}_{\mathrm{F}}=100 \mathrm{~mA}$, See Note 4 | 3 | $\mathrm{mV} /{ }^{\circ} \mathrm{C}$ |
| $\mathrm{C}_{\mathrm{F}}$ | Total Capacitance | $\mathrm{V}_{\mathrm{R}}=0, \quad \mathrm{f}=1 \mathrm{mHz}$ | 5 | pF |

*operating characteristics at $25^{\circ} \mathrm{C}$ free-air temperature

| PARAMETER |  | TEST CONDITIONS |  |  | MIN | MAX | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| $t_{\text {rr }}$ | Reverse Recovery Time | $\begin{aligned} & I_{\mathrm{F}}=30 \mathrm{~mA}, \\ & \mathrm{C}_{\mathrm{L}}=10 \mathrm{pF}, \end{aligned}$ | $\begin{aligned} & I_{\mathrm{RM}}=30 \mathrm{~mA}, \\ & \mathrm{i}_{\mathrm{rr}}=1 \mathrm{~mA}, \end{aligned}$ | $R_{L}=100 \Omega,$ <br> See Figure 2 |  | 50 | ns |
| $\eta_{r}$ | Rectification Efficiency | $\begin{aligned} & V_{r}=2 V \\ & z_{\text {source }}=50 \end{aligned}$ | $\begin{aligned} & R_{L}=5 \mathrm{k} \Omega, \\ & \mathrm{i}=100 \mathrm{MHz} \end{aligned}$ | $\mathrm{C}_{\mathrm{L}}=20 \mathrm{pF},$ | 35 \% |  |  |

HOTES: 1. Thase values may be applied cantinuously under single-phasa $60-\mathrm{Hz}$ holf-siae-wave operation with resistive load. Derate linearly to 0 at $200^{\circ} \mathrm{C}$ free-air temperature. 2. Thase valuas apply for the specified square-wave pulse with the device at nonoperating thermal equilibrium immeoiately prior to the surge.
3. For operation obove $25^{\circ} \mathrm{C}$ frat-air temperaturs, refer to Dissipation Derating Curve, figure 1.
4. Temperature coefficient, $\alpha_{\mathbf{Y F}_{F}}$ is determined by the following formula:

$$
\alpha_{\mathrm{VF}}=\frac{v_{F} @ 150^{\circ} \mathrm{C}-v_{F} @-55^{\circ} \mathrm{C}}{150^{\circ} \mathrm{C}-\left(-55^{\circ} \mathrm{C}\right)}
$$

* JEDEC ragistared data


## THERMAL CHARACTERISTICS


figure 1

## PARAMETER MEASUREMENT INFORMATION


figure 2 - reverse recovery time
MOTES: a. The input pulse is suppliod by a generater with the following charexieristics: $\mathbf{l}_{\text {out }}=50 \Omega, \mathrm{t}_{\mathrm{r}} \leq \mathbf{0 . 2 5} \mathrm{ns}, \mathrm{t}_{\mathrm{p}}=100 \mathrm{~ns}$.
b. The output wovaform is monitored on an oscilloscope with the following charecteristics: $\mathrm{t}_{\mathrm{r}} \leq 0.35 \mathrm{~ns}, \mathrm{l}_{\mathrm{in}}=50 \Omega$.

# TYPES 1N3506 THRU 1N3530 SILICON VOLTAGE-REGULATOR DIODES 

VZ...3.3V to 33 V , PD... 400 mW

- 5\% Tolerance
- Rugged Double-Plug Construction
mechanical data
These voltage regulator diodes have been designed using the best of both silicon material processing and packaging technologies. The silicon die is a planar oxide-passivated structure which has additional true-glass passivation over the junction. The double-plug package, proven by years of volume production, ensures the best in mechanical integrity and the lowest possible junction temperature when compared to the thermal characteristics of whisker packages. Because of this rugged double-plug (heat-sink) package, these devices offer very conservatively rated power dissipation capabilities.

*absolute maximum ratings

| TYPE | IZM Steady-State Regulator Current $\left(\mathrm{T}_{\mathrm{A}} \leqslant 50^{\circ} \mathrm{C}\right.$, See Note 1) | IRSM Nonrepetitive Reverse Surge Current ( $\mathbf{T}_{\mathbf{A}} \leqslant \mathbf{2 5}^{\circ} \mathbf{C}$, See Note 2) | PD <br> Continuous <br> Power Dissipation $\left(\mathrm{T}_{\mathrm{A}} \leqslant 50^{\circ} \mathrm{C}\right. \text {, See Note 3) }$ | $\mathbf{T}_{\text {stg }}$ Storage Temparature Range |
| :---: | :---: | :---: | :---: | :---: |
|  | mA | mA | mW | C |
| 1N3506 | 120 | 1000 | 4 | 4 |
| 1N3507 | 110 | 1000 |  |  |
| 1 N3508 | 100 | 1000 |  |  |
| 1N3509 | 90 | 990 |  |  |
| 1 N3510 | 85 | 980 |  |  |
| 1 N3511 | 75 | 960 |  |  |
| 1 N3512 | 70 | 950 |  |  |
| 1N3513 | 65 | 910 |  |  |
| 1N3514 | 60 | 870 |  |  |
| 1N3515 | 50 | 810 |  |  |
| 1N3516 | 45 | 740 |  |  |
| 1 N3517 | 40 | 650 |  |  |
| 1N3518 | 38 | 540 | 400 | -65 to 200 |
| 1N3519 | 35 | 450 |  |  |
| 1 N3520 | 32 | 400 |  |  |
| 1N3521 | 30 | 350 |  |  |
| 1N3522 | 26 | 250 |  |  |
| 1N3523 | 24 | 200 |  |  |
| 1N3524 | 21 | 175 |  |  |
| 1 N3525 | 19 | 150 |  |  |
| 1N3526 | 17 | 130 |  |  |
| 1 N3527 | 16 | 115 |  |  |
| 1 N3528 | 14 | 110 |  |  |
| 1N3529 | 13 | 100 |  |  |
| 1N3530 | 12 | 95 | - | $\checkmark$ |

NOTES: 1. The $I_{Z M}$ currents shown are nominal and do not represent absolute limits. The actual steady-state current-voltage product must not exceed the power rating in Figure 1.
2. These values apply for 10 square-wave surges of 8.3 ms duration at one-minute intervals.
3. Derate linearly to $200^{\circ} \mathrm{C}$ free-air temperature at the rate of $2.67 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$. See Dissipation Derating Curve, Figure 1 .
*JEDEC registered data. This data sheet contains all applicable registered date in effact at the time of publication.

## TYPES 1N3506 THRU 1N3530 SILICON VOLTAGE-REGULATOR DIODES

*electrical characteristics at $25^{\circ} \mathrm{C}$ free-air temperature

| CHARACTERISTICS |  |  |  |  |  | TEST CURRENT and Vol.tage |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| PARAMETER | $V_{\mathbf{Z}}$ <br> Regulator Voltage |  |  | $z_{z}$ <br> Small-Signal Regulator Impedance |  |  |  |
| TEST CONDITIONS | $I_{R}=I_{Z}(T)$ |  |  | $\begin{gathered} I_{R}=I_{Z}(T) \\ I_{r}=10 \% I_{Z}(T) \end{gathered}$ | $\mathbf{V}_{\mathbf{R}}=\mathbf{V}_{\mathbf{R}(\mathrm{T})}$ | $\mathrm{I} \mathbf{Z}(\mathrm{T})$ | $\mathbf{V}_{\mathbf{R}}(\mathrm{T})$ |
| LIMIT | NOM ${ }^{\text { }}$ | MIN | MAX | MAX | MAX |  |  |
| UNIT | V | V | V | $\Omega$ | $\mu \mathrm{A}$ | mA | V |
| 1N3506 | 3.3 | 3.14 | 3.46 | 24 | 4 | 20 | 1 |
| 1 N3507 | 3.6 | 3.42 | 3.78 | 22 | 2 | 20 | 1 |
| 1 N3508 | 3.9 | 3.71 | 4.09 | 20 | 0.4 | 20 | 1 |
| 1N3509 | 4.3 | 4.09 | 4.51 | 18 | 0.1 | 20 | 1 |
| 1 N3510 | 4.7 | 4.47 | 4.93 | 16 | 5 | 20 | 2 |
| 1N3511 | 5.1 | 4.85 | 5.35 | 14 | 2 | 20 | 2 |
| 1 N3512 | 5.6 | 5.32 | 5.88 | 8 | 5 | 20 | 3 |
| 1 N3513 | 6.2 | 5.89 | 6.51 | 3 | 5 | 20 | 4 |
| 1N3514 | 6.8 | 6.46 | 7.14 | 3 | 1 | 20 | 5 |
| 1 N3515 | 7.5 | 7.13 | 7.87 | 4 | 0.5 | 10 | 6 |
| 1N3516 | 8.2 | 7.79 | 8.61 | 5 | 0.25 | 10 | 7 |
| 1N3517 | 9.1 | 8.65 | 9.55 | 6 | 0.025 | 10 | 7 |
| 1 N3518 | 10 | 9.50 | 10.50 | 7 | 0.01 | 10 | 8 |
| 1 N3519 | 11 | 10.45 | 11.55 | 8 | 0.01 | 10 | 9 |
| 1 N3520 | 12 | 11.40 | 12.60 | 10 | 0.01 | 10 | 10 |
| 1N3521 | 13 | 12.35 | 13.65 | 12 | 0.01 | 5 | 11 |
| 1N3522 | 15 | 14.25 | 15.75 | 14 | 0.01 | 5 | 13 |
| 1 N3523 | 16 | 15.20 | 16.80 | 16 | 0.01 | 5 | 14 |
| 1N3524 | 18 | 17.10 | 18.90 | 18 | 0.01 | 5 | 16 |
| 1 N3525 | 20 | 19.00 | 21.00 | 20 | 0.01 | 5 | 18 |
| 1N3526 | 22 | 20.90 | 23.10 | 35 | 0.01 | 5 | 19 |
| 1 N3527 | 24 | 22.80 | 25.20 | 38 | 0.01 | 5 | 20 |
| 1N3528 | 27 | 25.65 | 28.35 | 40 | 0.01 | 4 | 22 |
| 1N3529 | 30 | 28.50 | 31.50 | 48 | 0.01 | 4 | 24 |
| 1N3530 | 33 | 31.35 | 34.65 | 50 | 0.01 | 3 | 26 |

${ }^{\dagger} V_{\boldsymbol{Z}}$ tolerance is $\pm 5 \%$.
THERMAL INFORMATION


FIGURE 1

- JEDEC registered data


## 50-1000 VOLTS • 1 AMP AVERAGE

- Rugged Double-plug Construction
- Hermetic Case
- 30-Amp Surge Rating


## description and mechanical data

These one-amp rectifier diodes are the product of combining the best of both silicon material processing and packaging technologies. The silicon die is a mesa oxide-passivated structure which has additional nitride passivation and glass passivation over the junction. Years of volume production have shown the double-plug package to have the highest inherent mechanical integrity of all hermetic-case diodes.

*absolute maximum ratings at specified ambient ${ }^{\dagger}$ temperature (unless otherwise noted)

|  |  | 1N4001 | 1N4002 | 1N4003 | 1N4004 | 1N4005 | 1N4006 | 1N4007 | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| $V_{\text {RM }}$ | Peak Reverse Voltage from $-65^{\circ} \mathrm{C}$ to $175^{\circ} \mathrm{C}$ (See Note 1) | 50 | 100 | 200 | 400 | 600 | 800 | 1000 | V |
| $\mathbf{V}_{\mathbf{R}}$ | Steady State Reverse Voltage from $25^{\circ} \mathrm{C}$ to $75^{\circ} \mathrm{C}$ | 50 | 100 | 200 | 400 | 600 | 800 | 1000 | V |
| 10 | Average Rectified Forward Current from $25^{\circ} \mathrm{C}$ to $75^{\circ} \mathrm{C}$ (See Notes 1 and 2) | 1 |  |  |  |  |  |  | A |
| IFRM | Repetitive Peak Forward Current, 10 Cycles, at (or below) $75^{\circ} \mathrm{C}$ (See Note 3) | 10 |  |  |  |  |  |  | A |
| IFSM | Peak Surge Current, One Cycle, at (or below) $75^{\circ} \mathrm{C}$ (See Note 3) | 30 |  |  |  |  |  |  | A |
| TA(opr) | Operating Ambient Temperature Range | -65 to 175 |  |  |  |  |  |  | ${ }^{\circ} \mathrm{C}$ |
| $\mathrm{T}_{\text {stg }}$ | Storage Temperature Range | -65 to 200 |  |  |  |  |  |  | C |
|  | Lead Temperature 3/8 Inch from Case for 10 Seconds | 350 |  |  |  |  |  |  | C |

NOTES: 1. These valuas mav be applied continuously under single-phase, $60-\mathrm{Hz}$, half-sine-wave operation with resistive load. Above $75^{\circ} \mathrm{C}$ derate 10 according to Figure 1.
2. This rectifier is a lead-conduction-cooled device. At (or above) ambient temperatures of $75^{\circ} \mathrm{C}$, the lead temperature $3 / 8$ inch from case must be no higher than $5^{\circ} \mathrm{C}$ above the ambient temperature for these ratings to apply.
3. These values apply for $60-\mathrm{Hz}$ half sine waves when the device is operating at (or below) rated values of peak reverse voltage and average rectified forward current. Surge may be repeated after the ctevice has retumed to original thermal equilibrium.
*JEDEC registered data. This data sheet contains all applicable registered date in effect at the time of publication.
${ }^{+}$The ambient temperature is measured at a point 2 inches below the device. Natural air cooling is used.
*electrical characteristics at specified ambient ${ }^{\dagger}$ temperature


- JEDEC registered data


## THERMAL INFORMATION



FIGURE 1

NOTE 2: This rectifier is a lead-conduetion-cooled device. At (or above) ambient temperatures of $75^{\circ} \mathrm{C}$, the lead temperature $3 / 8$ inch from case must be no higher than $5^{\circ} \mathrm{C}$ above the ambient temperature for these ratings to apply.
$\dagger_{\text {The ambient }}$ temperature is messured at a point 2 inches below the device. Natural air cooling is used

## FAST SWITCHING DIODES

- Rugged Double-Plug Construction

Electrical Equivalents:

| 1N4148 | 1N914 | 1N4447 . . . 1N916A |
| :---: | :---: | :---: |
| 1N4149 | 1N916 | 1N4448... 1N914B |
| 1N4446 | . 1N914A | 1N4449 . . . 1N916B |

## mechanical data

Double-plug construction affords integral positive contact by means of a thermal compression bond. Moisture-free stability is ensured through hermetic sealing. The coefficients of thermal expansion of the glass case and the dumet plugs are closely matched to allow extreme temperature excursions. Hot-solder-dipped leads are standard

*absolute maximum ratings at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

*electrical characteristics at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

| PARAMETER | TEST CONDITIONS | 1N4148 | 1N4149 | 7N4446 | 1N4447 | IN4448 | 1N4449 |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | MIN MAX | MIN MAX | MIN MAX | MIN MAX | MIN MAX | MIN MAX | UNIT |
| $V_{\text {(60) }}$ Reverse Breakdown Voltage | $\mathrm{I}_{\mathrm{R}}=5 \mu \mathrm{~A}$ | 75 | 75 | 75 | 75 | 75 | 75 | $V$ |
|  | $\mathrm{I}_{\mathrm{R}}=100 \mu \mathrm{~A}$ | 100 | 100 | 100 | 100 | 100 | 100 | $V$ |
| IR Static Reverse Current | $V_{R}=20 \mathrm{~V}$ | 25 | 25 | 25 | 25 | 25 | 25 | ni |
|  | $V_{R}=20 \mathrm{~V}, \mathrm{~T}_{A}=100^{\circ} \mathrm{C}$ |  |  |  |  | 3 | 3 | $\mu \boldsymbol{A}$ |
|  | $V_{R}=20 \mathrm{~V}, \mathrm{~T}_{\mathrm{A}}=150^{\circ} \mathrm{C}$ | 50 | 50 | 50 | 50 | 50 | 50 | $\mu A$ |
| $V_{\text {F }}$ Static Forward Yoltage | $\mathrm{I}_{\mathrm{F}}=5 \mathrm{~mA}$ |  |  |  |  | 0.620 .72 | $0.63 \quad 0.73$ | $V$ |
|  | $\mathrm{I}_{\mathrm{F}}=10 \mathrm{~mA}$ | 1 | 1 |  |  |  |  | $V$ |
|  | $I_{f}=20 \mathrm{~mA}$ |  |  | 1 | 1 |  |  | V |
|  | $\mathrm{I}_{\mathrm{F}}=30 \mathrm{~mA}$ |  |  |  |  |  | 1 | V |
|  | $\mathrm{I}_{\mathrm{F}}=100 \mathrm{~mA}$ |  |  |  |  | 1 |  | V |
| CT Total Capacitance | $\mathrm{V}_{\mathrm{R}}=0, \quad \mathrm{i}=1 \mathrm{mHz}$ | 4 | 2 | 4 | 2 | 4 |  | pF |

NOTE 1: Derate linearly to $200^{\circ} \mathrm{C}$ at the rale of $2.85 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$.

- JEDEC registared dato


## TYPES 1N4148, 1 N4149, $\mathbf{1 N 4 4 4 6}$ THRU $1 N 4449$ SILICON SWITCHING DIODES

*switching characteristics at $\mathbf{2 5}^{\circ} \mathrm{C}$ free-air temperature

| PARAMETER | TEST CONDITIONS | 1N4148 | IN4149 | 1N4446 | 1N4447 | IN4448 | 1N4449 | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Pre Reverse Recovery Time |  | MIN MAX | min max | 4 | min max | 4 | min ma | ns |
| $V_{\text {FM(mac) }}$ Forward Recovary Voltage | $I_{F}=50 \mathrm{~mA}, R_{L}=50 \Omega,$ <br> See Figure 2 |  |  |  |  | 2.5 | 2.5 | V |

*PARAMETER MEASUREMENT INFORMATION


TEST CIRCUIT



OUTPUT CURRENT WAVEFORM

FIGURE 1 - REVERSE RECOVERY TIME
MOTES: a. The input polse is suppliod by genereter with the following characteristics: $z_{\text {out }}=50 \Omega, t_{r} \leq 0.5 \mathrm{~ns}, \mathrm{t}_{\mathrm{p}}=100 \mathrm{~ns}$. b. The output wevatorm is mmitorad on en escilloseppe with the fotiowing characteristics: $\mathrm{t}_{\mathrm{r}} \leq 0.6 \mathrm{~ns}, \mathbf{Z}_{\text {in }}=50 \mathbf{\Omega}$.


VOLTAGE WAVEFORMS

FIGURE 2 - FORWARD RECOVERY VOLTAGE
MOTES: C. The input pulse is supplied by egomerater with the follewing characteristics: $\boldsymbol{z}_{\text {out }}=50 \Omega, \mathrm{I}_{\mathrm{r}} \leq 30 \mathrm{~ns}, \mathrm{t}_{\mathrm{p}}=100 \mathrm{~ns}, \mathrm{PRR}=5 \mathrm{to} \mathbf{1 0 0} \mathbf{k H z}$.
d. The eutput wavetorm is menitered en en escilisccope with the following characteristiks: $\mathrm{I}_{\mathrm{r}} \leq \mathbf{1 5} \mathrm{ns}, \mathrm{g}_{\mathrm{in}} \geq 1 \mathrm{~m} \Omega, \mathrm{c}_{\mathrm{in}} \leq \mathbf{5 p F}$.
*.JEDEC ragistered dints

## HIGH-CURRENT, CORE-DRIVER SWITCHING DIODE

- Rugged Double-Plug Construction
- Electrically Equivalent to 1N3600 (DO-7)


## mechanical data

Double-plug construction affords integral positive contact by means of a thermal compression bond. Moisture-free stability is ensured through hermetic sealing. The coefficients of thermal expansion of the glass case and the dumet plugs are closely matched to allow extreme temperature excursions. Hot-solder-dipped leads are standard.

*absolute maximum ratings at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

*electrical characteristics at $\mathbf{2 5}{ }^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

| PARAMETER |  | TEST CONDITIONS |  | MIN | MAX | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| $I^{\prime}$ | Static Reverse Current | $V_{R}=50 \mathrm{~V}$ |  | 0.1 |  | $\mu \mathrm{A}$ |
|  |  | $V_{R}=50 \mathrm{~V}$, | $\mathrm{T}_{\mathrm{A}}=150^{\circ} \mathrm{C}$ |  | 100 | $\mu \mathrm{A}$ |
|  | Static Forward Voltage | $1{ }_{1}=1 \mathrm{~mA}$ |  | 0.54 | 0.62 . | V |
|  |  | $I_{F}=10 \mathrm{~mA}$ |  | 0.66 | 0.74 | $V$ |
| $V_{F}$ |  | $\mathrm{I}_{\mathrm{F}}=50 \mathrm{~mA}$ |  | 0.76 | 0.86 | $V$ |
|  |  | $i^{\prime} F=100 \mathrm{~mA}$ |  | 0.82 | 0.92 | V |
|  |  | $I_{F}=200 \mathrm{~mA}$ |  | 0.87 | 1 | V |
| $\mathrm{C}_{\text {T }}$ | Total Capacitance | $V_{R}=0$, | $\mathrm{f}=1 \mathrm{MHz}$ | 2.5 |  | pF |

*switching characteristics at $25^{\circ} \mathrm{C}$ free-air temperature

| PARAMETER | TEST CONDITIONS | MIN | MAX | UNIT |
| :---: | :--- | :--- | :---: | :---: |
| $t_{f r}$ | Forward Recovery Time | $I_{F}=200 \mathrm{~mA}, \quad \mathrm{v}_{\mathrm{fr}}=1 \mathrm{~V}, \quad$ See Figure 1 |  |  |

NOTES: 1. These values apply for the specified square-wave pulse with the device at nonoperating thermal equilibrium immediately prior to the surge.
2. Derate linearly to $200^{\circ} \mathrm{C}$ free-air temperature at the rate of $2.85 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$.

- JEDEC registered data. This data sheet contains all applicable registered data in effect at the time of publication.


## TYPE 104150 <br> SILICON SWITCHING DIODE

## PARAMETER MEASUREMENT INFORMATION



FIGURE 1-FORWARD RECOVERY TIME

NOTES: $a$. The input pulse is supplied by a generator with the following cheracteristics: $Z_{\text {out }}=50 \Omega, \mathrm{t}_{\mathrm{r}} \leqslant \mathbf{0}, 4 \mathrm{~ns}, \mathrm{t}_{\mathbf{w}}=100 \mathrm{~ns}$, duty cycle $<1 \%$.
b. The output waveform is monitored on an oscilloscope with the following characteristics: $t_{r}<0.5 \mathrm{~ns}, \mathrm{R}_{\text {in }}>1 \mathrm{M} \Omega$, $C_{\text {in }}<5 \mathrm{pF}$.


NOTES: $c$. The input pulse is supplied by a generator with the following characteristics: $\mathrm{t}_{\mathrm{f}} \leqslant \mathbf{1} \mathrm{ns}, \mathrm{Z}_{\mathrm{out}}=\mathbf{5 0} \Omega, \mathrm{t}_{\mathrm{w}}=100 \mathrm{~ns}$, duty cycle $\leqslant 1 \%$.
d. The output waveform is monitored on an oscilloscope with the following characteristics: $t_{\mathbf{r}} \leq 0.4 \mathrm{~ns}, \mathrm{R}_{\text {in }}=50 \Omega$.

## TYPES 1N4151 THRU 1N4154 <br> SILICON SWITCHING DIODES

## FAST SWITCHING DIODES

- Rugged Double-Plug Construction


## Electrical Equivalents

1N4151 . . . 1N3604
1N4152 . . . 1N3605 . . . 1N4533
1N4153 . . . 1N3606 . . . 1N4534
1N4154 . . . 1N4009 . . . 1N4536
mechanical data
Double-plug construction affords integral positive contact by means of a thermal compression bond. Moisture-free stability is ensured through hermetic sealing. The coefficients of thermal expansion of the glass case and the dumet plugs are closely matched to allow extreme temperature excursions. Hot-solder-dipped leads are standard.

*absolute maximum ratings at $\mathbf{2 5}{ }^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

|  |  | 1N4151 | 1N4152 | 1N4153 | 1N4154 | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| $V_{\text {RM }}$ | Peak Reverse Voltage | 75 | 40 | 75 |  | V |
|  | Working Peak Reverse Voltage | 50 | 30 | 50 | 25 | V |
| P | Continuous Power Dissipation at (or below) $25^{\circ} \mathrm{C}$ Free-Air Temperature (See Note 1) | 500 |  |  |  | mW |
| $\mathrm{T}_{\text {stq }}$ | Storage Temperature Range | -65 to 200 |  |  |  | ${ }^{\circ} \mathrm{C}$ |
| $\mathrm{T}_{\mathrm{L}}$ | Lead Temperature 1/16 inch from Case for 10 Seconds | 300 |  |  |  | ${ }^{\circ} \mathrm{C}$ |

*electrical characteristics at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

| PARAMETER | TEST CONDITIONS | IN4151 | 1N4152 | IN4153 | IN4154 | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | MIN MAX | MIN MAX | MIN MAX | MIN MAX |  |
| $\mathrm{V}_{\text {(1x) }}$ Reverse Breakdown Voltage | $\mathrm{I}_{\mathrm{R}}=5 \mu \mathrm{~A}$ | 75 | 40 | 75 | 35 | $V$ |
| Static Reverse Current | $V_{R}=\operatorname{ratad} V_{\text {RM }}(\mathrm{mkg})^{\text {a }}$ | 0.05 | 0.05 | 0.05 | 0.1 | $\mu \mathrm{A}$ |
|  |  | 50 | 50 | 50 | 100 | $\mu$ |
| Stotic Forward Voltage | $\mathrm{l}_{F}=0.1 \mathrm{~mA}$ |  | 0.490 .55 | 0.49 |  | $V$ |
|  | $t_{F}=0.25 \mathrm{~mA}$ |  | 0.53 | $0.53 \quad 0.59$ |  | $V$ |
|  | $\mathrm{f}_{\mathrm{F}}=1 \mathrm{~mA}$ |  | $0.59 \quad 0.67$ | 0.590 .67 |  | $V$ |
|  | $I_{F}=2 \mathrm{~mA}$ |  | $0.62 \quad 0.70$ | $0.62 \quad 0.70$ |  | $V$ |
|  | $\mathrm{I}_{\mathrm{F}}=10 \mathrm{~mA}$ |  | $0.70 \quad 0.81$ | $0.70 \quad 0.81$ |  | $V$ |
|  | $\mathrm{I}_{\mathrm{F}}=20 \mathrm{~mA}$ |  | 0.74 | 0.740 .88 |  | $V$ |
|  | $\mathrm{I}_{\mathrm{F}}=30 \mathrm{~mA}$ |  |  |  | 1 | $v$ |
|  | $\mathrm{I}_{\mathrm{F}}=50 \mathrm{~mA}$ | 1 |  |  |  | $V$ |
| $\mathrm{C}_{\mathrm{T}} \quad$ Total Capacitance | $\mathrm{V}_{\mathrm{R}}=0, \quad i=1 \mathrm{mHz}$ | 2 | 2 | 2 | 4 | pF |

WOTE 1: Derate linearly to $200^{\circ} \mathrm{C}$ at the rate of $2.85 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$.

* JEDEC mgisfared data


## TYPES IN4151 THRU $1 N 4154$ SILICON SWITCHING DIODES

*switching characteristics at $25^{\circ} \mathrm{C}$ free-air temperature

|  |  | 1N4151 | 1N4152 | IN4153 | 1N4154 | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| PARAMETER | TEST CONDITIONS | MIN MAX | MIN MAX | MIN MAX | MIN MAX |  |
| $t_{\text {rr }}$ Revorse Recovery Time | $\begin{aligned} & I_{F}=10 \mathrm{~mA}, I_{R M}=10 \mathrm{~mA}, i_{r r}=1 \mathrm{~mA}, \\ & R_{L}=100 \Omega, \text { See Figure } 1 \text { (Condition I) } \end{aligned}$ | 4 | 4 | 4 | 4 | ns |
|  | $\begin{aligned} & \mathbf{l}_{\mathbf{F}}=10 \mathrm{~mA}, V_{R}=6 \mathrm{~V}, i_{\mathrm{rr}}=1 \mathrm{~mA} A_{1} \\ & R_{L}=100 \Omega, \text { See Figure } 1 \text { (Condition 2) } \end{aligned}$ | 2 | 2 | 2 | 2 | ns |

## *PARAMETER MEASUREMENT INFORMATION



TEST CIRCUIT


CONDITION 1: Adjust $V_{\text {in }}$ for
CONDITION 2: Adjust $V_{\text {in }}$ for $V_{R}=6 \mathrm{~V}$

INPUT VOLTAGE WAVEFORM


OUTPUT CURRENT WAVEFORMS

## FIGURE 1 - REVERSE RECOVERY TIME

MOTES: a. The input pulse is supplied by a generatar with the follawing choracteristics: $Z_{\text {out }}=50 \Omega_{r} f_{r} \leq 0.5 \mathrm{~ns}, \mathrm{t}_{\mathrm{p}}=100 \mathrm{~ns}$.
4. The output wavelorm is meatiored on an oscillescope with the foliaming characteristics: $\mathrm{I}_{\mathrm{t}} \leq \mathbf{0 . 6} \mathrm{ms}, \mathrm{I}_{\mathrm{in}}=50 \Omega$.

- Jeber rogistored data.


## FAST SWITCHING DIODES

## - Rugged Double-Plug Construction

Electrical Equivalents
1N4305 . . . 1N3063 . . . 1N4532
1N4454 ... 1 N3064

## mochanical data

Double-plug construction affords integral positive contact by means of a thermal compression bond. Moisture-free stability is ensured through hermetic sealing. The coefficients of thermal expansion of the glass case and the dumet plugs are closely matched to allow extreme temperature excursions. Hot-solder-dipped leads are standard.

*absolute maximum ratings at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

|  |  | 1N4305 | IN4444 | 1N4454 | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: |
| $V_{\text {RM }}$ | Peak Reverse Voltage | 75 |  | 75 | V |
| $V_{\text {RMM }}$ | Working Peak Reverse Voltage |  | 50 |  | V |
| P | Continuous Power Dissipation at (or below) $25^{\circ} \mathrm{C}$ Free-Air Temperature (See Note 1) | 500 |  |  | mW |
| $\mathrm{T}_{\text {stg }}$ | Storage Temperature Range | -65 to 200 |  |  | ${ }^{\circ} \mathrm{C}$ |
| $\mathrm{T}_{1}$ | Lead Temperoture 1/16 Inch from Case for 10 Seconds | 300 |  |  | ${ }^{\circ} \mathrm{C}$ |

*electrical characteristics af $25^{\circ} \mathrm{C}$ frec-air temperature (unless otherwise noted)

| PARAMETER | TEST CONDITIONS | IN4305 | IN4444 | 1N4454 | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | MIN MAX | MIN Max | MIN MAX |  |
| V ${ }_{\text {ERL }}$ Reverse Broakdown Voltage | $\mathrm{I}_{\mathrm{R}}=5 \mu \mathrm{~A}$ | 75 | 70 | 75 | $V$ |
| Static Reverse Current | $\mathrm{V}_{\mathrm{R}}=50 \mathrm{y}$ | 0.1 | 0.05 | 0.1 | $\mu \mathrm{A}$ |
|  | $\mathrm{V}_{\mathrm{R}}=50 \mathrm{~V}, \quad \mathrm{~T}_{\mathrm{A}}=150^{\circ} \mathrm{C}$ | 100 | 50 | 100 | $\mu \mathrm{n}$ |
| Static Fonward Yoltage | $\mathrm{I}_{5}=0.1 \mathrm{~mA}$ |  | $0.44 \quad 0.55$ |  | Y |
|  | $\mathrm{I}_{F}=0.25 \mathrm{~mA}$ | 0.5050 .575 |  |  | $V$ |
|  | $\mathrm{I}_{\mathrm{F}}=1 \mathrm{~mA}$ | $0.55 \quad 0.65$ | $0.56 \quad 0.68$ |  | $V$ |
|  | $\mathrm{I}_{\mathrm{F}}=2 \mathrm{~mA}$ | 0.610 .71 |  |  | $V$ |
|  | $I_{F}=10 \mathrm{~mA}$ | $0.70 \quad 0.85$ | 0.69 0.82 | 1 | $V$ |
|  | $i_{F}=100 \mathrm{~mA}$ |  | 0.85 - |  |  |
| $\alpha_{\mathrm{VF}} \begin{gathered}\text { Forwand Voltage Temperature } \\ \text { Coefficient }\end{gathered}$ | $I_{F}=10 \mu \mathrm{to} 10 \mathrm{~mA}$, See Note 2 | 3 |  |  | $\mathrm{mV} /{ }^{\circ} \mathrm{C}$ |
| $\mathrm{C}_{\text {T }}$ Total Copacitance | $\mathrm{V}_{\mathrm{R}}=0, \quad \mathrm{f}=1 \mathrm{mHz}$ | 2 | 2 | 2 | pf |

MOTES: 1. Derrite finearly to $200^{\circ} \mathrm{C}$ at the rute of $2.85 \mathrm{mw} /{ }^{\circ} \mathrm{C}$.
2. Temperature coefficient, $\alpha_{\mathrm{VF}}$, is determined by the following formula:

- JEDEC rogisioral deta

$$
\alpha_{V F}=\frac{v_{F} @ 150^{\circ} \mathrm{C}-v_{F} @-55^{\circ} \mathrm{C}}{150^{\circ} \mathrm{C}-1-55^{\circ} \mathrm{C}}
$$

*operating charmeteristics of $25^{\circ} \mathrm{C}$ free-dir tempersuture

|  |  | 1N4305 | IN4444 | 1N4454 | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: |
| PARAMETER | TEST CONDITIONS | MIN MAX | MIN MAX | MIN MAX |  |
| Itr Reverse Recovery True | $\begin{aligned} & I_{\mathbf{F}}=10 \mathrm{~mA}, i_{\mathrm{Rm}}=10 \mathrm{~mA}, i_{r r}=1 \mathrm{~mA}, \\ & \mathrm{R}_{\mathrm{L}}=100 \Omega, \text { seo Figure } 1, \text { Condition } 1 \end{aligned}$ | 4 | 7 | 4 | ns |
|  | $\begin{aligned} & I_{\mathrm{F}}=10 \mathrm{~mA}, V_{\mathrm{R}}=6 \mathrm{~V}, \mathrm{I}_{\mathrm{rr}}=1 \mathrm{~mA} \\ & \mathrm{~m}_{\mathrm{l}}=100 \Omega, \text { See Figure 1, Condition 2 } \end{aligned}$ | 2 |  | 2 | ns |
| Vfinrocl Forward lecovery | $I_{F}=100 \mathrm{~mA}, \mathrm{R}_{\mathbf{L}}=50 \Omega$, See Figure 2 |  |  | 3 | V |
| $\eta_{r}$ Rectification Efficiency | $\begin{aligned} & V_{r}=2 V, R_{L}=5 \mathrm{k} \Omega, C_{L}=20 \mathrm{pF}, \\ & Z_{\text {cource }}=50 \Omega, f=100 \mathrm{mHz} \end{aligned}$ | $45 \%$ |  |  |  |

*PARAMETER MEASUREMENT INFORMATION

figure 1 - reverse recovery time




FIBURI 2 - PORWARD RECOVEIV VOLTAGE



- JEDEC megistorad deta


## FAST SWITCHING DIODES

## - Rugged Double-Plug Construction

## Electrical Equivalents:

| 1N4148 | 1N914 . . . 1N4531 | 1N4447... 1N916A |
| :---: | :---: | :---: |
| 1N4149 | 1N916 | 1N4448... 1N914B |
| 1N4446 | 1N914A | 1N4449 . . . 1N916B |

## mechanical data

Double-plug construction affords integral positive contact by means of a thermal compression bond. Moisture-free stability is ensured through hermetic sealing. The coefficients of thermal expansion of the glass case and the dumet plugs are closely matched to allow extreme temperature excursions. Hot-solder-dipped leads are standard.

*absolute maximum ratings at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

*electrical characteristics at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

| PARAMETER | TEST CONDITIONS | 1N4148 | IN4149 | 1 N4446 | 1N4447 | 1N4448 | IN4449 |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | TEST CONDITIONS | MIN MAX | MIN MAX | MIN MAX | MIN MAX | MIN MAX | MIN MAX |  |
| $\mathbf{V}_{(\text {ER, }}$ Reverse Brackdown Voltoga | $\mathrm{I}_{\mathrm{R}}=5 \mu \mathrm{~A}$ | 75 | 75 | 75 | 75 | 75 | 75 | $V$ |
|  | $\mathrm{I}_{\mathrm{R}}=100 \mu \mathrm{~A}$ | 100 | 100 | 100 | 100 | 100 | 100 | $V$ |
| Static Reverse Current | $\mathrm{V}_{\mathrm{R}}=20 \mathrm{~V}$ | 25 | 25 | 25 | 25 | 25 | 25 | ni |
|  | $\mathrm{V}_{\mathrm{R}}=20 \mathrm{~V}, \mathrm{~T}_{\mathrm{A}}=100^{\circ} \mathrm{O}$ |  |  |  |  | 3 | 3 | $\mu \mathrm{A}$ |
|  | $\mathrm{V}_{\mathrm{R}}=20 \mathrm{~V}, \mathrm{I}_{\mathrm{A}}=150^{\circ} \mathrm{O}$ | 50 | 50 | 50 | 50 | 50 | 50 | $\mu \mathrm{A}$ |
| VF Static Forward Voltage | $\mathrm{I}_{\mathrm{F}}=5 \mathrm{~mA}$ |  |  |  |  | $0.62 \quad 0.72$ | 0.63 | $V$ |
|  | $\mathrm{I}_{\mathrm{F}}=10 \mathrm{~mA}$ | 1 | 1 |  |  |  |  | $V$ |
|  | $\mathrm{I}_{\mathrm{F}}=20 \mathrm{~mA}$ |  |  | 1 | 1 |  |  | $V$ |
|  | $\mathrm{I}_{\mathrm{F}}=30 \mathrm{~mA}$ |  |  |  |  |  | 1 | $V$ |
|  | $\mathrm{I}_{\mathrm{F}}=100 \mathrm{~mA}$ |  |  |  |  | 1 |  | $V$ |
| $\mathrm{C}_{\mathbf{T}}$ Tofal Capacitance | $V_{\mathrm{R}}=0, \quad \mathrm{f}=1 \mathrm{MHz}$ | 4 | 2 | 4 | 2 | 4 |  | pF |

WOTE 1: Berate lineorly to $200^{\circ} \mathrm{C}$ at the rate of $2.85 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$.

- JEDEC registered dota


## TYPES $1 N 4148,1 \times 4149,1 N 4446$ THRU $1 N 4449$ SILICON SWITCHING DIODES

*switching characteristics at $\mathbf{2 5}{ }^{\circ} \mathbf{C}$ free-air temperature

| PARAMETER | TEST CONDITIONS | 1N4148 | 1N4149 | IN4446 | IN4447 | 1N4448 | 1N4449 | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Pre Reverse Recovery Time | $\begin{aligned} & I_{\mathbf{F}}=10 \mathrm{~mA}, V_{R}=6 \mathrm{~V}, i_{\text {rr }}=1 \mathrm{~mA}, \\ & \mathbf{R}_{\mathbf{L}}=100 \Omega, \text { Soeo Figura } \end{aligned}$ | MIN MAX | MIN max | 4 |  | min max | 4 | ns |
| $V_{\text {FMumec }}$ Forward Recovery Voitage | $I_{F}=50 \mathrm{~mA}, R_{L}=50 \Omega,$ <br> 5ee Flgure 2 |  |  |  |  | 2.5 | 2.5 | $v$ |

*PARAMETER MEASUREMENT INFORMATION


INPUT VOLTAGE WAVEFORM
OUTPUT CURRENT WAVEFORM

FIGURE 1-REVERSE RECOVERY TIME
MoTES: a. The input pulse is supplied by a gmerrater with the followieg cheracieristics: $z_{\text {out }}=50 \Omega, \mathrm{ir} \leq 0.5 \mathrm{~ns}, \mathrm{t}_{\mathrm{p}}=100 \mathrm{~ms}$.



FIGURE 2-FORWARD RECOVERY VOLTAGE



* JJEDEC realstwoll mate


## FAST SWITCHING DIODES

## - Rugged Double-Plug Construction <br> Electrical Equivalents <br> 1N4305 . . . 1N3063 . . . 1N4532 <br> 1N4454 . . . $1 N 3064$

## mechanicell dete

Double-plug construction affords integral positive contact by means of a thermal compression bond. Moisture-free stability is ensured through hermetic sealing. The coefficients of thermal expansion of the glass case and the dumet plugs are closely matched to allow extreme temperature excursions. Hot-solder-dipped leads are standard.

*absolute maximum ratings at $25^{\circ} \mathrm{C}$ free-air tomperature (unless otherwise noted)

| Vay |  | 1N4305 | 1N4444 | 1N4454 | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: |
| $\mathrm{V}_{\text {RM }}$ | Peak Reverse Voltage | 75 |  | 75 | V |
| $\mathrm{V}_{\text {RMM }}$ | Working Peak Reverse Voliage |  | 50 |  | $V$ |
| P | $25^{\circ} \mathrm{C}$ Free-Air Temperature (See Note 1) | 500 |  |  | mW |
| $\mathrm{T}_{\text {tig }}$ | Storage Temperature Range | -65 to 200 |  |  | ${ }^{\circ} \mathrm{C}$ |
| $\mathrm{T}_{2}$ | Lead Temperature $1 / 16$ Inch from Case for 10 Seconds | 300 |  |  | ${ }^{\circ} \mathrm{C}$ |

*electrical characteristics of $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

| Parameter | TEST CONDITIONS | IN4305 | IN4444 | 1N4454 | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | MIN MAX | MIN MAX | MIN MAX |  |
| (1m) Reverse Breokdown Voltage | $\mathrm{I}_{\mathrm{R}}=5 \mu \mathrm{~A}$ | 75 | 70 | 75 | $V$ |
| In Stotic Reverse Current | $V_{R}=50 y$ | 0.1 | 0.05 | 0.1 | $\mu \mathrm{A}$ |
|  | $V_{R}=50 \mathrm{~V}, \quad T_{A}=150^{\circ} \mathrm{C}$ | 100 | 50 | 100 | $\mu \mathrm{A}$ |
| VF Static Forward Voltage | $\mathrm{I}_{\mathrm{F}}=0.1 \mathrm{~mA}$ |  | $0.44 \quad 0.55$ |  | V |
|  | $\mathrm{I}_{\mathrm{F}}=0.25 \mathrm{~mA}$ | 0.5050 .575 |  |  | V |
|  | $\mathrm{I}_{\mathrm{F}}=1 \mathrm{~mA}$ | 0.55 0.65 | $0.56 \quad 0.68$ |  | V |
|  | $\mathrm{I}_{\mathrm{F}}=2 \mathrm{~mA}$ | 0.610 .71 |  |  | $\checkmark$ |
|  | $t_{F}=10 \mathrm{~mA}$ | $0.70 \quad 0.85$ | $0.69 \quad 0.82$ | 1 | $V$ |
|  | $I_{F}=100 \mathrm{~mA}$ |  | $0.85-1$ |  | $V$ |
| $\begin{aligned} & \alpha_{\text {VF }} \begin{array}{l} \text { Forword Voltege Temperature } \\ \text { Coefficient } \end{array} \\ & \hline \end{aligned}$ | $J_{f}=10 \mu A$ to 10 mA , See Note 2 | 3 |  |  | $\mathrm{mV} /{ }^{\circ} \mathrm{C}$ |
| $\mathrm{Cr}_{5}$ Total Capacitance | $V_{R}=0, \quad i=1 \mathrm{mHz}$ | 2 | 2 | 2 | pF |

WOTES: 1. Derate linearly to $200{ }^{\circ} \mathrm{C}$ at the rele of $2.85 \mathrm{~min} /{ }^{\circ} \mathrm{C}$.
2. Tomperatury confficient, $\alpha_{\text {vf, }}$ is deterneined by the following fermula:

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$$
\alpha_{V F}=\frac{v_{F} @ 150^{\circ} \mathrm{C}-v_{F} @-55^{\circ} \mathrm{C}}{150^{\circ} \mathrm{C}-\left(-55^{\circ} \mathrm{C}\right)}
$$

* operating characteristics at $\mathbf{2 5}{ }^{\circ} \mathrm{C}$ free-air temperature

|  |  | 1N4305 | IN4444 | 1N4454 | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: |
| PARAMETER | TEST CONDITIONS | MIN MAX | MIN MAX | MIN MAX |  |
| $\dagger_{\text {rr }}$ Reverse Rocovery Time | $\begin{aligned} & I_{F}=10 \mathrm{~mA}, i_{x m}=10 \mathrm{~mA}, i_{r r}=1 \mathrm{~mA}, \\ & R_{L}=100 \Omega, \text { see Figure } 1, \text { Condition } 1 \end{aligned}$ | 4 | 7 | 4 | ns |
|  | $\begin{aligned} & I_{F}=10 \mathrm{~mA}, V_{R}=6 \mathrm{~V}, \mathrm{I}_{\mathrm{rr}}=1 \mathrm{~mA} \\ & \mathrm{R}_{\mathrm{L}}=100 \Omega, \text { see Figure } 1, \text { Condition } 2 \end{aligned}$ | 2 |  | 2 | ns |
| ( $\mathrm{V}_{\text {FM(rocc }} \begin{aligned} & \text { Forward Recovery } \\ & \text { Voltoge }\end{aligned}$ | $I_{F}=100 \mathrm{~mA}, R_{L}=50 \Omega$, See Figure 2 |  |  | 3 | $V$ |
| $\eta_{\mathrm{r}}$ Rectification Efficiency | $\begin{aligned} & V_{1}=2 \mathrm{~V}, \mathrm{R}_{\mathrm{L}}=5 \mathrm{k} \Omega, \mathrm{C}_{L}=20 \mathrm{pF}, \\ & Z_{\text {sourco }}=50 \Omega, i=100 \mathrm{mHz} \end{aligned}$ | $45 \%$ |  |  |  |

*PARAMETER MEASUREMENT INFORMATION


FIGURE 1 - REVERSE RECOVERY TIME
NOTES: a. The input palse is supplied by a geanater with the following charecteristics: $I_{\text {out }}=50 n, t_{r} \leq 0.5 \mathrm{~mm}, t_{p}=100 \mathrm{~ns}$.
b. Output waveforms are menitorod on an oscilloscopo with the following charecteristics: $\mathrm{t}_{\mathrm{r}} \leq 0.6 \mathrm{~ns}, \mathbf{z}_{\mathrm{in}}=50 \Omega$.


TEST CIRCUIT


VOLTAGE WAVEFORMS

FIGURE 2 - FORWARD RECOVERY VOLTAGE
notes: c. The input pulse is supplied by a gemerater with the foltowing characteristics: $z_{\text {out }}=50 \Omega, \mathrm{t}_{\mathrm{r}} \leq 30 \mathrm{~ms}, \mathrm{t}_{\mathrm{p}}=100 \mathrm{~ns}, \mathrm{PRR}=5$ io 100 kHz .
d. The outpur wavetorm is meniterod on an escilloscope with the following charocteristics: $\mathrm{i}_{\mathrm{r}} \leq 15 \mathrm{~ns}, \mathrm{n}_{\mathrm{in}} \geq 1 \mathrm{Mn}, \mathrm{C}_{\mathrm{in}} \leq 5 \mathrm{pF}$.

- JEDEC regisfored data


# TYPES 1N4531 THRU 1N4534, 1 N4536 <br> SILICON SWITCHING DIODES 

BULLETIN NO. DL-S 739774, MARCH 1967-REVISED MARCH 1973

## FAST SWITCHING DIODES

- Rugged Double-Plug Construction

Electrical Equivalents
1N4531 . . . 1N4148 . . . 1N914 1N4533 . . 1N4152 . . . 1N3605
1N4532 ... 1N4454 ... 1N3064 1N4534... 1N4153... 1N3606
1N4536 ... 1N4154 ... iN4009

## mechanical data

Double-plug construction affords integral positive contact by means of a thermal compression bond. Moisture-free stability is ensured through hermetic sealing. The coefficients of thermal expansion of the glass case and the dumet plugs are closely matched to allow extreme temperature excursions. Hot-solder-dipped leads are standard.

absolute maximum ratings af $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

|  |  | 1 N 4531 | 1N4532 | IN4533 | 1N4534 | 1N4536 | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| $V_{\text {RM }}$ | Peak Reverse Voltage | 100 |  |  | N4534 | 35 | N |
|  | Working Peak Reverse Voltage | 75 | 75 | 40 | 50 | 25 | $\checkmark$ |
| *P | Continuous Powar Dissipation of (or below) $25^{\circ} \mathrm{C}$ Free-Air Temperature (See Note 1) | 500 |  |  |  |  | mW |
| ${ }^{*} \mathrm{~T}_{\text {stg }}$ | Storage Temperature Rangs | -65 to 200 |  |  |  |  | ${ }^{\circ} \mathrm{C}$ |
| ${ }^{*} \mathrm{~T}_{\mathrm{L}}$ | Lead Temperature $1 / 18$ Inch from Cose for 10 Seconds | 300 |  |  |  |  | ${ }^{\circ} \mathrm{C}$ |

*electrical characteristics at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

| PARAMETER | TEST CONDITIONS | 1N4531 | IN4532 | IN4533 | IN4534 | IN4536 |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| $\mathbf{V}_{\text {(18) }}$ Reverse Breakdown Voltage |  | MIN MAX | MIN MAX | MIN MAX | MIN MAX | MIN MAX | UNIT |
|  | $\mathrm{I}_{\mathrm{R}}=5 \mu \mathrm{~A}$ | 75 | 75 | 40 | 75 | 35 | $V$ |
|  | $I_{R}=100 \mu \mathrm{~A}$ | 100 |  |  |  |  | $V$ |
| $\mathrm{I}_{\mathrm{R}} \quad$ Static Reverse Current | $V_{R}=20 \mathrm{~V}$ | 0.025 |  |  |  |  | $\mu \mathrm{A}$ |
|  | $\mathrm{V}_{\mathrm{R}}=20 \mathrm{~V}, \mathrm{~T}_{\mathrm{A}}=150^{\circ} \mathrm{C}$ | 50 |  |  |  |  | $\mu \mathrm{A}$ |
|  | $\mathrm{V}_{\mathrm{R}}=25 \mathrm{y}$ |  |  |  |  | 0.1 | $\mu \mathrm{A}$ |
|  | $\mathrm{V}_{\mathrm{R}}=25 \mathrm{~V}, \mathrm{~T}_{\mathrm{A}}=150^{\circ} \mathrm{C}$ |  |  |  |  | 100 | $\mu A$ |
|  |  |  |  | 0.05 |  |  | $\mu \mathrm{A}$ |
|  | $\mathrm{V}_{\mathrm{R}}=30 \mathrm{~V}, \mathrm{~T}_{\mathrm{A}}=150^{\circ} \mathrm{C}$ |  |  | 50 |  |  | $\mu \mathrm{A}$ |
|  | $V_{R}=50 \mathrm{~V}$ |  | 0.1 |  | 0.05 |  | $\mu \mathrm{A}$ |
|  | $V_{\mathrm{R}}=50 \mathrm{~V}, \mathrm{~T}_{\mathrm{A}}=150^{\circ} \mathrm{C}$ |  | 100 |  | 50 |  | $\mu \mathrm{A}$ |
| $V_{F} \quad$ Static Forward Voltage | $\mathrm{L}_{\mathrm{F}}=0.1 \mathrm{~mA}$ |  |  | 0.490 .55 | 0.490 .55 |  | V |
|  | $\mathrm{I}_{\mathrm{F}}=0.25 \mathrm{~mA}$ |  |  | 0.530 .59 | 0.530 .59 |  | $V$ |
|  | $\mathrm{I}_{\mathrm{F}}=1 \mathrm{~mA}$ |  |  | 0.590 .67 | 0.59 |  | $V$ |
|  | $\mathrm{I}_{\mathrm{F}}=2 \mathrm{~mA}$ |  |  | $0.62 \quad 0.70$ | $0.62 \quad 0.70$ |  | $V$ |
|  | $\mathrm{I}_{\mathrm{F}}=10 \mathrm{~mA}$ | 1 | 1 | $0.70 \quad 0.81$ | $0.70 \quad 0.81$ |  | $V$ |
|  | $l_{\text {F }}=20 \mathrm{~mA}$ |  |  | 0.74 | 0.74 |  | $V$ |
| $C_{T}$ Total Capocitance | $\mathrm{I}_{\mathrm{F}}=30 \mathrm{~mA}$ $\mathrm{~V}_{\mathrm{R}}=0, \quad \mathrm{f}=1 \mathrm{MHz}$ |  |  |  |  | 1 | $V$ |
| $\mathrm{C}_{7}$ Total Capokitance | $V_{\mathrm{R}}=0, \quad \mathrm{f}=1 \mathrm{MHz}$ | 4. | 2 | 2 | 2 | 4 | PF |

NOTE I: Derafe finearly to $200^{\circ} \mathrm{C}$ free-air femparature at the rate of $2.85 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$.
*JEDEC registored data
*operating characteristics at $25^{\circ} \mathrm{C}$ free-air temperature

| PARAMETER | TEST CONDITIONS | IN4531 | 1N4532 | 1N4533 | 1N4534 | 1N4536 | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | $\begin{aligned} & I_{\mathbf{F}}=10 \mathrm{~mA}, I_{R M}=10 \mathrm{~mA}, i_{r r}=1 \mathrm{~mA}, \\ & R_{L}=100 \Omega, \text { See Figure } 1, \quad \text { Condition } 1 \end{aligned}$ |  | 4 | 4 | 4 | 4 | ns |
| $\mathrm{trr}^{\text {rr }}$ Reverse Recovery | $\begin{array}{ll} \begin{array}{l} i_{\mathrm{F}}=10 \mathrm{~mA}, \\ X_{\mathrm{R}}=6 \mathrm{~V}, \end{array} & i_{\mathrm{rr}}=1 \mathrm{~mA}, \\ n_{L}=100 \Omega, & \text { see Figure 1, } \\ \text { Condition 2 } \end{array}$ | 4 | 2 | 2 | 2 | 2 | ns |
| $\begin{array}{\|l\|} \hline V_{\text {FMM rece) }} \text { Forward Roctage } \\ \text { Vocovery } \end{array}$ | $\mathrm{I}_{\mathrm{F}}=100 \mathrm{~mA}, \mathrm{R}_{\mathrm{L}}=50 \Omega, \quad$ See Figure 2 |  | 3 |  |  |  | V |

*PARAMETER MEASUREMENT INFORMATION


FIGURE 1 - REVERSE RECOVERY TIME
WOTES: a. The input pulse is suppliad by a gemerator with-the following char acteristics: $z_{\text {out }}=50 \Omega, \mathrm{I}_{\mathrm{r}} \leq 0.5 \mathrm{~ms}, \mathrm{t}_{\mathrm{p}}=100 \mathrm{~ns}$.
b. Oviput waveforms are meniterad en encilloscepe with the following characieristics: $\mathrm{t}_{\mathrm{r}} \leq 0.6 \mathrm{~ns}, \mathrm{t}_{\mathrm{in}}=50 \Omega$.


Figure 2 - forward recovery voltage
MOTES: c. The input pulse is suppliad by a generator with the following characteristics: $\boldsymbol{z}_{\text {out }}=50 \Omega, \mathrm{t}_{\mathrm{r}} \leq 30 \mathrm{~ms}, \mathrm{i}_{\mathrm{p}}=100 \mathrm{~ns}, \mathrm{PRR}=5$ to 100 kHz .
d. The output woveform is moniterad of an ascilloscope with the following characteristics: $\mathrm{I}_{\mathrm{r}} \leq \mathbf{1 5} \mathrm{ns}, \mathrm{n}_{\mathrm{in}} \geq \mathbf{1} \mathbf{m n}, \mathrm{c}_{\mathrm{in}} \leq \mathbf{5 p}$.

- JEDEC rugisterod data


## FAST HIGH-CURRENT CORE-DRIVER SWITCHING DIODES

## mechanical data

## - Rugged Double-Plug Construction

Double-plug construction affords integral positive contact by means of a thermal compression bond. Moisture-free stability is ensured through hermetic sealing. The coefficients of thermal expansion of the glass case and the dumet plugs are closely matched to allow extreme temperature excursions. Hot-solder-dipped leads are standard.

*absolute maximum ratings at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

*electrical characteristics at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

| Parameter | TEST CONDITIONS | IN4606 | IN4607 | IN4608 | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  | , 1000 CONDITONS | MIN MAX | MIN MAX | MIN MAX |  |
| V(0x) Reverse Breakdown Voltage | $\mathrm{I}_{\mathrm{R}}=100 \mu \mathrm{~A}$ | 85 | 85 | 85 | V |
| Static Reverse Current | $V_{\mathrm{R}}=50 \mathrm{~V}$ | 0.1 | 0.1 | 0.1 | $\mu \mathrm{A}$ |
|  | $\mathrm{V}_{\mathrm{R}}=70 \mathrm{~V}$ | 0.25 | 0.25 | 0.25 | $\mu \mathrm{A}$ |
|  | $\mathrm{V}_{\mathrm{R}}=50 \mathrm{~V}, \mathrm{~T}_{\mathrm{A}}=100^{\circ} \mathrm{C}$ | 25 | 25 | 25 | $\mu \mathrm{A}$ |
| $V_{F}$ Static Forward Volitage | $\mathrm{I}_{\mathrm{F}}=0.1 \mathrm{~mA}$ | 0.430 .55 | 0.390 .50 | $\begin{array}{lll}0.39 & 0.49\end{array}$ | V |
|  | $\mathrm{l}_{\mathrm{F}}=1 \mathrm{~mA}$ | 0.540 .66 | 0.50 | $0.50 \quad 0.60$ | $V$ |
|  | $\mathrm{I}_{\mathrm{F}}=10 \mathrm{~mA}$ | $0.65 \quad 0.77$ | $0.61 \quad 0.72$ | 0.610 .71 | $V$ |
|  | $\mathrm{I}_{\mathrm{F}}=50 \mathrm{~mA}$, See Note 2 | 0.740 .86 |  |  | $V$ |
|  | $\mathrm{I}_{\mathrm{F}}=100 \mathrm{~mA}$, See Note 2 | 0.79 | $0.74 \quad 0.87$ | $0.74 \quad 0.85$ | V |
|  | $\mathrm{I}_{\mathrm{F}}=200 \mathrm{~mA}$, See Note 2 | 0.86 |  |  | $V$ |
|  | $I_{F}=250 \mathrm{~mA}$, See Note 2 | 1.1 | 0.810 .95 | 0.810 .93 | $V$ |
|  | $I_{F}=350 \mathrm{~mA}$, See Note 2 |  | 1.0 | 0.840 .96 | $V$ |
|  | $\mathrm{I}_{\mathrm{F}}=400 \mathrm{~mA}$, See Note 2 |  | 1.1 |  | $V$ |
|  | $I_{F}=450 \mathrm{~mA}$, Soe Note 2 |  |  | 1.0 | $V$ |
|  | $\mathrm{I}_{\mathrm{F}}=500 \mathrm{~mA}$, Soe Note 2 |  |  | 1.1 | V |
| CT Total Capacitonce | $V_{R}=0, \quad f=1 \mathrm{mHz}$ | 2.5 | 4 | 4 | pF |

MOTES: 1 . Derale linearly to $200^{\circ} \mathrm{C}$ of the rete of $2.85 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$.
2. Thess paremolers must be measured wising pulso lochniques. $\mathrm{I}_{\mathrm{w}} \leq 300 \mu$ s, dury crele $\leq \mathbf{2 \%}$.

[^186]*switching characteristics at $\mathbf{2 5}{ }^{\circ} \mathrm{C}$ free-air temperature

|  |  | 1N4606 | IN4607 | 1N4608 | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: |
| PARAMETER | TEST CONDITIONS | MIN MAX | MIN MAX | MIN MAX | UNIT |
| trr Reverse Recovery lime | $\begin{aligned} & i_{f}=10 \mathrm{~mA}, \mathrm{I}_{\mathrm{RM}}=1 \mathrm{~mA}, \\ & i_{r r}=0.1 \mathrm{~m}, \mathrm{~A}_{\mathrm{L}}=100 \Omega \text {, see figure } 1 \end{aligned}$ | 6 |  |  | ms |
|  | $\begin{aligned} & I_{\mathrm{F}}=\mathrm{ImM}_{\mathrm{kM}}=10 \mathrm{~mA} \text { to } 200 \mathrm{~mA} \\ & i_{\mathrm{ir}}=0.1 \mathrm{I}_{\mathrm{F}}, R_{L}=100 \Omega \text {, See Figure 2 } \\ & \hline \end{aligned}$ | 4 |  |  | ns |
|  | $\begin{aligned} & I_{\mathrm{F}}=I_{\mathrm{RM}}=200 \mathrm{~mA} \text { to } 400 \mathrm{~mA}, \\ & i_{\mathrm{rr}}=0.1 \mathrm{I}_{\mathrm{F},} \mathrm{R}_{\mathrm{L}}=100 \Omega, \text { Soe Figure 2 } \end{aligned}$ | 6 |  |  | ns |
|  | $\begin{aligned} & I_{F}=10 \mathrm{~mA} A_{R M}=10 \mathrm{~mA}, \\ & i_{r r}=1 \mathrm{~mA}, \mathrm{R}_{\mathrm{L}}=100 \Omega, \text { seo Figure } 1 \end{aligned}$ |  | 10 | 10 | ns |
|  | $\begin{aligned} & I_{f}=500 \mathrm{~mA}, I_{\text {RM }}=500 \mathrm{~mA}, \\ & i_{\text {rr }}=50 \mathrm{~mA}, \mathrm{~h}_{\mathrm{L}}=100 \Omega \text {, See Figure } 2 \end{aligned}$ |  | 15 | 15 | ns |

## PARAMETER MEASUREMENT INFORMATION



FIGURE I-LOW-CURRENT $t_{\text {Ir }}$ TEST CIRCUIT


FIGURE 2 - HIGH-CURRENT If TEST CIRCUIT


Adjust amplitude for specified'I RM

INPUT VOLTAGE WAVEFORM FOR LOW-CURRENT TEST CIRCUIT


INPUT VOLTAGE WAVEFORM FOR HIGH-CURRENT TEST CIRCUIT


OUTPUT CURRENT WAVEFORM

$$
\text { FIGURE } 3 \text { - WAVEFORMS }
$$

MOTES: I. Input pulses are supplited by generatoss with the fellowing charecteristics.

$$
\begin{aligned}
& \text { FIGURE 1: } z_{\text {out }}=50 \Omega, i_{r} \leq 0.5 \mathrm{~ns}, i_{p}=100 \mathrm{~ns} \\
& \text { FIGURE 2: } z_{\text {out }}=50 \Omega, i_{r} \leq 0.5 \mathrm{~ns}, \mathrm{t}_{\mathrm{p}}=9 \mathrm{~ms}
\end{aligned}
$$

2. Output wevaterms are viowed on en estillescope with the following charecterlstics: $i_{r} \leq 0.6 \mathrm{~ns}, 1_{\mathrm{in}}=50 \Omega$.

* JEDEC mogistored date


## FAST SWITCHING DIODE

## - Rugged Double-Plug Construction

- Electrically Equivalent to 1N4726
mechanical data
Double-plug construction affords integral positive contact by means of a thermal compression bond. Moisture-free stability is ensured through hermetic sealing. The coefficients of thermal expansion of the glass case and the dumet plugs are closely matched to allow extreme temperature excursions. Hot-solder-dipped leads are standard.

*absolute maximum ratings at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

*electrical characteristics at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

|  | PARAMETER | TEST CONDITIONS | MIN MAX | UNIT |
| :---: | :---: | :---: | :---: | :---: |
| $V_{\text {(0) }}$ | Reverse Breakdown Voltage | $\mathrm{I}_{\mathrm{R}}=5 \mu \mathrm{~A}$ | 30 | $V$ |
| $\mathrm{I}_{\mathrm{R}}$ | Static Reverse Current | $V_{\mathrm{R}}=20 \mathrm{~V}$ | 0.1 | $\mu \mathrm{A}$ |
|  |  | $\mathrm{V}_{\mathrm{R}}=20 \mathrm{~V}, \quad \mathrm{~T}_{\mathrm{A}}=100^{\circ} \mathrm{C}$ | 10 | $\mu \mathrm{A}$ |
| $V_{F}$ | Static Forward Voltage | $\mathrm{I}_{\mathrm{F}}=10 \mathrm{~mA}$ | 0.85 | V |
| $\mathrm{C}_{\mathrm{T}}$ | Total Capacitance | $V_{R}=0, \quad f=1 \mathrm{MHz}$ | 4 | pf |

*operating characteristics at $25^{\circ} \mathrm{C}$ free-air temperature

| PARAMETER | TEST CONDITIONS | MIN MAX | UNIT |
| :---: | :---: | :---: | :---: | :---: |
| $\mathbf{Q}_{\mathbf{S}} \quad$ Stored Charge | $I_{F}=10 \mathrm{~mA}$, See Note 2 | 40 | PC |

MOTES: 1. For operation above $25^{\circ} \mathrm{C}$ free-air femperature, refer to Dissipation Derating Curve figure i.
2. Stored charge is measured in accordance with JEDEC Suggested Standard Mo. 1 (June, 1966), wsing the rest circuit of figure 2.

[^187]
## *THERMAL CHARACTERISTICS



PARAMETER MEASUREMENT INFORMATION


FIGUAE 2-STORED CHARGE TEST CIRCUIT

NOTES: a. The input pulse is supplied by a generator with the following characteristics: $Z_{o u t}=10 \Omega, t_{r}(1 \%$ to $50 \%) \leqslant 5 \mathrm{~ns}, \mathrm{t}_{\mathrm{w}}=50 \mathrm{~ns}$.
b. If is the reading of the meter with zero voltage across the diode under test (hence zero current through the diode under test); $I_{2}$ is the reading of the meter when the specified forward current ( 10 mA ) flows; $f$ is the pulse-generator frequency.
c. $V_{1}$ is adjusted for $I_{F}=10 \mathrm{~mA}$.
d. $V_{2}$ is adjusted so that the voltage between point $A$ and ground is $\mathbf{- 0 . 6} \mathbf{V}$ when the diode under test is conducting forward current.
e. The stored charge of diode $D_{1}$ is small compared to the stored charge of the diode under test.
4. The reverse recovery time of diode $D_{2}$ is short relative to the 50 -ns input pulse.
g. The resistance of the current meter is sufficiently low that doubling it does not affect the reading by more than the required accuracy.

## TYPES 1N4728 THRU 1N4752, 1N4728A THRU 1N4752A SILICON VOLTAGE-REGULATOR DIODES

BULLETIN NO. DL-S 7311949, MARCH 1973

$\mathrm{V} \underset{\mathrm{Z}}{ } \ldots 3.3 \mathrm{~V}$ to 33 V
$\mathrm{PD} \ldots 1 \mathrm{~W}$

- Available in 5\% and 10\% Tolerances
- Rugged Double-Plug Construction


## mechanical data

These voitage regulator diodes have been designed using the best of both silicon material processing and packaging technologies. The silicon die is a planar oxide-passivated structure which has additional true-glass passivation over the junction. The double-plug package, proven by years of volume production, ensures the best in mechanical integrity and the lowest possible junction temperature when compared to the thermal characteristics of whisker packages.

absolute maximum ratings at specified free-air temperature (unless otherwise noted)
${ }^{*}$ Steady-State Regulator Current, IZM, at (or below) $50^{\circ} \mathrm{C}$ (See Note 1) . . . . . . . . . . . . See Table 1
${ }^{*}$ Nonrepetitive Reverse Surge Current, IRSM, at (or below) $25^{\circ} \mathrm{C}$ (See Note 2) . . . . . . . . . . See Table 1
${ }^{*}$ Continuous Power Dissipation at (or below) $50^{\circ} \mathrm{C}$ (See Note 3) . . . . . . . . . . . . . . . . . . 1 W
*Operating Free-Air Temperature Range . . . . . . . . . . . . . . . . . . . . . . $-65^{\circ} \mathrm{C}$ to $\mathbf{2 0 0}{ }^{\circ} \mathrm{C}$
Storage Temperature Range . . . . . . . . . . . . . . . . . . . . . . . . . . . $-65^{\circ} \mathrm{C}$ to $\mathbf{2 0 0 ^ { \circ } \mathrm { C }}$
${ }^{*}$ Lead Temperature $1 / 16$ Inch from Case for 10 Seconds . . . . . . . . . . . . . . . . . . . . $230^{\circ} \mathrm{C}$
TABLE 1-CURRENT RATINGS

| TYPE | $\begin{aligned} & \mathrm{I} \mathrm{ZM} \\ & (\mathrm{~mA}) \end{aligned}$ | $\begin{aligned} & \hline \text { IRSM } \\ & \text { (mA) } \\ & \hline \end{aligned}$ | TYPE | $\begin{aligned} & \mathrm{I}_{\mathrm{ZM}} \\ & (\mathrm{~mA}) \end{aligned}$ | $\begin{aligned} & \hline \mathrm{I}_{\text {RSM }} \\ & (\mathrm{mA}) \end{aligned}$ | TYPE | $\begin{aligned} & \mathrm{I} \mathrm{ZM} \\ & (\mathrm{~mA}) \end{aligned}$ | $\begin{aligned} & \hline \text { IRSM } \\ & \text { (mA) } \end{aligned}$ |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 1N4728, A | 276 | 1380 | 1N4738, A | 110 | 550 | 1N4748, A | 41 | 205 |
| 1N4729, A | 252 | 1260 | 1N4739, A | 100 | 500 | 1N4749, A | 38 | 190 |
| 1N4730, A | 234 | 1190 | 1N4740, A | 91 | 454 | 1N4750, A | 34 | 170 |
| 1N4731, A | 217 | 1070 | 1N4741, A | 83 | 414 | 1N4751, A | 30 | 150 |
| 1N4732, A | 193 | 970 | 1N4742, A | 76 | 380 | 1N4752, A | 27 | 135 |
| 1N4733, A | 178 | 890 | 1N4743, A | 69 | 344 |  |  |  |
| 1N4734, A | 162 | 810 | 1N4744, A | 61 | 304 |  |  |  |
| 1N4735, A | 146 | 730 | 1N4745, A | 57 | 285 |  |  |  |
| 1N4736, A | 133 | 660 | 1N4746. A | 50 | 250 |  |  |  |
| 1N4737, A | 121 | 605 | 1N4747. A | 45 | 225 |  |  |  |

NOTES: 1. The nominal IZM currents shown are applicable for devices having regulator voltages approximately $10 \%$ above the nominal $V_{Z}$ values shown under electrical characteristics. These values do not represent absolute limits. The actual steady-state current-voltage product must not exceed the power rating.
2. These values apply for an $8.3-\mathrm{ms}$ square-wave pulse superposed on a steady-state reverse current equal to $\mathbf{l}_{\mathbf{Z}}(\mathrm{T})$ as shown under electrical characteristics.
3. Derate linearly to $200^{\circ} \mathrm{C}$ at the rate of $6.67 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$. See Figure 1.
*JEDEC registered data. This data sheet contains all applicable registered data in effect at the time of publication.

## TYPES 1N4728 THRU 1N4752, 1N4728A THRU 1N4752A SILICON VOLTAGE-REGULATOR DIODES

*electrical characteristics at $25^{\circ} \mathrm{C}$ free-air temperature

| CHARACTERISTICS |  |  |  |  |  | TEST CURRENT AND VOLTAGE |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| PARAMETER | $v_{z}$ <br> Regulator Voltage | $z_{z}$ <br> Small-Signal Regulator Impedance | $\mathbf{z z k}_{\mathbf{z}}$ <br> Small-Signal <br> Regulator Knee Impedance |  | $V_{F}$ <br> Static <br> Fonward Voltage |  |  |  |
| TEST CONDITIONS | $I_{R}=1 z(T)$ | $\begin{gathered} I_{R}=I_{Z}(T), \\ I_{r}=10 \% I_{Z(T)} . \\ f=60 \mathrm{~Hz} \end{gathered}$ | $\begin{gathered} I_{R}=I_{Z K}, \\ I_{r}=10 \% I_{Z K}, \\ f=60 \mathrm{~Hz} \end{gathered}$ | $\mathbf{V}_{\mathbf{R}}=\mathbf{V}_{\mathbf{R}}(\mathrm{T})$ | $I_{F}=\mathbf{2 0 0} \mathrm{mA}$ | l ( T ) | '2K | $V_{R(T)}$ |
| LIMIT | NOM ${ }^{+}$ | MAX | MAX | MAX | MAX |  |  |  |
| UNIT | $V$ | $\Omega$ | $\Omega$ | $\mu \mathbf{A}$ | V | mA | mA | V |
| 1N4728, A | 3.3 | 10 | 400 | 100 | 1.2 | 76 | 1 | 1 |
| 1N4729, A | 3.6 | 10 | 400 | 100 | 1.2 | 69 | 1 | 1 |
| 1N4730, A | 3.9 | 9 | 400 | 50 | 1.2 | 64 | 1 | 1 |
| 1N4731, A | 4.3 | 9 | 400 | 10 | 1.2 | 58 | 1 | 1 |
| 1N4732, A | 4.7 | 8 | 500 | 10 | 1.2 | 53 | 1 | 1. |
| 1N4733, A | 5.1 | 7 | 550 | 10 | 1.2 | 49 | 1 | 1 |
| 1N4734, A | 5.6 | 5 | 600 | 10 | 1.2 | 45 | 1 | 2 |
| 1N4735, A | 6.2 | 2 | 700 | 10 | 1.2 | 41 | 1 | 3 |
| 1N4736, A | 6.8 | 3.5 | 700 | 10 | 1.2 | 37 | 1 | 4 |
| IN4737, A | 7.5 | 4.0 | 700 | 10 | 1.2 | 34 | 0.5 | 5 |
| 1N4738, A | 8.2 | 4.5 | 700 | 10 | 1.2 | 31 | 0.5 | 6 |
| 1N4739, A | 9.1 | 5 | 700 | 10 | 1.2 | 28 | 0.5 | 7 |
| 1N4740, A | 10 | 7 | 700 | 10 | 1.2 | 25 | 0.25 | 7.6 |
| 1N4741, A | 11 | 8 | 700 | 5 | 1.2 | 23 | 0.25 | 8.4 |
| 1N4742, A | 12 | 9 | 700 | 5 | 1.2 | 21 | 0.25 | 9.1 |
| 1N4743, A | 13 | 10 | 700 | 5 | 1.2 | 19 | 0.25 | 9.9 |
| 1N4744, A | 15 | 14 | 700 | 5 | 1.2 | 17 | 0.25 | 11.4 |
| 1N4745, A | 16 | 16 | 700 | 5 | 1.2 | 15.5 | 0.25 | 12.2 |
| 1N4746, A | 18 | 20 | 750 | 5 | 1.2 | 14.0 | 0.25 | 13.7 |
| 1N4747, A | 20 | 22 | 750 | 5 | 1.2 | 12.5 | 0.25 | 15.2 |
| 1N4748, A | 22 | 23 | 750 | 5 | 1.2 | 11.5 | 0.25 | 16.7 |
| 1N4749, A | 24 | 25 | 750 | 5 | 1.2 | 10.5 | 0.25 | 18.2 |
| 1N4750, A | 27 | 35 | 750 | 5 | 1.2 | 9.5 | 0.25 | 20.6 |
| 1N4751, A | 30 | 40 | 1000 | 5 | 1.2 | 8.5 | 0.25 | 22.8 |
| 1N4752, A | 33 | 45 | 1000 | 5 | 1.2 | 7.5 | 0.25 | 25.1 |

${ }^{\dagger} V_{Z}$ tolerance is $\pm 10 \%$ for 1 N4728 through 1 N4752; $\pm 5 \%$ for 1 N4728A through 1 N4752A.
THERMAL INFORMATION


FIGURE 1

- JEDEC registered data
texas instruments reserves the right to make changes at any tme in order to improve design and to suppiy the best product possible.


## TYPE IN4938 SILICON SWITCHING DIODE

## HIGH-VOLTAGE SWITCHING DIODE

## - Rugged Double-Plug Construction

mechanical data

## - Electrically Equivalent to 1N3070

Double-plug construction affords integral positive contacts by means of a thermal compression bond. Moisture-free stability is ensured through hermetic sealing. The coefficients of thermal expansion of the glass case and the dumet plugs are closely matched to allow extreme temperature excursions. Hot-solder-dipped leads are standard.


## absolute maximum ratings at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)


*electrical characteristics at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

| PARAMETER |  | TEST CONDITIONS |  | MIN MAX |  | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| $V_{\text {(BR) }}$ | Reverse Breakdown Voltage | $\mathrm{I}_{\mathrm{R}}=0.1 \mathrm{~mA}$ |  | 200 |  | V |
| ${ }^{\prime} \mathrm{R}$ | Static Reverse Current | $V_{R}=175 \mathrm{~V}$ |  |  | 0.1 | $\mu \mathrm{A}$ |
|  |  | $V_{R}=175 \mathrm{~V}$, | $T_{A}=150^{\circ} \mathrm{C}$ |  | 100 |  |
| $V_{F}$ | Static Forward Voltage | $I_{F}=100 \mathrm{~mA}$ |  |  | 1 | V |
| $\mathrm{C}_{\text {T }}$ | Total Capacitance | $\mathrm{V}_{\mathrm{R}}=0$, | $\mathrm{f}=1 \mathrm{MHz}$ |  | 5 | pF |

*operating characteristics at $\mathbf{2 5}{ }^{\circ} \mathrm{C}$ free-air temperature

| PARAMETER | TEST CONDITIONS | MIN MAX | UNIT |
| :---: | :---: | :---: | :---: |
| $\mathbf{t r r}_{\text {rr }}$ Reverse Recovery Time | $\begin{array}{lll} I_{F}=30 \mathrm{~mA}, & I_{\mathrm{RM}}=30 \mathrm{~mA}, & R_{\mathrm{L}}=100 \Omega, \\ C_{\mathrm{L}}=\leqslant 3 \mathrm{pF}, & i_{\mathrm{rr}}=1 \mathrm{~mA}, & \text { See Figure } 2 \\ \hline \end{array}$ | 50 | ns |

NOTES: 1. This value may be applied continuously under single-phase $60-\mathrm{Hz}$ half-sine-wave operation with resistive load. Derate linearly to 0 at $200^{\circ} \mathrm{C}$ free-air temperature.
2. These values apply for the specified square-wave pulse with the device at nonoperating thermal equilibrium immediately prior to the surge.
3. For operation above $25^{\circ} \mathrm{C}$ free-air temperature, refer to Dissipation Derating Curve, Figure 1 .

[^188]THERMAL CHARACTERISTICS
DISSIPATION DERATING CURVE

figure 1
PARAMETER MEASUREMENT INFORMATION


NOTES: a. The input pulse is supplied by a generator with the following characteristics: $Z_{\text {out }}=50 \Omega, \mathbf{t}_{\mathbf{r}} \leqslant 0.5 \mathrm{~ns}, \mathrm{t}_{\mathbf{w}}=100 \mathrm{~ns}$. b. The output waveform is monitored on an oscilloscope with the following characteristics: $\mathbf{t}_{\mathbf{r}}<0.5 \mathrm{~ns}, \mathbf{Z}_{\mathrm{in}}=50 \Omega$.
$\mathrm{V}_{\mathrm{Z}} \ldots 3.3 \mathrm{~V}$ to 33 V
PD... 500 mW

- Available with 5\%, 10\% and 20\% Tolerances
- Rugged Double-Plug Construction
description and mechanical data
These voltage regulator diodes have been designed using the best of both silicon material processing and packaging technologies. The silicon die is a planar oxide-passivated structure which has additional true-glass passivation over the junction. The double-plug package, proven by years of volume production, ensures the best in mechanical integrity and the lowest possible junction temperature when compared to the thermal characteristics of whisker packages. Because of this rugged double-plug (heat-sink) package, these devices offer very conservatively rated power dissipation capabilities.

*absolute maximum ratings at specified lead temperature


TABLE 1-STEADY-STATE REGULATOR CURRENT

| TYPE | $\begin{aligned} & \mathrm{I}_{\mathrm{ZM}}{ }^{\dagger} \\ & (\mathrm{mA}) \end{aligned}$ | TYPE | $\begin{aligned} & \operatorname{lZM}^{4} \\ & (\mathrm{~mA}) \end{aligned}$ | TYPE | $\begin{aligned} & \left(2 M^{\dagger}\right. \\ & (\mathrm{mA}) \end{aligned}$ | TYPE | $\begin{aligned} & \mathrm{IZM}^{\dagger} \\ & (\mathrm{mA}) \end{aligned}$ |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 1N5226, A, B | 138 | 1N5234, A, B | 73 | 1N5242, A, B | 38 | 1N5250, A, B | 23 |
| 1N5227, $A, B$ | 126 | 1N5235, A, B | 67 | 1N5243, A, $B$ | 35 | 1N5251, A, B | 21 |
| 1N5228, A, B | 116 | 1N5236, A, B | 61 | 1N5244, A, B | 32 | 1N5252, A, B | 18.1 |
| 1N5229, A, B | 106 | 1N5237, A, B | 55 | 1N5245, A, B | 30 | 1N5253, A, B | 18.2 |
| 1N5230, A, B | 97 | 1N5238, A, B | 52 | 1N5246, A, B | 28 | 1N5254, A, B, | 16.8 |
| 1N5231, A, B | 89 | IN5239, A, B | 50 | 1N5247, A, B | 27 | 1N5256, A, B | 16.2 |
| 1N5232, A, B | 81 | 1N5240, A, B | 45 | 1N5248, A, B | 25 | 1N5256, A, B | 15.1 |
| 1N5233, A, B | 76 | 1N5241, A, B | 41 | 1N5249, A, B | 24 | 1N5257, A, B | 13.8 |

$\dagger^{\dagger}$ The nominal $\mathrm{I}_{2} \mathrm{M}$ currents shown are applicable for devices having regulator volteges approximately $\mathbf{1 0 \%}$ above the nominal $\mathbf{V}_{\mathbf{Z}}$ values shown under electrical charecteristics. These values do not represent absolute limits. The actual steady-state current-voltage product must not exceed the power reting.
NOTES: 1. Derate linearly to $200^{\circ} \mathrm{C}$ lead temperature at the rate of $4 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$.
2. This value applies for an $8.3-\mathrm{ms}$ square-wave pulse with the device at nonoperating thermal equilibrium immediately prior to the surge.

## 1N5226 THRU 1N5257

*electrical characteristics at $25^{\circ} \mathrm{C}$ lead temperature

| CHARACTERISTICS |  |  |  | TEST CURRENT and voltage |  |
| :---: | :---: | :---: | :---: | :---: | :---: |
| Parameter | $\mathbf{V}_{\mathbf{z}}$ <br> Requllutior Voltage | $I_{R}$ <br> Static <br> Roverse <br> Current | $\mathbf{V}_{F}$ <br> Static <br> Forwerd <br> Voltage |  |  |
| $\begin{aligned} & \text { TEST } \\ & \text { CONDITIONS } \\ & \hline \end{aligned}$ | $I_{R}=I_{Z}(T) .$ $\text { Sen Note } 3$ | $V_{R}=V_{R}(T)$ | $I_{F}=200 \mathrm{~mA}$ | Iz(T) | $V_{R}(T)$ |
| LIMIT | NOM\# | MAX | max |  |  |
| UNIT | V | $\mu \mathrm{A}$ | V | mA | V |
| 1N5226 | 3.3 | 100 | 1.1 | 20 | 0.95 |
| 1N5227 | 3.6 | 100 | 1.1 | 20 | 0.95 |
| 1N5228 | 3.9 | 75 | 1.1 | 20 | 0.95 |
| 1N5229 | 4.3 | 50 | 1.1 | 20 | 0.95 |
| 1N5230 | 4.7 | 50 | 1.1 | 20 | 1.9 |
| 1N5231 | 5.1 | 50 | 1.1 | 20 | 1.9 |
| 1N5232 | 5.6 | 50 | 1.1 | 20 | 2.9 |
| 1N5233 | 6.0 | 50 | 1.1 | 20 | 3.3 |
| 1N5234 | 6.2 | 50 | 1.1 | 20 | 3.8 |
| 1N5235 | 6.8 | 30 | 1.1 | 20 | 4.8 |
| 1N5236 | 7.5 | 30 | 1.1 | 20 | 5.7 |
| 1N5237 | 8.2 | 30 | 1.1 | 20 | 6.2 |
| 1N5238 | 8.7 | 30 | 1.1 | 20 | 6.2 |
| 1N5239 | 9.1 | 30 | 1.1 | 20 | 6.7 |
| 1N5240 | 10 | 30 | 1.1 | 20 | 7.6 |
| 1N5241 | 11 | 30 | 1.1 | 20 | 8.0 |
| 1N5242 | 12 | 10 | 1.1 | 20 | 8.7 |
| 1N5243 | 13 | 10 | 1.1 | 9.5 | 9.4 |
| 1N5244 | 14 | 10 | 1.1 | 9.0 | 9.5 |
| 1N5245 | 15 | 10 | 1.1 | 8.5 | 10.5 |
| 1N5246 | 16 | 10 | 1.1 | 7.8 | 11.4 |
| 1N5247 | 17 | 10 | 1.1 | 7.4 | 12.4 |
| 1N524B | 18 | 10 | 1.1 | 7.0 | 13.3 |
| 1N5249 | 19 | 10 | 1.1 | 6.6 | 13.3 |
| 1N5250 | 20 | 10 | 1.1 | 6.2 | 14.3 |
| 1N5251 | 22 | 10 | 1.1 | 5.6 | 16.2 |
| 1N5252 | 24 | 10 | 1.1 | 5.2 | 17.1 |
| 1N5253 | 25 | 10 | 1.1 | 5.0 | 18.1 |
| 1N5254 | 27 | 10 | 1.1 | 4.6 | 20 |
| 1N5255 | 28 | 10 | 1.1 | 4.5 | 20 |
| 1N5256 | 30 | 10 | 1.1 | 4.2 | 22 |
| 1N5257 | 33 | 10 | 1.1 | 3.8 | 24 |

$\ddagger V_{Z}$ tolerance is $\pm 20 \%$ for 1 N5226 thru 1 N5257. See next page for $5 \%$-tolerance and $10 \%$-tolerance devices.
NOTE 3: $V_{Z}$ is measured with the device at thermal equilibrium while held in clips at loast $3 / 8$ inch from the case in still air at $25^{\circ} \mathrm{C}$.
*JEDEC ragistered data

## TYPES 1N5226 THRU 1N5257. <br> 1N5226A THRU 1N5257A, 1N5226B THRU 1N5257B SILICON VOLTAGE-REGULATOR DIODES

1N5226A THRU 1N5257A AND 1N5226B THRU 1N5257B
"electrical characteristics at $\mathbf{2 5}{ }^{\circ} \mathrm{C}$ lead temperature (unless otherwise noted)

| CHARACTERISTICS |  |  |  |  |  |  |  | TEST CURRENT and voltage |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| PARAMETER | $\overline{\mathbf{v}_{\mathbf{z}}}$ <br> Regulator Voltage | $\alpha \mathbf{V z}$ <br> Temperature <br> Confficient of Requiator Voltage | 2z <br> Small-Signal Regulator Impedance | $\mathbf{z a k}_{\text {2 }}$ <br> Small-Signal Regulator Knee Imperdance | $I_{R}$ <br> Static <br> Reverse <br> Current | $\mathbf{V}_{\mathrm{F}}$ <br> Static <br> Forward Voltage | Iz(t) |  |  |
|  |  |  |  |  |  |  |  | $V_{\text {R }}(\mathrm{T})$ |  |
| TEST CONDITIONS | $\begin{aligned} & I_{R}=I_{Z(T)}, \\ & \text { See Note } 3 \end{aligned}$ | See Note 4 | $\begin{gathered} I_{R}=I_{Z}(T) . \\ L_{=10 \%}=10(T) \\ f=60 \mathrm{~Hz} \end{gathered}$ | $\begin{aligned} I_{\text {ZK }} & =250 \mu \mathrm{~A}, \\ \mathrm{I}_{\text {kk }} & =25 \mu \mathrm{~A}, \\ f & =60 \mathrm{~Hz} \end{aligned}$ | $V_{R}=V_{R(T)}$ | $I_{F}=200 \mathrm{~mA}$ |  | 1N5226A thru 1N5257A | 1N5226B thru 1N5257B |
| LIMIT | NOM ${ }^{8}$ | MAX | MaX | MAX | MAX | MAX |  |  |  |
| UNIT | V | \%PC | $\Omega$ | $\Omega$ | $\mu \mathrm{A}$ | V | mA | V | V |
| 1N5226A, B | 3.3 | -0.070 | 28 | 1600 | 25 | 1.1 | 20 | 0.95 | 1.0 |
| 1N5227A, $B$ | 3.6 | -0.065 | 24 | 1700 | 15 | 1.1 | 20 | 0.95 | 1.0 |
| 1N5228A, B | 3.9 | -0.060 | 23 | 1900 | 10 | 1.1 | 20 | 0.95 | 1.0 |
| 1N5229A, B | 4.3 | $\pm 0.055$ | 22 | 2000 | 5 | 1.1 | 20 | 0.95 | 1.0 |
| 1N5230A, B | 4.7 | $\pm 0.030$ | 19 | 1900 | 5 | 1.1 | 20 | 1.9 | 2.0 |
| IN5231A, B | 5.1 | $\pm 0.030$ | 17 | 1600 | 5 | 1.1 | 20 | 1.9 | 2.0 |
| 1N5232A, B | 5.6 | +0.038 | 11 | 1600 | 5 | 1.1 | 20 | 2.9 | 3.0 |
| 1N5233A, B | 6.0 | +0.038 | 7 | 1600 | 5 | 1.1 | 20 | 3.3 | 3.5 |
| 1N5234A, B | 6.2 | +0.045 | 7 | 1000 | 5 | 1.1 | 20 | 3.8 | 4.0 |
| 1N5235A, B | 6.8 | +0.050 | 5 | 750 | 3 | 1.1 | 20 | 4.8 | 5.0 |
| 1N5236A, B | 7.5 | +0.058 | 6 | 500 | 3 | 1.1 | 20 | 5.7 | 6.0 |
| 1N5237A, B | 8.2 | +0.062 | 8 | 500 | 3 | 1.1 | 20 | 6.2 | 6.5 |
| 1N5238A, B | 8.7 | +0.065 | 8 | 600 | 3 | 1.1 | 20 | 6.2 | 6.5 |
| 1N5239A, B | 9.1 | +0.068 | 10 | 600 | 3 | 1.1 | 20 | 6.7 | 7.0 |
| 1N5240A, B | 10 | +0.075 | 17 | 600 | 3 | 1.1 | 20 | 7.6 | 8.0 |
| 1N5241A, B | 11 | +0.076 | 22 | 600 | 2 | 1.1 | 20 | 8.0 | 8.4 |
| 1N5242A, B | 12 | +0.077 | 30 | 600 | 1 | 1.1 | 20 | 8.7 | 9.1 |
| 1N5243A, B | 13 | +0.079 | 13 | 600 | 0.5 | 1.1 | 9.5 | 9.4 | 9.9 |
| 1N5244A, B | 14 | +0.082 | 15 | 600 | 0.1 | 1.1 | 9.0 | 9.5 | 10 |
| 1N5245A, B | 15 | +0.082 | 16 | 600 | 0.1 | 1.1 | 8.5 | 10.5 | 11 |
| 1N5246A, B | 16 | +0.083 | 17 | 600 | 0.1 | 1.1 | 7.8 | 11.4 | 12 |
| 1N5247A, B | 17 | +0.084 | 19 | 600 | 0.1 | 1.1 | 7.4 | 12.4 | 13 |
| 1N5248A, B | 18 | +0.085 | 21 | 600 | 0.1 | 1.1 | 7.0 | 13.3 | 14 |
| 1N5249A, B | 19 | +0.086 | 23 | 600 | 0.1 | 1.1 | 6.6 | 13.3 | 14 |
| 1N5250A, B | 20 | +0.086 | 25 | 600 | 0.1 | 1.1 | 6.2 | 14.3 | 15 |
| 1 N5251A, B | 22 | +0.087 | 29 | 600 | 0.1 | 1.1 | 5.6 | 16.2 | 17 |
| 1N5252A, B | 24 | +0.088 | 33 | 600 | 0.1 | 1.1 | 5.2 | 17.1 | 18 |
| 1N5253A, B | 25 | +0.089 | 35 | 600 | 0.1 | 1.1 | 5.0 | 18.1 | 19 |
| 1N5254A, B | 27 | +0.090 | 41 | 600 | 0.1 | 1.1 | 4.6 | 20 | 21 |
| 1N5225A, B | 28 | +0.091 | 44 | 600 | 0.1 | 1.1 | 4.5 | 20 | 21 |
| 1N5226A, B | 30 | +0.091 | 49 | 600 | 0.1 | 1.1 | 4.2 | 22 | 23 |
| 1N5257A, B | 33 | +0.092 | 58 | 700 | 0.1 | 1.1 | 3.8 | 24 | 25 |

$\S \mathrm{V}_{\mathbf{Z}}$ tolerance is $\pm \mathbf{1 0 \%}$ for 1 N5226A thru $\mathbf{1 N 5 2 5 7 A}$ series; $\pm 5 \%$ for $\mathbf{1 N 5 2 2 6 B}$ thru $\mathbf{1 N 5 2 5 7 B}$ series. See preceding page for $20 \%$-tolerance devices.
NOTES: 3. $V_{Z}$ is measured with the device at thermal equilbrium while held in clips at least $\mathbf{3 / 8}$ inch from the case in still air at $\mathbf{2 5}{ }^{\circ} \mathrm{C}$
4. Temperature Coefficient $\alpha_{V Z}=\left[\frac{\left(v_{Z} @ 125^{\circ} \mathrm{C}\right)-\left(V_{Z} @ 25^{\circ} \mathrm{C}\right)}{\mathrm{V}_{Z} @ 25^{\circ} \mathrm{C}}\right] \times \frac{100 \% \text {. }}{125^{\circ} \mathrm{C}-25^{\circ} \mathrm{C}}$

For determining $\alpha_{V Z}, V_{Z}$ is measured at 7.5 mA for $1 \mathrm{~N} 5226 \mathrm{~A} / 1 \mathrm{~N} 52268$ thru $1 \mathrm{~N} 5242 \mathrm{~A} / 1 \mathrm{~N} 5242 \mathrm{~B}$ and at I ZT for 1 N5243A/1N5243B thru 1N5257A/1N5257B.

[^189]
## CORE-DRIVER DIODE ARRAYS

For Application With

\author{

- Magnetic Cores <br> - Thin-Film Memories <br> For Use In <br> - Airborne Computers <br> - Industrial Computers <br> - Plated-Wire Memories <br> - Decoding or Encoding Applications <br> - Military Computers <br> - Peripheral Equipment
}

Electrically Equivalent to TID21A thru TID26A, TID131, TID132

## description

These diode arrays are multiple diode junctions fabricated by a planar process and mounted in integrated circuit packages for use in high-current, fast-switching core-driver applications. These arrays offer many of the advantages of integrated circuits such as high-density packaging and improved reliability. These advantages result from such factors as fewer connections, more uniform device parameters, smaller size, less weight, fewer glass-to-metal seals, and the elimination of pressure contacts and whiskers.

## "terminal assignments and schematics


(1)

No internal connoection


1N5770, 1N5771
8-DIODE ARRAY (COMMON ANODE)
10-PIN PACKAGE

(1) No internal connection

1N5774, 1N5775
DUAL 8-DIODE ARRAY
14-PIN PACKAGE


No internal connection

[^190]
## TYPES 1 N5768 THRU $1 N 5775$ SILICON DIODE ARRAYS

mechanical data
These hermeticaliy-sealed packages consist of a ceramic base ${ }^{\star}$, metal cap ${ }^{*}$, and a 10- or 14 -lead frame. Gold-plated leads require no additional cleaning or processing when used in welded or soldered assembly.


The JEDEC registration allows these devices to be built with top and bottom surfaces either metallic or nonmetallic at the option of the manufacturer.
*absolute maximum ratings at $\mathbf{2 5} \mathbf{}{ }^{\circ} \mathbf{C}$ free-air temperature (unless otherwise noted)

| 8-DIODE ARRAYS (COMMON CATHODE) 8-DIODE ARRAYS (COMMON ANODE) 16-DIODE ARRAYS DUAL 8-DIODE ARRAYS | EACH DIODE |  | TOTAL DEVICE | UNIT |
| :---: | :---: | :---: | :---: | :---: |
|  | 1N5768 <br> 1N5770 <br> 1N5772 <br> 1N5774 | 1N5769 <br> 1N5771 <br> 1N5773 <br> 1N5775 | ALL TYPES |  |
| Peak Reverse Voltage (See Note 1) | 60 | 40 |  | $V$ |
| Steady-State Reverse Voltage, $\mathbf{V}_{\mathbf{q}}$ | 40 | 25 |  | V |
| Peak Forward Current at (or below) $25^{\circ} \mathrm{C}$ Free-Air Temperature (See Notes 1 and 2) |  |  |  | mA |
| Continuous Forward Current at (or below) $25^{\circ} \mathrm{C}$ Free-Air Temperature (See Note 3) |  |  |  | mA |
| Continuous Power Dissipation at (or below) $25^{\circ} \mathrm{C}$ Free-Air Temperature (See Note 4) |  |  | 500 | mW |
| Operating Free-Air Temperature Range |  | -65 to 15 |  | ${ }^{\circ} \mathrm{C}$ |
| Storage Temperature Range |  | -65 to 20 |  | ${ }^{\circ} \mathrm{C}$ |
| Lead Temperature 1/16 Inch from Case for 10 Seconds |  | 300 |  | ${ }^{\circ} \mathrm{C}$ |

NOTES: 1. These values apply for $\mathrm{t}_{\mathrm{w}} \leqslant \mathbf{1 0 0} \mu \mathrm{s}$, duty cycle $\leqslant \mathbf{2 0 \%}$.
2. Derate linearly to $150^{\circ} \mathrm{C}$ free-air temperature at the rate of $4 \mathrm{~mA} /{ }^{\circ} \mathrm{C}$.
3. Derate linearly to $150^{\circ} \mathrm{C}$ free-air temperature at the rate of $2.4 \mathrm{~mA}{ }^{\circ} \mathrm{C}$.
4. Derate linearly to $150^{\circ} \mathrm{C}$ free-air temperature at the rate of $4 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$.

[^191]*electrical characteristics at $25^{\circ} \mathrm{C}$ free-air temperature
single-diode operation (sea note 6)

| PARAMETER |  | TEST CONDITIONS | 1N5768 |  | 1N5769 |  | $\begin{aligned} & \hline \text { 1N5770 } \\ & \text { 1N5772 } \\ & \text { 1N5774 } \\ & \hline \end{aligned}$ |  | $\begin{aligned} & \hline \text { 1N5771 } \\ & \text { 1N5773 } \\ & \text { 1N5775 } \\ & \hline \end{aligned}$ |  | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | MIN | MAX | MIN | MAX | MIN | MAX | MIN | MAX |  |
| $V_{(B R)}$ | Reverse Braakdown Voltage |  | $I_{R}=10 \mu A, \quad$ See Note 5 | 60 |  | 40 |  | 60 |  | 40 |  | V |
| $\mathbf{I}_{\mathbf{R}}$ | Static Reverse Current | $\mathrm{V}_{\mathrm{R}}=40 \mathrm{~V}$, See Note 7 |  | 0.1 |  |  |  | 0.1 |  |  | $\mu \mathrm{A}$ |
|  |  | $V_{R}=25 \mathrm{~V}$, See Note 7 |  |  |  | 0.1 |  |  |  | 0.1 |  |
| $V_{F}$ | Static Forward Voitaga | $I_{F}=100 \mathrm{~mA}$ |  | 1 |  | 1.1 |  | 1 |  | 1.1 | V |
| $\mathrm{V}_{\mathrm{F}}$ | Instantaneous Forward Voltage | $I_{F}=500 \mathrm{~mA}$, See Note 8 |  | 1.3 |  | 1.5 |  | 1.3 |  | 1.5 | V |
| $V_{\text {FM }}$ | Peak Forward Voltage | $I_{F}=500 \mathrm{~mA}$, See Note 9 |  | 5 |  | 5 |  | 5 |  | 5 | V |
| $\mathrm{C}_{\boldsymbol{T}}$ | Total Capacitance ${ }^{\text {t }}$ | $V_{R}=0, \quad f=1 \mathrm{MHz}$ |  | 4 |  | 4 |  | 8 |  | 8 | pF |

multiple-diode operation

| PARAMETER |  | TEST CONDITIONS |  | ALL TYPES | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | MIN MAX |  |
| $\mathrm{I}_{\mathrm{R}}$ | Static Reverse Current |  |  | $V_{R}=$ rated $V_{\text {R }}$, | See Note 10 | 10 | $\mu \mathrm{A}$ |
| $V_{F}$ | Static Forward Voltage | $I_{F}=25 \mathrm{~mA}$, | See Note 10 | 1 | V |

*switching characteristics at $\mathbf{2 5}{ }^{\circ} \mathrm{C}$ free-air temperature
single-diode operation (see note 6)

| PARAMETER |  | TEST CONDITIONS |  | ALL TYPES |  | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | MIN | MAX |  |
| ${ }_{\text {f }}$ | Forwerd Recovery Time |  |  | $I_{F}=500 \mathrm{~mA}$, | See Figure 3 |  | 40 | ns |
| $\mathrm{t}_{\mathrm{rr}}$ | Reverse Recovery Time | $\begin{aligned} & T_{F}=200 \mathrm{~mA}, \\ & R_{L}=100 \Omega \end{aligned}$ <br> See Figure 4 | $\begin{aligned} & I_{R M}=200 \mathrm{~mA}, \\ & i_{r r}=20 \mathrm{~mA}, \end{aligned}$ |  | 20 | ns |

NOTES: 6. This parameter must be measured using pulse techniques. $t_{w}=100 \mu s$, duty cycle $\leqslant 20 \%$.
6. Test conditions and limits apply separately to each of the diodes. The diodes not under test are open-circuited during the measurement of these characteristics except for the measurement of $I_{R}$ on arravs having both common-cathode and common-anode diodes (see Figures 1 and 2).
7. For arrays having both common-anode'and common-cathode diodes see Figures 1 and 2, Parameter Measirrement Information section.
 puise.
9. The initial instantancous value is measured using puise. techniques. $t_{w}=150 \mathrm{~ns}$, duty cycle $\leqslant \mathbf{2 \%}$, pulse rise time $\leqslant 10 \mathrm{~ns}$. The total capacitance shunting the diode is 19 pF maximum and the equipment bandwidth is 80 MHz .
10. These parameters are messured with each of the other diodes in the section' conducting 25 mA forward current, Each diode is individually tested after the device reaches operating thermal equilibrium. Test conditions apply separately to common-anode and common-cathode sections.
${ }^{\dagger} \mathbf{C}_{\boldsymbol{T}}$ is the total pin-to-pin capacitance measured across any of the diodes. For arrays having both common-anode and common-cathode sections, the interection of the other diodes cannot easily be separated out unless three-terminal guarded measurement techniques are used. The actual capacitance of a single isolated diode will typically be $30 \%$ of the measured pin-to-pin value for the common-cathode diodes, and 75\% of the measured value for the common-anode diodes.

## TYPES 1 N5768 THRU $1 N 5775$ SILICON DIODE ARRAYS

## PARAMETER MEASUREMENT INFORMATION

When measuring the reverse current of an individual diode of a device having both common-anode and common-cathode sections, the current meter must be placed so that the shunt current through the other diodes is bypassed around the meter. To obtain accurate readings, the voltage drop across the current meter must be less than 10 mV .


FIGURE 2-TEST CIRCUIT
FIGURE 1-TEST CIRCUIT FOR FOR COMMON-ANODE DIODES


TEST CIRCUIT


FIGURE 3-FORWARD RECOVERY TIME

NOTES: d. The input pulise is supplied by a generator with the following characteristics: $t_{r} \leqslant 15 \mathrm{~ns}, \mathbf{Z}_{\text {out }}=50 \Omega, \mathrm{t}_{\mathrm{w}}=150 \mathrm{~ns}, \mathrm{duty}$ cycle $\leqslant$ $2 \%$.
b. The output waveform is monitored on an oscilloscope with the following characteristics: $t_{r} \leqslant 4.5 \mathrm{~ns}, \mathrm{R}_{\mathrm{in}} \geqslant 1 \mathrm{M} \Omega, \mathrm{C}_{\mathrm{in}} \leqslant 5 \mathrm{pF}$.

## PARAMETER MEASUREMENT INFORMATION



OUTPUT CURRENT WAVEFORM

## FIGURE 4-REVERSE RECOVERY TIME

NOTES: $c$. The input pulse is supplied by a generator with the following characteristics: $\mathbf{t}_{\mathrm{f}} \leqslant \mathbf{1} \mathbf{n s}, \mathrm{Z}_{\text {out }}=50 \Omega, \mathrm{t}_{\mathbf{w}}=200 \mathrm{~ns}, \mathrm{duty}$ cycle $\leqslant 1 \%$.
d. The output waveform is monitored on an oscilloscope with the following characteristics: $\mathrm{t}_{\mathrm{r}} \leqslant 0.4 \mathrm{~ns}, \mathrm{R}_{\text {in }}=50 \Omega$.

TYPICAL CHARACTERISTICS
FORWARD CONDUCTION CHARACTERISTICS


Figure 5
NOTE 8: This parameter is measured using pulse techniques. $t_{w}=300 \mu \mathrm{~s}$, duty cycle $=2 \%$. Read time is $90 \mu \mathrm{~s}$ from the ieading edge of the pulse.

BULLETIN NO. DL-S 7311936, MARCH 1973

## FOR STABISTOR APPLICATIONS

- Meter Protectors
- Temperature Sensors
- Transistor Biasing
- Signal Limiters
- Voltage Stabilizers
- Logarithmic Attenuators


## mechanical data

Double-plug construction affords integral positive contact by means of a thermal compression bond. Moisture-free stability is ensured through hermetic sealing. The coefficients of thermal expansion of the glass case and the dumet plugs are closely matched to allow extreme temperature excursions. Hot-solder-dipped leads are standard.

absolute maximum ratings at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

electrical characteristics at $25^{\circ} \mathrm{C}$ free-air temperature

| PARAMETER |  | TEST CONDITIONS | MIN MAX | UNIT |
| :---: | :---: | :---: | :---: | :---: |
|  | Static Reverse Current | $V_{R}=2 \mathrm{~V}$ | 0.1 | $\mu \mathrm{A}$ |
| $V_{F}$ | Static Forward Voltage | $\mathrm{I}_{\mathrm{F}}=1 \mathrm{~mA}$ | 500610 | mV |
|  |  | $I_{F}=100 \mathrm{~mA}$ | 1 | V |
| $\mathbf{r f}_{f}$ | Small-Signal Forward Resistance | $I_{F}=1 \mathrm{~mA}, \quad f=1 \mathrm{kHz}$ | 60 | $\Omega$ |

NOTES: 1. Derate linearly to $150^{\circ} \mathrm{C}$ free-air temperature at the rate of $2 \mathrm{~mA} /{ }^{\circ} \mathrm{C}$.
2. This value applies for a $60-\mathrm{Hz}$ sine wave.
3. This value applies for one-second square-wave pulse with the device at nonoperating thermal equilibrium immediately prior to the surge.

# TYPE 6129 <br> SILICON STABISTOR DIODE 

## TYPICAL APPLICATIONS

TEMPERATURE-SENSING ERIDGE

The temperature caefficient of the REF UNIT stabistor makes it well-suited to bridee circuit sensing upplications.


METER PROTECTION
The low thresheld veltoge of the stabistor will profect a sensitive microammeter from over veltoge while allowing nermal eperation.


BASE-CLAMPINE DIODE

The stabistor in this circuit provides protection for transisters having low $V_{\text {(n) }}$ evo by elamping the revarse base voltage. This type of protection allows high collector currents and does not require additional base bies.

STABILIZED TRANSISTOR BIAS

The stabistor provides temperature compensatien propertional to the tempercture coefficient of the bese emitter diode of the transistor.


## LOGARITHMIC ATTENUATORS

The characteristic of the stabistor approximates a log function accord. ing to the equation:

$$
v_{f} \simeq \frac{\eta K T}{q} \ln \left(\frac{i_{1}+i_{\operatorname{sen}}}{i_{\text {wat }}}\right)
$$

$K=$ Boltzmann's Constant
$\mathrm{T}=$ Free-Air Temperature in ${ }^{\circ}$ Kelvin
$q=$ Charge on an Electron
$i_{p}=$ Forward Diode Current

$I_{\text {rat }}=$ Diode Saturation
Current ( $\approx 10^{-9} \mathrm{amp}$ )
for $v_{i}>\frac{K T}{q}$ and $\frac{K T}{q} \approx 25.5 \mathrm{mV}$ at $T_{A}=25^{\circ} \mathrm{C}$
$\eta$ may be considered an officlancy factor, which, for an efficient stabistor, is a number close to one.

## TRANSISTOR EMITTER VARISTOR

The stabistor, acting as a variable emifter resistor for switching applications, presents a high small-signal impedance for a low de emittor current and a low small-signal impedance for a high dee emitter current. The temperature dependence of the dec voltage across the stabistor must be allowed for in setting the quiescent biasing of the transiator.

## FOR STABISTOR APPLICATIONS

- Meter Protectors
- Temperature Sensors
- Transistor Biasing
- Signal Limiters
- Voltage Stabilizers
- Logarithmic Attenuators


## mechanical data

Double-plug construction affords integral positive contact by means of a thermal compression bond. Moisture-free stability is ensured through hermetic sealing. The coefficients of thermal expansion of the glass case and the dumet plugs are closely matched to allow extreme temperature excursions. Hot-solder-dipped leads are standard.

absolute maximum ratings at $25^{\circ} \mathbf{C}$ free-air temperature (unless otherwise noted)

$$
\begin{aligned}
& \text { Peak Reverse Voltage . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . } 6 \text { V } \\
& \text { Continuous Forward Current at (or below) } \mathbf{2 5 ^ { \circ }}{ }^{\circ} \text { Free-Air Temperature (See Note 1) } \\
& \text { Repetitive Peak Forward Current at (or below) } \mathbf{2 5 ^ { \circ }}{ }^{\circ} \text { C Free-Air Temperature (See Note 2) }
\end{aligned} \text {. . . . . . . . . . . . } 150 \mathrm{~mA}
$$

electrical characteristics at $25^{\circ} \mathrm{C}$ free-air temperature

| PARAMETER |  | TEST CONDITIONS | MIN | MAX | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  | Static Reverse Current | $\mathrm{V}_{\mathrm{R}}=2 \mathrm{~V}$ |  | 0.1 | $\mu \mathrm{A}$ |
| $V_{F}$ Static Forward Voltage |  | $\mathrm{I}_{\mathrm{F}}=1 \mathrm{~mA}$ | 570 | 700 | mV |
|  |  | $I_{F}=100 \mathrm{~mA}$ |  | 1 | V |
|  | Small-Signal Forward Resistance | $\mathrm{I}_{\mathrm{F}}=1 \mathrm{~mA}, \quad f=1 \mathrm{kHz}$ |  | 60 | $\Omega$ |

NOTES: 1. Derate linearly to $150^{\circ} \mathrm{C}$ free-air temperature at the rate of $2 \mathrm{~mA}{ }^{\circ} \mathrm{C}$.
2. This value applies for $a \mathbf{6 0 - H z}$ sine wave.
3. This value applies for a one-second square-wave pulse with the device at nonoperating thermal equilibrium immediately prior to the surge.


- $V_{R M(w k g) ~ . ~ . ~} 10$ to $\mathbf{3 0 0}$ Volts
- Rugged Double-Plug Construction


## mechanical data

Double-plug construction affords integral positive contact by means of a thermal compression bond. Moisture-free stability is ensured through hermetic sealing. The coefficients of thermal expansion of the glass case and the dumet plugs are closely matched to allow extreme temperature excursions. Hot-solder-dipped leads are standard.

absolute maximum ratings

|  |  | T151 | TI52 | TI53 | TI54 | T155 | T156 | T157 | 1158 | T159 | 1160 | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| $V_{\text {RMIM }}$ (s) | Working Peak Reverse Volitage ot $25^{\circ} \mathrm{C}$ Free-Air Temperature | 10 | 20 | 30 | 40 | 60 | 100 | 150 | 175 | 200 | 300 | V |
| P | Continuous Power Dissipation at (or below) $25^{\circ} \mathrm{C}$ Free-Air Temperature (See Note) | 400 |  |  |  |  |  |  |  |  |  | mW |
| $T_{\text {Alopr) }}$ | Operating Free-Air Temperature Range | -65 to 100 |  |  |  |  |  |  |  |  |  | ${ }^{\circ} \mathrm{C}$ |
| $\mathrm{T}_{\text {stg }}$ | Storage Temperature Range | -65 to 125 |  |  |  |  |  |  |  |  |  | ${ }^{\circ} \mathrm{C}$ |

electrical characteristics of $25^{\circ} \mathrm{C}$ free-air temperature

| PARA | AMETER | TEST CONDITIONS | TI51 | 1152 | T153 | TI54 | 1155 | T156 | 1157 | T158 | T159 | T160 | UNIT | LIMIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| $V_{\text {(Ra) }}$ | Reverse <br> Breakdown <br> Voltage | $\mathrm{I}_{\mathrm{R}}=100 \mu \mathrm{~A}$ | 20 | 30 | 40 | 50 | 80 | 120 | 200 | 270 | 320 | 400 | y | M M |
| $I_{R}$ | Static Reverse Current | $\mathrm{V}_{\mathrm{R}}=$ Roted $\mathrm{V}_{\mathrm{RM}}(\mathrm{wgg})$ | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | $\mu \mathrm{A}$ | MAX |
| $\mathbf{V F}_{\mathbf{F}}$ | Static Forward Voltage | $\mathrm{I}_{\mathrm{F}}=200 \mathrm{~mA}$ | 1 | 1 | 1 | 1 | 1 |  |  |  |  |  | $V$ | MAX |
|  |  | $I_{F}=400 \mathrm{~mA}$ |  |  |  |  |  | 1 | 1 | 1 | 1 | 1 | $v$ | max |

NOTE: Derate linearly to $100^{\circ} \mathrm{C}$ free-air temperature at the rate of $5.33 \mathrm{~mW} \rho^{\circ} \mathrm{C}$.

# TYPES TI 71 THRU TI75 SILICON SWITCHING DIODES 

## MEDIUM-SPEED SWITCHING DIODES

- For Industrial Switching Applications
- Rugged Double-Plug Construction
mechanical data
Double-plug construction affords integral positive contacts by means of a thermal compression bond. Moisture-free stability is ensured through hermeti sealing. The coefficients of thermal expansion of the glass case and the dumet plugs are closely matched to allow extreme temperature excursions. Hot-solder-dipped leads are standard.

absolute maximum ratings at $\mathbf{2 5} \mathbf{}{ }^{\circ} \mathbf{C}$ free-air temperature (unless otherwise noted)

electrical characteristics at $25^{\circ} \mathrm{C}$ free-air temperature

| PARAMETER |  | TEST CONDITIONS | TI71 |  | TI72 |  | T173 |  | T174 |  | T175 |  | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | MIN | MAX | MIN | MAX | MIN | MAX | MIN | MAX | MIN | MAX |  |
| $V_{\text {(BR) }}$ | Reverse Breakdown Voltage |  | $I_{R}=100 \mu \mathrm{~A}$ | 40 |  | 40 |  | 40 |  | 40 |  | 40 |  | V |
| $I_{R}$ | Static Reverse Current | $V_{R}=15 \mathrm{~V}$ |  |  |  |  |  |  |  | 1 |  |  | $\mu \mathrm{A}$ |
|  |  | $\mathrm{V}_{\mathrm{R}}=20 \mathrm{~V}$ |  | 1 |  | 1 |  | 1 |  |  |  |  |  |
|  |  | $V_{R}=35 \mathrm{~V}$ |  |  |  |  |  |  |  |  |  | 5 |  |
| $\mathbf{V}_{\mathbf{F}}$ | Static Forward Voltage | $I_{F}=6 \mathrm{~mA}$ |  | 1 |  |  |  |  |  |  |  |  | V |
|  |  | $\mathrm{I}_{F}=10 \mathrm{~mA}$ |  |  |  | 1 |  |  |  |  |  |  |  |
|  |  | $\mathrm{I}_{F}=20 \mathrm{~mA}$ |  |  |  |  |  | 1 |  |  |  |  |  |
|  |  | $\mathrm{I}_{\mathrm{F}}=30 \mathrm{~mA}$ |  |  |  |  |  |  |  | 1 |  |  |  |
|  |  | $\mathrm{I}_{\mathrm{F}}=75 \mathrm{~mA}$ |  |  |  |  |  |  |  |  |  | 1 |  |

switching characteristics at $25^{\circ} \mathrm{C}$ free-air temperature

| PARAMETER |  | TEST CONDITIONS | T171 |  | 7172 |  | T173 |  | T174 |  | TI75 |  | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | MIN | MAX | MIN | MAX | MIN | MAX | MIN | MAX | MIN | MAX |  |
| $\mathrm{trr}^{\text {r }}$ | Reverse <br> Renovery <br> Time |  | $\begin{array}{ll} I_{F}=10 \mathrm{~mA}, & I_{R M}=10 \mathrm{~mA}, \\ R_{L}=100 \Omega, & C_{L}=10 \mathrm{pF}, \\ i_{r r}=1 \mathrm{~mA}, & \text { See Figure } 1 \end{array}$ |  | 10 |  | 20 |  | 20 |  | 30 |  | 50 | ns |

[^192]
figure I - reverse recovery time
NOTES: a. The input pulse is supplied by a generator with the following characteristics: $Z_{\text {out }}=50 \Omega, t_{r} \leqslant 0.25 \mathrm{~ns}, \mathrm{t}_{\mathrm{w}}=100 \mathrm{~ns}$. b. Output waveform is monitored on en oscilloscope with the following characteristic: $\mathrm{t}_{\mathbf{r}}<\mathbf{0 . 3 5} \mathrm{ns}, \mathbf{Z}_{\text {in }}=60 \Omega$.

THERMAL CHARACTERISTICS
DISSIPATION DERATING CURVE


## HIGH-VOLTAGE RADIATION-TOLERANT DIODES

- Extremely Resistant to Radiation Environments
- Rugged Double-Plug Construction
mechanical data
Double-plug construction affords integral positive contact by means of a thermal compression bond. Moisture-free stability is ensured through hermetic sealing. The coefficients of thermal expansion of the glass case and the dumet plugs are closely matched to allow extreme temperature excursions. Hot-solder-dipped leads are standard.

absolute maximum ratings af $\mathbf{2 5}^{\circ} \mathrm{C}$ free-air temporature (unless otherwise noted)

|  |  | 71550 | 71551 | UNIT |
| :---: | :---: | :---: | :---: | :---: |
| $\mathrm{V}_{\mathrm{R}}$ | Steady State Reverse Voltage | 175 | 225 | v |
| ${ }_{1}$ | Average Rectified Forward Current from $-55^{\circ} \mathrm{C}$ to $+75^{\circ}$ Free-Air Temperature (See Note 1) | 150 | 150 | ma |
| $\mathrm{I}_{\text {FM }}$ | Peak Forward Current from $-55^{\circ} \mathrm{C}$ to $+75^{\circ} \mathrm{C}$ <br> Free-Air Temperature (See Note 1) | 500 | 500 | ma |
| $\mathrm{I}_{\text {FM (surge) }}$ | Surge Current, One Cycle (See Note 2) | 4 | 4 | - |
| $\mathrm{T}_{\text {Alopr) }}$ | Operating Free-Air Temperature Range | $-55 \text { to }+125$ |  | ${ }^{\circ} \mathrm{C}$ |
| $\mathrm{T}_{\text {stg }}$ | Storage Temperature Range | -55 to +200 |  | ${ }^{\circ} \mathrm{C}$ |

electrical characteristics at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

| PARAMETER |  | TEST CONDITIONS | 71550 |  | 71551 |  | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | MIN | MAX | MIN | MAX |  |
| $V_{\text {(ak) }}$ | Roverse Breakdown Voltage |  | $\mathrm{I}_{\mathrm{R}}=100 \mathrm{va}$ | 200 | 300 | 290 | 400 | $\vee$ |
| $\Delta Y_{\text {(LR) }}$ | Breakdown Voltage Change With Reverse Current | $\mathrm{I}_{\mathrm{R}}=1 \mu \mathrm{a}$ to $\mathrm{I}_{\mathrm{R}}=100 \mu \mathrm{a}$ |  | 20 |  | 20 | $\checkmark$ |
| $\mathrm{I}_{\mathrm{R}}$ | Static Reverse Current | $\mathbf{V}_{\mathbf{R}}=$ Rated $\mathrm{V}_{\mathbf{R}}$ |  | 0.1 |  | 0.1 | $\mu \mathrm{a}$ |
| $\mathrm{I}_{\mathbf{R}}$ | Static Reverse Current | $\mathrm{V}_{\mathrm{R}}=$ Rated $\mathrm{V}_{\mathrm{R}}, \mathrm{T}_{\mathrm{A}}=125^{\circ} \mathrm{C}$ |  | 10 |  | 10 | $\mu \mathrm{a}$ |
| $\mathbf{V}_{\text {F }}$ | Static Forward Voltage | $\mathrm{J}_{\mathrm{F}}=100 \mathrm{ma}$ |  | 1 |  | 1 | $\checkmark$ |
| $\mathrm{C}_{\text {T }}$ | Total Capacitance | $\mathrm{V}_{\mathrm{R}}=0, f=1 \mathrm{Mc}$ |  | 20 |  | 20 | pf |

switching characteristics at $25^{\circ} \mathrm{C}$ free-air temperature

| $t_{\text {trr }}$ | Reverse Recovery Timo | Soe Note 3 | 0.7 | 0.7 | $\mu \mathrm{mec}$ |
| :---: | :---: | :---: | :---: | :---: | :---: |

radiation-resistance characteristics at $25^{\circ} \mathrm{C}$ free-air temperature

| PARAMETER |  | TEST | RADIATION DOSE $\dagger$ |  | T1550 |  | T1551 |  | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | T1550 | T1551 | MIN | MAX | MIN | MAX |  |
| $V$ (ex) | Reverse Breakdown Voltage |  | $1_{\mathrm{R}}=100 \mu \mathrm{a}$ | $5 \times 10^{16}$ e/cm ${ }^{2}$ | $1 \times 10^{16} \cdot / \mathrm{cm}^{2}$ | 200 |  | 290 |  | V |
| $\mathrm{I}_{\mathrm{R}}$ | Static Reverse Current | $\mathrm{V}_{\mathrm{R}}=$ Ratod $\mathrm{V}_{\mathrm{R}}$ | $5 \times 10^{16} \mathrm{e} / \mathrm{cm}^{2}$ | $1 \times 10^{16} / \mathrm{cm}^{2}$ |  | 0.1 |  | 0.1 | $\mu$ |
| $V_{F}$ | Static Forward Voltage | $\mathrm{I}_{\mathrm{F}}=100 \mathrm{ma}$ | $5 \times 10^{16} / \mathrm{cm}^{2}$ | $1 \times 10^{16} \cdot / \mathrm{cm}^{2}$ |  | 1 |  | 1 | $\checkmark$ |
| $V_{\text {( }{ }_{\text {a }} \text { ) }}$ | Reverse Breakdown Voltage | $I_{R}=100 \mu \mathrm{a}$ | $2 \times 10^{15} \mathrm{~N} / \mathrm{cm}^{2}$ | $1 \times 10^{15} \mathrm{~N} / \mathrm{cm}^{2}$ | 200 |  | 290 |  | $\checkmark$ |
| $\mathrm{I}_{\mathrm{R}}$ | Static Reverse Current | $\mathrm{V}_{\mathrm{R}}=$ Rated $\mathrm{V}_{\mathrm{R}}$ | $2 \times 10^{15} \mathrm{~N} / \mathrm{cm}^{2}$ | $1 \times 10^{15} \mathrm{~N} / \mathrm{cm}^{2}$ |  | 0.1 |  | 0.1 | $\mu$ |
| $\mathrm{V}_{\mathrm{F}}$ | Static Forward Voltage | $\mathrm{If}_{\mathrm{F}}=100 \mathrm{ma}$ | $2 \times 10^{15} \mathrm{~N} / \mathrm{cm}^{2}$ | $1 \times 10^{15} \mathrm{~N} / \mathrm{cm}^{2}$ |  | 1.1 |  | 1.2 | $v$ |

thodiation levals are dectrons (o) at $E=2$ Mev or noutrons ( $M$ ) at $E \geq 10 \mathrm{kov}$.
MOTES: 1. These velves may be applied continueusily under single-phose, $60-\mathrm{eps}$, half-sine-wave operation with resistive load. Above $75^{\circ} \mathrm{C}$, derate $\mathrm{I}_{\mathrm{O}}$ and $\mathrm{I}_{\mathrm{fm}}$ linearly to $125^{\circ} \mathrm{C}$ fret-air temperature.
2. This value applies for one $\mathbf{s 0 - c p s}$ hali-sino-wava when the device is aperating at or below ruted values of peak reverse voitage and average rectified forward curnsat. Surge may be mepeated ofter the device has roturaed to original thermal equilibrium conditions.
3. Reverse recovery time is measured in the tost circeit of Drawing $256-\mathrm{Jan}$ with $\mathrm{I}_{\mathrm{F}}=5 \mathrm{ma}, \mathbf{Y}_{\mathrm{R}}=40 \mathrm{v}, \mathrm{i}_{\mathrm{rr}}=500 \mu \mathrm{a}, \mathrm{R}_{\mathrm{L}}=2 \mathrm{k} \Omega$, and $\mathrm{C}_{\mathrm{L}}=10 \mathrm{pf}$.
texas instruments reserves the right to make changes at any time in order to improve design and to supply the best product possible.

## DUAL-DIODE CORE DRIVERS

## For Application with

Magnetic Cores - Memory Drums - Memory Tapes Magnetic Discs - Diode-Capacitor Storage
mechanical data

schematic diagrams

absolute maximum ratings at $\mathbf{2 5}{ }^{\circ} \mathbf{C}$ free-air temperature (unless otherwise noted)

|  | EACH DIODE |  | TOTAL DEVICE | UNIT |
| :---: | :---: | :---: | :---: | :---: |
|  | $\begin{array}{\|l\|} \hline \text { TID17 } \\ \text { TID19 } \\ \hline \end{array}$ | $\begin{array}{\|l\|} \hline \text { TID18 } \\ \text { TID20 } \\ \hline \end{array}$ | ALL TYPES |  |
| Peak Reverse Voltage (See Note 1) | 60 | 40 |  | V |
| Steady State Reverse Voltage, $\mathbf{V}_{\mathbf{R}}$ | 30 | 15 |  | V |
| Peak Forward Current at (or below) $25^{\circ} \mathrm{C}$ Free-Air Temperature (See Notes 1 and 2) |  | 00 | 500 | mA |
| Continuous Forward Current at (or below) $25^{\circ} \mathrm{C}$ Free-Air Temperature (See Note 3) | 10 | 00 | 200 | mA |
| Storage Temperature Range | -65 to 200 |  |  | C |
| Lead Temperature 1/16 Inch from Case for 10 Seconds | 300 |  |  | ${ }^{\circ} \mathrm{C}$ |

NOTES: 1. These values apply for $\mathbf{t}_{\mathbf{w}}<\mathbf{1 0 0} \mu \mathrm{s}$, duty cycle $\leqslant \mathbf{2 0 \%}$.
2. Derate linearly to $150^{\circ} \mathrm{C}$ free-air tempersture at the rate of $4 \mathrm{~mA} /{ }^{\circ} \mathrm{C}$.
3. Derate linearly to $150^{\circ} \mathrm{C}$ free-air temperature at the rate of $0.8 \mathrm{~mA} /^{\circ} \mathrm{C}$ for each diode and $1.6 \mathrm{~mA} /{ }^{\circ} \mathrm{C}$ for the total device.
electrical characteristics at $25^{\circ} \mathrm{C}$ free-air temperature
single-diode operation (see note 4)

| PARAMETER |  | TEST CONDITIONS | TID17 | TID18 | TID19 | TID20 | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | MIN MAX | MIN MAX | MIN MAX | MIN MAX |  |
| $V_{\text {(BR) }}$ | Reverse Breakdown Voltage |  | $I_{R}=10 \mu \mathrm{~A}, \quad$ See Note 5 | 60 | 40 | 60 | 40 | V |
| $I_{R}$ | Static Reverse Current | $V_{\text {R }}=30 \mathrm{~V}$ | 0.1 |  | 0.1 |  | $\mu \mathrm{A}$ |
|  |  | $V_{R}=15 \mathrm{~V}$ |  | 0.1 |  | 0.1 |  |
| $V_{F}$ | Static Forward Voltage | $I_{F}=100 \mathrm{~mA}$ | 1 | 1.1 | 1 | 1.1 | V |
| $V_{F}$ | Instantaneous Forward Voltage | $I_{F}=500 \mathrm{~mA}$, See Note 6 | 1.5 | 1.7 | 1.5 | 1.7 | V |
| $V_{\text {FM }}$ | Peak Forward Voltege | $I_{F M}=500 \mathrm{~mA}$, See Note 7 | 5 | 5 | 5 | 5 | V |
| $\mathrm{C}_{\boldsymbol{T}}$ | Total Capacitance | $V_{R}=0, \quad t=1 \mathrm{MHz}$ | 4 | 4 | 7 | 7 | pF |

dual-diode operation (see note 8)

| PARAMETER | TEST CONDITIONS | TID17 | TID18 | TID19 | TID20 | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | MIN MAX | MIN MAX | MIN MAX | MIN MAX |  |
| $\mathbf{I}_{\mathbf{R 1}}$ (or $\mathbf{I R 2}^{\prime}$ ) Static Reverse Current | $\begin{aligned} & V_{R 1}\left(\text { or } V_{R 2}\right)=\text { rated } V_{R}, \\ & I_{F 2}\left(\text { or } I_{F_{1}}\right)=100 \mathrm{~mA} \end{aligned}$ | 1 | 1 | 1 | 1 | $\mu \mathrm{A}$ |
| $\mathrm{V}_{\mathrm{F} 1}$ (or $\mathrm{V}_{\mathrm{F} 2}$ ) Static Forward Voltage | $I_{F}=I_{F 2}=100 \mathrm{~mA}$ | 1 | 1.1 | 1 | 1.1 | V |

switching characteristics at $\mathbf{2 5}{ }^{\circ} \mathrm{C}$ free-air temperature
single-diode operation (see note 4)

| PARAMETER |  | TEST CONDITIONS |  | $\frac{\text { ALL TYPES }}{\text { MAX }}$ | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  |  |
| tfr | Forward Recovery Time | $I_{F}=500 \mathrm{~mA}$, | See Figure 2 | 40 | ns |
| $\mathrm{trr}_{\mathrm{rr}}$ | Reverse Recovery Time | $\begin{aligned} & I_{F}=200 \mathrm{~mA}, \\ & R_{L}=100 \Omega, \\ & i_{r r}=20 \mathrm{~mA}, \end{aligned}$ | $I_{R M}=200 \mathrm{~mA}$ <br> See Figure 3 | 25 | ns |

NOTES: 4. Test conditions and limits apply separately to each of the two diodes. The diode not under test is open-circuited during the measurement of these characteristics.
5. This parameter must be measured using pulse techniques. $\mathbf{t}_{\mathbf{w}}=\mathbf{1 0 0} \mu \mathrm{s}$, duty cycle $\leqslant \mathbf{2 0 \%}$.
6. This parameter is measured using pulse techniques. $t_{w}=100 \mu \mathrm{~s}$, duty cycle $<2 \%$. Read time is $\mathbf{9 0} \mu \mathrm{s}$ from leading edge of the pulse.
7. The initial instentaneous value is measured using pulse techniques. $\mathbf{t w w}_{\mathbf{w}}=\mathbf{1 5 0} \mu \mathrm{s}$, duty cycle $<\mathbf{2 \%}$, pulse rise time $<\mathbf{1 0} \mathrm{ns}$. The total capacitance shunting the diode is 19 pF maximum and the equipment bandwidth is 80 MHz .
8. Each diode is individualiy tested after the device reaches operating thermal equilibrium.

## TYPES TIDTT THRU TID2O <br> SILICON DUAL DIODES



NOTE 6: This parameter is measured using pulse techniques. $t_{w}=100 \mu s$, duty cycle $\leqslant 2 \%$. Read time is $90 \mu \mathrm{~s}$ from leading edge of the pulse.
PARAMETER MEASUREMENT INFORMATION


TEST CIRCUIT
VOLTAGE WAVEFORMS
FIGURE 2-FORWARD RECOVERY TIME
 cycle $\leqslant 2 \%$.
b. Output waveform is monitored on an oscilloscope with the following characteristics: $\tau_{r} \leqslant 4.5 \mathrm{~ns}, \mathrm{R}_{\text {in }} \geqslant 1 \mathrm{M} \Omega, \mathrm{C}_{\text {in }} \leqslant 5 \mathrm{pF}$.

## PARAMETER MEASUREMENT INFORMATION



OUTPUT CURRENT WAVEFORM

[^193]
## CORE-DRIVER DIODE ARRAYS

## For Application With

- Magnetic Cores
- Thin-Film Memories
- Plated-Wire Memories
- Decoding or Encoding Applications

For Use In

- Airborne Computers
- Industrial Computers
- Military Computers
- Peripheral Equipment


## description

These diode arrays are multiple diode junctions fabricated by a planar process and mounted in integrated circuit packages for use in high-current, fast-switching core-driver applications. These arrays offer many of the advantages of integrated circuits such as high-density packaging and improved reliability. These advantages result from such factors as fewer connections, more uniform device parameters, smaller size, less weight, fewer glass-to-metal seals, and the elimination of pressure contacts and whiskers.

The arrays are available in hermetically sealed, welded flat packages ( $F$ ) or in dual-in-line plastic packages ( N ).
absolute maximum ratings at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

| 8-DIODE ARRAYS (COMMON CATHODE) <br> 8-DIODE ARRAYS (COMMON ANODE) <br> 16-DIODE ARRAYS <br> DUAL 10-DIODE ARRAYS <br> DUAL 8-DIODE ARRAYS | FLAT PACKAGE |  |  | DUAL-IN-LINE PACKAGE |  |  | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | EACH DIODE |  | TOTAL DEVICE | EACH DIODE |  | TOTAL DEVICE |  |
|  | $\begin{array}{\|l\|} \hline \text { TID21A } \\ \text { TID23A } \\ \text { TID25A } \\ \text { TID29A } \\ \text { TID131 } \\ \hline \end{array}$ | $\begin{aligned} & \text { TID22A } \\ & \text { TID24A } \\ & \text { TID26A } \\ & \text { TID30A } \\ & \text { TID132 } \end{aligned}$ | ALL TYPES | $\begin{aligned} & \text { TID121 } \\ & \text { TID123 } \\ & \text { TID125 } \\ & \text { TID129 } \\ & \text { TID133 } \end{aligned}$ | $\begin{aligned} & \text { TID122 } \\ & \text { TID124 } \\ & \text { TID126 } \\ & \text { TID130 } \\ & \text { TID134 } \end{aligned}$ | ALL TYPES |  |
| Peak Reverse Voltage (See Note 1) | 60 | 40 |  | 60 | 40 |  | V |
| Steady-State Reverse Voltage, $\mathrm{V}_{\mathrm{R}}$ | 40 | 25 |  | 40 | 25 |  | $V$ |
| Peak Forward Current at (or below) $25^{\circ} \mathrm{C}$ Free-Air Temperature (See Note 1) |  |  |  |  |  |  | mA |
| Continuous Forward Current at (or below) $25^{\circ} \mathrm{C}$ Free-Air Temperature |  |  |  |  |  |  | mA |
| Continuous Power Dissipation at (or below) $25^{\circ} \mathrm{C}$ Free-Air Temperature |  |  | 5003 |  |  | $600^{\circ}$ | mW |
| Operating Free-Air Temperature Range |  | -65 to 150 |  |  | 65 to 125 |  | ${ }^{\circ}$ |
| Storage Temperature Range |  | -65 to 200 |  |  | 65 to 150 |  | C |
| Lead Temperature 1/16 Inch from Case for 10 Seconds |  | 300 |  |  | 260 |  | ${ }^{\circ} \mathrm{C}$ |

NOTE 1: These values apply for $\tau_{w} \leqslant 100 \mu$ s, duty cycle $\leqslant 20 \%$.
${ }^{t}$ Derate linearly to $150^{\circ} \mathrm{C}$ free-air temperature at the rate of $4 \mathrm{~mA} /{ }^{\circ} \mathrm{C}$.
¥ Derate linearly to $125^{\circ} \mathrm{C}$ free-air temperature at the rate of $5 \mathrm{~mA} /{ }^{\circ} \mathrm{C}$.
§Derate linearly to $150^{\circ} \mathrm{C}$ free-air temperature at the rate of $2.4 \mathrm{~mA} /{ }^{\circ} \mathrm{C}$.
D Derate linearly to $125^{\circ} \mathrm{C}$ free-air temperature at the rate of $4 \mathrm{~mA} /{ }^{\circ} \mathrm{C}$.
${ }^{\circ}$ Derate linearly to $150^{\circ} \mathrm{C}$ free-air temperature at the rate of $4 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$.
${ }^{\circ}$ Derate linearly to $125^{\circ} \mathrm{C}$ free-air temperature at the rate of $6 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$.

# TYPES TID21A THRU TID26A, TID29A, TID30A, TID121 THRU TID126, TID129 THRU TID134 SILICON DIODE ARRAYS 

| F FLAT PACKAGES | 14-PIN N PLASTIC DUAL-IN-LINE PACKAGES |
| :---: | :---: |
| T1021A $11222 A$ TRAY (COMMON CATHODE) 10-PIN PACKAGE <br> No internal connection | TID121, TID122 <br> 8-DIODE ARRAY (COMMON CATHODE) 14-PIN PACKAGE <br> (1) (4) (6) (13) No internal connection |
| (1) No internal connection |  |
|  |  |
|  |  |
|  |  |

## TYPES TID21A THRU TID26A, TID29A, TID30A, TID121 THRU TID126, TID129 THRU TID134 SILICON DIODE ARRAYS

electrical characteristics at $25^{\circ} \mathrm{C}$ free-air temperature

multiple-diode operation

| PARAMETER |  | TEST CONDITIONS |  | ALL TYPES | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | MIN MAX |  |
| $I_{R}$ | Static Reverse Current |  |  | $\mathrm{V}_{\mathbf{R}}=\operatorname{rated} \mathrm{V}_{\mathrm{R}}$, | See Note 7 | 10 | $\mu \mathrm{A}$ |
| $V_{F}$ | Static Forward Voltage | $I_{F}=25 \mathrm{~mA}$, | See Note 7 | 1 | V |

switching characteristics at $25^{\circ} \mathrm{C}$ free-air temperature
single-diode operation (see note 3)

| PARAMETER |  | TEST CONDITIONS |  | ALL TYPES |  | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | MIN | MAX |  |
| ${ }_{\text {t }}^{\text {fr }}$ | Forward Recovery Time |  |  | $I_{F}=500 \mathrm{~mA}$, | See Figure 3 |  | 40 | ns |
| $t_{\text {rr }}$ | Reverse Recovery Time | $\begin{aligned} & I_{F}=200 \mathrm{~mA}, \\ & R_{L}=100 \Omega, \\ & \text { See Figure } 4 \end{aligned}$ | $\begin{aligned} & I_{R M}=200 \mathrm{~mA}, \\ & i_{r r}=20 \mathrm{~mA}, \end{aligned}$ |  | 20 | ns |

NOTES: 2. This parameter must be measured using pulse techniques, $\mathrm{t}_{\mathrm{w}}=\mathbf{1 0 0} \mu \mathrm{s}$, duty cycle $\leqslant \mathbf{2 0 \%}$.
3. Test conditions and limits apply separately to each of the diodes. The diodes not under test are open-circuited during the measurement of these characteristics except for the measurement of $\mathrm{I}_{\mathbf{R}}$ on arrays having both common-cathode and commonanode diodes (see Figures 1 and 2).
4. For arrays having both common-anode and common-cathode diodes see Figures 1 and 2, Parameter Measurement Information section.
5. This parameter is measured using pulse techniques. $t_{w}=300 \mu_{s}$, duty cycle $\leqslant 2 \%$. Read time is $90 \mu_{s}$ from the leading edge of the pulse.
6. The initial instantaneous value is measured using pulse techniques. $\mathbf{t}_{\mathbf{w}}=\mathbf{1 5 0} \mathbf{n s}$, duty cycle $\leqslant \mathbf{2 \%}$, pulse rise time $\leqslant 10 \mathrm{~ns}$. The total capacitance shunting the diode is 19 pF maximum and the equipment bandwidth is 80 MHz .
7. These parmeters are measured with each of the other diodes in the section conducting 25 mA forward current. Each diode is individually tested after the device reaches oparating thermal equilibrium. Test conditions apply separately to common-anode and common-cathode sections.

[^194]
# TYPES TID21A THRU TID26A, TID29A, TID30A, TID121 THRU TID126, TID129 THRU TID134 SILICON DIODE ARRAYS 

## PARAMETER MEASUREMENT INFORMATION

When measuring the reverse current of an individual diode of a device having both common-anode and common-cathode sections, the current meter must be placed so that the shunt current through the other diodes is bypassed around the meter. To obtain accurate readings, the voltage drop across the current meter must be less than 10 mV .


FIGURE 2-TEST CIRCUIT
FIGURE 1-TEST CIRCUIT FOR
FOR COMMON-ANODE DIODES COMMON-CATHODE DIODES


VOLTAGE WAVEFORMS
FIGURE 3-FORWARD RECOVERY TIME
 $2 \%$
b. The output waveform is monitored on an oscilloscope with the following characteristics: $t_{r} \leqslant 4.5 \mathrm{~ns}, \mathrm{R}_{\mathrm{in}} \geqslant \uparrow \mathrm{M} \Omega, \mathrm{C}_{\mathrm{in}} \leqslant 5 \mathrm{pF}$.


FIGURE 4-REVERSE RECOVERY TIME
NOTES: c. The input pulse is supplied by a generator with the following characteristics: $\tau_{f} \leqslant 1 \mathrm{~ns}, \mathrm{Z}_{\text {out }}=50 \Omega$, $\mathrm{t}_{\mathbf{w}}=200 \mathrm{~ns}, \mathrm{duty}$ cycle $\leqslant 1 \%$.
d. The output waveform is monitored on an oscilloscope with the following characteristics: $\mathrm{t}_{\mathrm{r}}<0.4 \mathrm{~ns}, \mathrm{R}_{\text {in }}=50 \Omega$.

TYPICAL CHARACTERISTICS
FORWARD CONDUCTION CHARACTERISTICS


FIGURE 5
NOTE 8: This parameter is mesaured using puise techniques. $t_{w}=300 \mu \mathrm{~s}$, duty cycle $=\mathbf{2 \%}$. Read time is $90 \mu \mathrm{~s}$ from the leading edge of the pulso.

## MECHANICAL DATA

## F flat packages

These hermetic packages feature glass-to-metal seals and welded construction in 10 -pin and 14 -pin configurations. Package body and leads are gold-plated F-15 $\ddagger$ glass-sealing alloy. Approximate weight is 0.1 gram. All external surfaces are metallic. Devices are shipped mounted in a Mech-Pak carrier.

TID21A, TID22A, TID23A, TID24A, TID25A, TID26A


TID29A, TID30A, TID131, TID132


## N plastic dual-in-line package

The compound used to mold the dual-in-line package will withstand soldering temperature with no deformation and circuit performance characteristics remain stable when operated in high-humidity conditions. These packages are intended for insertion in mounting-hole rows on $\mathbf{0 . 3 0 0}$-inch centers. Once the leads are compressed to 0.300 -inch separation and inserted, sufficient tension is provided to secure the package in the board during soldering. The silver-plated leads require no additional cleaning or processing when used in soldered assembly.

TID121, TID122, TID123, TID124, TID125, TID126, TID129, TID130, TID133, TID134

$\ddagger$ F-16 is the ASTM designation for an iron-nickal-cobalt alloy containing nominally B3\% Iron, $\mathbf{2 9 \%}$ nickel, and $\mathbf{1 7 \%}$ cobalt.

## FAST SWITCHING DIODES

## - Rugged Double-Plug Construction

## mechanical data

Double-plug construction affords integral positive contact by means of a thermal compression bond. Moisture-free stability is ensured through hermetic sealing. The coefficients of thermal expansion of the glass case and the dumet plugs are closely matched to allow extreme temperature excursions. Hot-solder-dipped leads are standard.

absolute maximum ratings at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

|  |  | TiD31 | TID32 | TID33 | TID34 | TID35 | TID36 | TID37 | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| $V_{\text {RM }} /$ whgl | Working Peak Reverse Voltage from $-65^{\circ} \mathrm{C}$ to $150^{\circ} \mathrm{C}$ Free-Air Temperature (See Note 1) | 50 | 75 | 50 | 75 | 50 | 75 | 50 | UNT |
| ${ }_{1}$ | Average Rectified Forward Current (See Note 1) | 150 | 150 | 150 | 150 | 150 | 150 | 150 | me |
| ${ }^{\text {' }}$ F | Continuous Forward Current | 225 | 225 | 225 | 225 | 225 | 225 | 225 | ma |
| ${ }^{\text {I }}$ FM/surgal | Surge Current, One Second (See Note 2) | 500 | 500 | 500 | 500 | 500 | 500 | 500 | ma |
| $\mathrm{T}_{\text {Alopr })}$ | Operating Free-Air Temperature Range | $\begin{array}{llll}-65 & 10 \quad 15\end{array}$ |  |  |  |  |  |  | ${ }^{\circ} \mathrm{C}$ |
| $\mathrm{T}_{\text {stg }}$ | Storage Temperature Range | -65 to 200 |  |  |  |  |  |  | ${ }^{\circ} \mathrm{C}$ |

electrical characteristics at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

| PARAMETER | TEST CONDITIONS | TID31 | 71032 | TID33 | TiD34 | TID35 | TID36 | TID37 | UNIT | LIMIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| $\mathbf{V}_{\text {(GR) }}$ Reverse Breakdown Voltage | $\mathrm{I}_{\mathrm{R}}=100 \mu \mathrm{a}$ | 75 | 100 | 75 | 100 | 75 | 100 | 75 | UNI | MIN |
| Static Reverse Current | $\mathrm{V}_{\mathrm{R}}=75 \mathrm{v}$ |  | 5 |  | 5 |  | 5 |  | $\mu \mathrm{a}$ | max |
|  | $\mathrm{V}_{\mathrm{R}}=50 \mathrm{v}$ | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | $\mu \mathrm{a}$ | max |
|  | $\mathrm{V}_{\mathrm{R}}=50 \mathrm{v}, \quad \mathrm{T}_{\mathrm{A}}=150^{\circ} \mathrm{C}$ | 100 | 100 | 100 | 100 | 100 | 100 | 100 | $\mu{ }^{\prime \prime}$ | max |
| Static Forward Voltage | $\mathrm{I}_{\mathrm{F}}=100 \mathrm{ma}$ |  |  |  |  |  | 1 | 1 | $v$ | max |
|  | $\mathrm{I}_{\mathrm{F}}=150 \mathrm{ma}$ |  |  |  | 1 | 1 |  |  | $v$ | max |
|  | $\mathrm{I}_{\mathrm{F}}=200 \mathrm{ma}$ | 1 | 1 | 1 |  |  |  |  | $\checkmark$ | max |
| $C_{T}$ Total Capacitance | $\mathrm{V}_{\mathrm{R}}=0, \quad \mathrm{t}=1 \mathrm{mc}$ | 2.5 | 4 | 4 | 4 | 4 | 4 | 4 | pf | max |

switching characteristics at $\mathbf{2 5}{ }^{\circ} \mathbf{C}$ free-air temperature

| PARAMETER | TEST CONDITIONS | TID31 | TID32 | TID33 | TID34 | 71035 | 71036 | TID37 | UNIT | Limit |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| trr Reverse Recovery Time | $\begin{array}{ll} I_{\mathbf{F}}=200 \mathrm{ma}, & I_{\mathrm{R}}=200 \mathrm{ma} \\ \mathrm{i}_{\mathrm{rr}}=20 \mathrm{ma}, & R_{\mathrm{L}}=100 \Omega \end{array}$ | 6 | 10 | 10 | 10 | 10 | 10 | 6 | nsec | max |

NOTES: 1. These values may be applied continuously under single-phase, 60 -eps, half-sine-wave operation with resistive load, Above $25^{\circ} \mathrm{C}$, derate $\mathrm{I}_{0}$ and
$I_{F}$ linearly to 0 at $150^{\circ} \mathrm{C}$ free-air temperafure.
2. These valuas apply for a one-second square-wave pulse with the device af nonoperating thermal equilibrium immediately prior to the surge.

## DESIGNED FOR TV APPLICATIONS WHERE HIGH SPEED AND MEDIUM CURRENT and voltage are required

- Horizontal Phase Comparator
- Convergence Circuitry
- AGC Diode
- Video Blocking
- Horizontal Limiting
- Video Clamp
mechanical data
Double-plug construction affords integral positive contact by means of a thermal compression bond. Moisture-free stability is ensured through hermetic sealing. The coefficients of thermal expansion of the glass case and the dumet plugs are closely matched to allow extreme temperature excursions. Hot-solder-dipped leads are standard.

absolute maximum ratings at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

| Continuous Power Dissipation at (or below) $\mathbf{2 5}{ }^{\circ} \mathrm{C}$ Free-Air Temperature (See Note 1) . . . . . . . 500 mWStorage Temperature Range . . . . . . . . . . . . . . . . . . . . . . . . . $-65^{\circ} \mathrm{C}$ to $\mathbf{2 0 0 ^ { \circ } \mathrm { C }}$Lead Temperature $1 / 16$ Inch from Case for 10 Seconds . . . . . . . . . . . . . . . . . . . . . $250^{\circ} \mathrm{C}$ |  |
| :---: | :---: |
|  |  |
|  |  |

electrical characteristics at $25^{\circ} \mathrm{C}$ free-air temperature

| PARAMETER |  | TEST CONDITIONS | TID38 |  | TID39 |  | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | MIN | MAX | MIN | MAX |  |
| $V_{\text {(BR) }}$ | Reverse Breakdown Voltage |  | $I_{R}=100 \mu \mathrm{~A}$ | 75 |  | 75 |  | V |
| $I_{R}$ | Static Reverse Current | $\mathrm{V}_{\mathrm{R}}=50 \mathrm{~V}$ |  | 100 |  | 100 | nA |
| $V_{F}$ | Static Forward Voltage | $\mathrm{I}_{\mathrm{F}}=1 \mathrm{~mA}$ | 0.5 | 0.75 | 0.5 | 0.75 | V |
|  |  | $\mathrm{I}_{\mathrm{F}}=10 \mathrm{~mA}$ | 0.6 | 0.9 | 0.6 | 0.9 |  |
|  |  | $I_{F}=100 \mathrm{~mA}$ | 0.9 | 1.2 | 0.9 | 1.2 |  |
| $\mathrm{C}_{T}$ | Total Capacitance | $V_{R}=0, \quad f=1 \mathrm{MHz}$ |  | 3 |  | 5 | pF |
| rf | Small-Signal Forward Resistance | $\begin{aligned} & I_{F}=1 \mathrm{~mA}, \quad I_{f}=0.1 \mathrm{~mA}, \\ & f=1 \mathrm{kHz} \end{aligned}$ |  | 100 |  | 100 | $\Omega$ |

switching characteristics at $25^{\circ} \mathrm{C}$ free-air temperature

| PARAMETER | TEST CONDITIONS | TID38 |  | TID39 |  | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | MIN | MAX | MIN | MAX |  |
| trr Reverse Recovery Time | $\begin{array}{ll} I_{F}=10 \mathrm{~mA}, & I_{R M}=10 \mathrm{~mA}, \\ i_{r r}=1 \mathrm{~mA}, & R_{L}=100 \Omega, \\ \text { See Figure } 1 & \end{array}$ |  | 5 |  | 20 | ns |

NOTE: 1. Derate linearly to $200^{\circ} \mathrm{C}$ at the rate of $2.87 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$

## TYPES TID38, TID39 <br> SILICON SWITCHING DIODES



FIGURE 1 - REVERSE RECOVERY TIME

NOTES: s. The input pulse is supplied by a generator with the following characteristics: $\mathbf{z}_{\text {out }}=50 \Omega, t_{r} \leqslant 0.25 \mathrm{~ns}, \mathrm{t}_{\mathrm{p}} \geqslant 200 \mathrm{~ns}$. b. The output waveform is monitored on an oscilloscope with the following characteristics: $t_{r} \leqslant 0.35 \mathrm{~ns}, Z_{\text {in }}=50 \Omega$.

TYPICAL CHARACTERISTICS


NOTE 2: Temperature coefficient, $\alpha_{V F}$, is determined by the following formula:

$$
\alpha V F=\frac{\left(V_{F} @ 150^{\circ} \mathrm{C}\right)-\left(V_{F} @-55^{\circ} \mathrm{C}\right)}{150^{\circ} \mathrm{C}-\left(-55^{\circ} \mathrm{C}\right)}
$$

## TYPES TID40 THRU TID44 <br> SILICON SWITCHING DIODES

BULLETIN NO. DL-S 738605, MARCH 1966-REVISED MARCH 1973

## HIGH-VOLTAGE SWITCHING DIODES

## - Rugged Double-Plug Construction

## mechanical data

Double-plug construction affords integral positive contacts by means of a thermal compression bond. Moisture-free stability is ensured through hermetic sealing. The coefficients of thermal expansion of the glass case and the dumet plugs are closely matched to allow extreme temperature excursions. Hot-solder-dipped leads are standard.

absolute maximum ratings at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

|  | TID40 | TID41 | T1D42 | TID43 | TID44 | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| V RM Peak Reverse Voltoge | 250 | 200 | 150 | 150 | 100 | $V$ |
| $\mathrm{V}_{\text {RM }}$ (wig) Working Peak Reverse Voltage | 100 |  |  |  |  | $V$ |
|  Peak Forward Current of (or below) <br> $I_{F M}$ $25^{\circ}$ ( Free-Air Temperature (See Note 1) | 225 |  |  |  |  | mA |
| $\mathrm{l}_{\text {FM(surgo) }}$ Surge Current, One Second (See Note 2) | 500 |  |  |  |  | mA |
| $\mathbf{P}$ Continuous Power Dissipation at (or below) <br> $25^{\circ} \mathrm{C}$ Free-Air Temperature (See Note 3) | 250 |  |  |  |  | mW |
| $\mathrm{T}_{\text {Aloprl }} \ldots$ Operating Free-Air Temperature Range | -65 to 150 |  |  |  |  | ${ }^{\circ} \mathrm{C}$ |
| $\mathrm{T}_{\text {stg }}$ Storage Temperature Range | -65 to 200 |  |  |  |  | ${ }^{\circ} \mathrm{C}$ |
| Leod Temperature $K_{6}$ Inch from Case for 10 Seconds | 250 |  |  |  |  | ${ }^{\circ} \mathrm{C}$ |

electrical characteristics at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

| PARAMETER | TEST CONDITIONS | TID40 | TID41 | TID42 | TID43 | TID44 | UNIT | LIMIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| $V_{\text {(Br) }}$ Reverse Breakdown Voltage | $\mathrm{I}_{\mathrm{R}}=100 \mu \mathrm{~A}$ | 250 | 200 | 150 | 150 | 100 | $V$ | MIIN |
| Stotic Reverse Current | $V_{R}=$ Rated $V_{\text {RM }}$ w $M$ gl | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | $\mu \mathrm{A}$ | max |
|  | $\mathrm{V}_{\mathrm{R}}=20 \mathrm{~V}, \mathrm{~T}_{\mathrm{A}}=150^{\circ} \mathrm{C}$ | 50 | 50 | 50 | 50 | 50 | $\mu \mathrm{A}$ | mix |
| $\boldsymbol{V}_{\mathrm{F}}$ Static Forward Voltage | $\mathrm{I}_{\mathrm{F}}=50 \mathrm{~mA}$ | 1 |  |  |  |  | V | max |
|  | $\mathrm{I}_{\mathrm{F}}=100 \mathrm{~mA}$ |  | 1 | 1 |  |  | V | max |
|  | $\mathrm{I}_{\mathrm{F}}=150 \mathrm{~mA}$ |  |  |  | 1 |  | $V$ | Max |
|  | $\mathrm{I}_{\mathrm{F}}=200 \mathrm{~mA}$ |  |  |  |  | 1 | V | MAX |
| $\mathrm{C}_{\mathrm{T}}$ Total Capacitance | $V_{R}=0, \quad t=1 \mathrm{mHz}$ | 5 | 5 | 5 | 5 | 5 | pF | MAX |

switching characteristics at $25^{\circ} \mathrm{C}$ free-air temperature

| PARAMETER | TEST CONDITIONS | TID40 | TID41 | TID42 | TID43 | TID44 | UNIT | LIMIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| $i_{\text {rr }}$ Reverse Recovery Time | $\begin{aligned} & i_{F}=10 \mathrm{~mA}, l_{R M}=10 \mathrm{~mA}, \\ & i_{\mathrm{rr}}=1 \mathrm{~mA}, \mathrm{R}_{\mathrm{L}}=100 \Omega \end{aligned}$ | 30 | 30 | 30 | 30 | 30 | ns | max |

NOTES: 1 . This value applies for $\mathrm{t}_{\mathrm{p}} \leq 8.3 \mathrm{~ms}$, duty cycle $\leq 50 \%$. Abave $25^{\circ} \mathrm{C}$, derate linearly to $150^{\circ} \mathrm{C}$ freo-air temperafure at the rote of $1.8 \mathrm{~mA} /$ deg.
2. This value applies fer a one-second square-wave pulse with the device at nonoperating thermal equilibrium immediately prior to the serge.
3. Derate linearly to $150^{\circ} \mathrm{C}$ free-oir temperature at the rate of $2 \mathrm{~mW} / \mathrm{deg}$.

## DESIGNED FOR USE IN VIDEO AND COLOR PROCESSING CIRCUTRY OF TV RECEIVERS WHERE LOW CAPACITANCE AND HIGH BREAKDOWN VOLTAGE ARE REQUIRED

\author{

- Color Killer <br> - Color-Phase Comparator <br> - AFC
}
- Gated AGC Amplifier
- Blanking Restorer
- Video Clamp


## mechanical data

Double-plug construction affords integral positive contacts by means of a thermal compression bond. Moisture-free stability is ensured through hermetic sealing. The coefficients of thermal expansion of the glass case and the dumet plugs are closely matched to allow extreme temperature excursions. Hot-solder-dipped leads are standard.

absolute maximum ratings at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

Peak Reverse Voltage . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 250 V
Peak Surge Current, One Second (See Note 1)
Continuous Power Dissipation at (or below) $25^{\circ} \mathrm{C}$ Free-Air Temperature (See Note 2) . . . . . . . . . . 250 mW
Storage Temperature Range . . . . . . . . . . . . . . . . . . . . . . . . . . . . $-65^{\circ} \mathrm{C}$ to $\mathbf{2 0 0 ^ { \circ }} \mathrm{C}$
Lead Temperature $1 / 16$ Inch from Case for 2 Seconds . . . . . . . . . . . . . . . . . . . . . . $250^{\circ} \mathrm{C}$

NOTES: 1. These values apply for the specified square-wave pulse with the device at nonoperating thermal equilibrium immediately prior to the surge.
2. For operation above $25^{\circ} \mathrm{C}$ free-air temperature, refer to Dissipation Derating Curve, Figure 5.
electrical characteristics at $25^{\circ} \mathrm{C}$ free-air temperature

|  | Parameter | TEST CONDITIONS | MIN | MAX | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: |
| $V_{\text {(BR) }}$ | Reverse Breakdown Voltage | ${ }^{1}{ }_{R}=0.1 \mathrm{~mA}$ | 250 |  | $v$ |
| $\mathrm{I}_{\mathrm{R}}$ | Static Reverse Current | $\mathrm{V}_{\mathrm{R}}=200 \mathrm{~V}$ |  | 2 | $\mu \mathrm{A}$ |
| $v_{F}$ | Static Forwerd Voltage | $\mathrm{I}_{F}=1 \mathrm{~mA}$ | 0.55 | 0.8 | v |
|  |  | $\mathrm{I}_{\mathrm{F}}=50 \mathrm{~mA}$ | 0.75 | 1 |  |
| rf | Small-Signal Forward Resistance | $\begin{aligned} & I_{F}=10 \mathrm{~mA}, \quad I_{f}=1 \mathrm{~mA}, \\ & f=1 \mathrm{kHz} \end{aligned}$ |  | 10 | $\Omega$ |
| $c_{\text {T }}$ | Total Capacitance | $\mathrm{V}_{\mathrm{R}}=0, \quad \mathrm{f}=1 \mathrm{MHz}$ | 0.5 | 1.5 | pF |

operating characteristics at $25^{\circ} \mathrm{C}$ free-air temperature

| PARAMETER | TEST CONDITIONS | MIN MAX | UNIT |
| :---: | :---: | :---: | :---: |
| $t_{\text {rr }} \quad$ Reverse Recovery Time | $\begin{array}{ll} I_{F}=10 \mathrm{~mA}, & I_{R M}=10 \mathrm{~mA} \\ I_{r r}=1 \mathrm{~mA}, & R_{L}=100 \Omega \end{array}$ <br> See Figure 1 | 50 | ns |
| $\mathbf{O}_{\mathbf{5}} \quad$ Stored Charge | $I_{F}=10 \mathrm{~mA}$ <br> See Figure 2 and Note 3 | 300 | pC |

NOTE: 3. Stored charge is measured in accordance with JEDEC Suggested Standard No. 1 (June, 1966), using the test circuit of Figure 2.

## PARAMETER MEASUREMENT INFORMATION



## test circuit



Adjust amplitude for $I_{R M}=10 \mathrm{~mA}$

INPUT VOLTAGE WAVEFORM


OUTPUT CURRENT WAVEFORM

NOTES: a. The input puise is supplied by a generator with the following characteristics: $Z_{\text {out }}=50 \Omega, t_{r} \leqslant 0.25 \mathrm{~ns}, \mathrm{t}_{\mathrm{p}} \geqslant 500 \mathrm{~ns}$. b. The output wevoform is monitored on an oxcilloscope with the following characteristics: $t_{r} \leqslant 0.35 \mathrm{~ns}, \mathrm{Z}_{\mathrm{in}}=50 \Omega$.

FIGURE 1 - REVERSE RECOVERY TIME


NOTES: a. The input puise is supplied by a generator with the following characteristics: $Z_{\text {out }}=\mathbf{1 0} \Omega, \mathrm{t}_{\mathrm{r}}(1 \%$ to $50 \%) \leqslant 5 \mathrm{n}$, $t_{p}=50 \mathrm{~ns}$.
b. If is the reading of the meter with zero voltage across the diode under test (hence zero current through the diode under test). $I_{2}$ is the reading of the meter when the specified forward current ( 10 mA ) flows.
c. $V_{1}$ is adjusted for $I_{F}=10 \mathrm{~mA}$.
d. $V_{2}$ is adjusted so that the voltege between point $A$ and ground is -0.6 V when the diode under test is conducting forward curront.

- The stored charge of diode $\mathrm{O}_{1}$ is amall compared to the stored charge of the diode under test.
f. The reverse recovery time of diode $\mathrm{D}_{2}$ is short rolative to the 50 -ns input pulse.
g. The resistance of the current meter is sufficiently low that doubling le doen not affect the reading by more than the required accuracy.

FIGURE 2 - STORED CHARGE TEST CIRCUIT

## TYPE TID45 SILICON SWITCHING DIODE

TYPICAL CHARACTERISTICS


THERMAL CHARACTERISTICS
DISSIPATION DERATING CURVE


FIGURE 5

NOTE 4: Temperature coefficient, $\alpha_{V F}$, is determined by the following formula: $\alpha_{V F}=\frac{\left(V_{F} @ 150^{\circ} \mathrm{C}\right)-\left(V_{F} @-55^{\circ} \mathrm{C}\right)}{150^{\circ} \mathrm{C}-\left(-55^{\circ} \mathrm{C}\right)}$.

## LOGIC AND CORE-DRIVER DIODE ARRAYS

## For Application With

- Magnetic Cores
- Thin-Film Memories
- Airborne Computers
- Industrial Computers
- Plated-Wire Memories
- Decoding or Encoding Applications


## For Use In

- Military Computers
- Peripheral Equipment


## description

These diode arrays are multiple diode junctions fabricated by a planar process and mounted in integrated circuit packages for use in logic and core-driver applications. These arrays offer many of the advantages of integrated circuits such as high-density packaging and improved reliability. These advantages result from such factors as fewer connections, more uniform device parameters, smaller size, less weight, fewer glass-to-metal seals, and the elimination of pressure contacts and whiskers.

These arrays are available in heremtically sealed welded flat packages ( $F$ ) or in dual-in-line plastic packages ( $N$ ). absolute maximum ratings at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

| 16-DIODE ARRAY <br> 7 INDEPENDENT DIODES <br> OUAL 4-DIODE ARRAY (COMMON CATHODE) <br> DUAL 4-DIODE ARRAY (COMMON ANODE) | FLAT PACKAGE |  |  | DUAL-IN-LINE PACKAGE |  |  | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | EACH DIODE |  | TOTAL DEVICE | EACH DIODE |  | TOTAL DEVICE |  |
|  | TID139F <br> TID141F <br> TID143F | $\begin{aligned} & \text { TID140F } \\ & \text { TID142F } \\ & \text { TID144F } \end{aligned}$ | ALL TYPES | $\begin{aligned} & \text { TID135N } \\ & \text { TID139N } \\ & \text { TID141N } \\ & \text { TID143N } \end{aligned}$ | TID136N <br> TID140N <br> TID142N <br> TID144N | ALL TYPES |  |
| Peak Reverse Voltage (See Note 1) | 60 | 40 |  | 60 | 40 |  | V |
| Steady-State Reverse Voltage, $\mathrm{V}_{\mathbf{R}}$ | 40 | 20 |  | 40 | 20 |  | V |
| Continuous Forward Current at (or below) $25^{\circ} \mathrm{C}$ Free-Air Temperature (See Note 2) | $300{ }^{\text {t }}$ |  |  | 400才 |  |  | mA |
| Peak Forward Current at (or below) <br> $25^{\circ} \mathrm{C}$ Free-Air Temperature (See Notes 1 and 2) | $500 \S$ |  |  | 500! |  |  | mA |
| Peak Surge Current (See Note 2) | 1 |  |  | 1 |  |  | A |
|  | 2 | 2 |  | 2 |  |  |  |
| Continuous Power Dissipation at (or below) $25^{\circ} \mathrm{C}$ Free-Air Temperature |  |  | $500{ }^{\circ}$ |  |  | $600^{\circ}$ | mW |
| Operating Free-Air Temperature Range | -65 to 150 |  |  | -65 to 125 |  |  | C |
| Storage Temperature Range | -65 to 200 |  |  | -65 to 150 |  |  | ${ }^{\circ} \mathrm{C}$ |
| Lead Temperature 1/16 Inch from Case for 10 Seconds | 300 |  |  | 260 |  |  | ${ }^{\circ} \mathrm{C}$ |

NOTES: 1. These values apply for $\mathrm{t}_{\mathbf{w}} \leqslant \mathbf{1 0 0} \mu$ s, duty cycle $<\mathbf{2 0 \%}$.
2. These values apply for the specified square-wave pulse with the device at nonoperating thermal equilibrium immediately prior to the surge.

+ Derate linearly to $150^{\circ} \mathrm{C}$ free-air temperature at the rate of $2.4 \mathrm{~mA} /{ }^{\circ} \mathrm{C}$.
$\ddagger$ Derate linearly to $125^{\circ} \mathrm{C}$ free-air temperature at the rate of $4 \mathrm{~mA} /^{\circ} \mathrm{C}$.
§ Derate lineariv to $150^{\circ} \mathrm{C}$ free-air temperature at the rate of $4 \mathrm{~mA} /{ }^{\circ} \mathrm{C}$.
TDerate linearly to $125^{\circ} \mathrm{C}$ free-air temperature at the rate of $5 \mathrm{~mA} /{ }^{\circ} \mathrm{C}$.
Derate linearly to $150^{\circ} \mathrm{C}$ free-air temperature at the rate of $4 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$.
Derate linearly to $125^{\circ} \mathrm{C}$ free-air temperature at the rate of $6 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$.


# TYPES TID135, TID136, TID139 THRU TID144 <br> SILICON DIODE ARRAYS 

## ORDERING INSTRUCTIONS

PLASTIC DUAL-IN-LINE PACKAGES

TID135 and TID136 diode arrays are available in the plastic dual-in-line package (outline N) and TID139 through TID 144 diode arrays are available in both the N package and the hermetically sealed metal flat package (outline F). Orders for these arrays should include the package outline letter ( $F$ or $N$ ) at the end of the type number.


METAL FLAT PACKAGES

TID139F, TID140F 7 INDEPENDENT DIODES

14-PIN PACKAGE
TID139N, TID140N 7 INDEPENDENT DIODES 14-PIN PACKAGE


TID141F, TID142F DUAL 4-DIODE ARRAY (COMMON CATHODE) 10-PiN PACKAGE


TID143F, TID144F
DUAL 4-DIODE ARRAY (COMMON ANODE) 10-PIN PACKAGE


TID141N, TIO142N
DUAL 4-DIODE ARRAY (COMMON CATHODE) 14-PIN PACKAGE

(4) (6) (10) (13) No internal connection

## TYPES TID135, TID136, TID139 THRU TID144 SILICON DIODE ARRAYS

electrical characteristics at $25^{\circ} \mathrm{C}$ free-air temperature
single-diode operation (see note 3)

| PARAMETER |  | TEST CONDITIONS |  | TID139 TID141 | TID140 <br> TID142 | TID135 <br> TID143 | TID136 <br> TID144 | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | MIN MAX | MIN MAX | MIN MAX | MIN MAX |  |
| $V_{(B R)}$ | Reverse Breakdown Voltage |  |  | $I_{R}=10 \mu \mathrm{~A}$ |  | 60 | 40 | 60 | 40 | V |
| $I^{\prime}$ | Static Reverse Current | $\mathrm{V}_{\mathrm{R}}=40 \mathrm{~V}$ | See Note 4 | 100 |  | 100 |  | nA |
|  |  | $V_{R}=40 \mathrm{~V}, \quad \mathrm{~T}_{\mathrm{A}}=125^{\circ} \mathrm{C}$ |  | 100 |  | 100 |  | $\mu \mathrm{A}$ |
|  |  | $V_{R}=20 \mathrm{~V}$ |  |  | 50 |  | 50 | nA |
|  |  | $\mathrm{V}_{\mathrm{R}}=20 \mathrm{~V}, \quad \mathrm{~T}_{\mathrm{A}}=125^{\circ} \mathrm{C}$ |  |  | 50 |  | 50 | $\mu \mathrm{A}$ |
| $V_{F}$ | Static Forward Voltage | $\mathrm{I}_{\mathrm{F}}=10 \mathrm{~mA}$ |  |  | 1 |  | 1 | V |
|  |  | $I_{F}=100 \mathrm{~mA}$ |  | 1 | 1.3 | 1 | 1.3 |  |
| $V_{F}$ | Instantaneous Forward Voltage | $I_{F}=500 \mathrm{~mA}$, | See Note 5 | 1.3 |  | 1.3 |  | V |
| $V_{\text {FM }}$ | Peak Forward Voltage | $\mathrm{I}_{\mathrm{F}}=500 \mathrm{~mA}$, | See Note 6 | 5 |  | 5 |  | V |
| $\mathrm{C}_{\mathbf{T}}$ | Total Capacitance ${ }^{\dagger}$ | $V_{R}=0, \quad f=1 \mathrm{MHz}$ |  | 4 | 4 | 8 | 8 | pF |

multiple-diode operation

| PARAMETER |  | TEST CONDITIONS | ALL <br> TYPES | UNIT |
| :---: | :---: | :---: | :---: | :---: |
|  |  | MIN MAX |  |
| ${ }^{\prime} \mathrm{B}$ | Static Reverse Current |  | $V_{R}=$ rated $V_{R}$, See Note 7 | 10 | $\mu \mathrm{A}$ |
| $\mathrm{V}_{\mathrm{F}}$ | Static Forward Voltage | $I_{F}=25 \mathrm{~mA}$, See Note 7 | 1 | V |

## switching characteristics at $25^{\circ} \mathrm{C}$ free-air temperature

single-diode operation (see note 3 )

| PARAMETER |  | TEST CONDITIONS | TID 139 TID 141 | TID140 TID142 | TID135 TID143 | TID136 TID144 | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | MIN MAX | MIN MAX | MIN MAX | MIN MAX |  |
| $\mathrm{t}_{\mathrm{fr}}$ | Forward Recovery Time |  | $I_{F}=50 \mathrm{~mA}$, See Figure 3 |  | 20 |  | 20 | ns |
|  |  | $I_{F}=500 \mathrm{~mA}$, See Figure 3 | 40 |  | 40 |  |  |
| ${ }_{\text {trr }}$ | Reverse Recovery Time | $\begin{array}{lll} I_{F}=10 \mathrm{~mA}, & I_{R M}=10 \mathrm{~mA}, & R_{L}=100 \Omega, \\ i_{r r}=1 \mathrm{~mA}, & \text { See Figure } 4 & \\ \hline \end{array}$ |  | 6 |  | 6 | ns |  |
|  |  | $\begin{aligned} & I_{F}=200 \mathrm{~mA}, \quad I_{R M}=200 \mathrm{~mA}, R_{\mathrm{L}}=100 \Omega, \\ & i_{r r}=20 \mathrm{~mA}, \quad \text { See Figure } 4 \end{aligned}$ | 20 |  | 20 |  |  |  |

NOTES: 3. Test conditions and limits apply separately to each of the diodes. The diodes not under test are open-circuited during the measurement of these characteristics except for the measurement of ${ }^{\prime} R$ on arrays having both common-cathode and common-anode diodes (see Figures 1 and 2).
4. For arrays having both common-anode and common-cathode diodes see Figures 1 and 2 , Parameter Measurement Information section.
5. This parameter is measured using pulse techniques. $t_{w}=300 \mu \mathrm{~s}$, dutv cvcle $=2 \%$. Read time is $90 \mu s$ from the leading edge of the pulse.
6. The initial instantaneous value is measured using pulse techniques. $t_{w}=150 \mathrm{~ns}$, duty cycle $\leqslant 2 \%$, puise rise time $\leqslant 10 \mathrm{~ns}$. The total capacitance shunting the diode is 19 pF maximum and the equipment bandwidth is 80 MHz .
7. These parameters are measured with each of the other diodes in the section simultaneously conducting 25 mA forward current. Each diode is individually tested after the device reaches operating thermal equilibrium, Test conditions apply separately to common-anode and common-cathode sections.
${ }^{\dagger} C_{T}$ is the total pin-to-pin capacitance measured ecross any of the diodes. For arravs having both common-anode and common-cathocle eections, the interaction of the other diodes cannot easily be separated out unless three-terminal guarded measurement techniques are used. The actual capacitance of a single isolated diode will typically be $\mathbf{3 0 \%}$ of the measured pin-to-pin value for the common-cathode diodes, and $75 \%$ of the measured value for the common-an ode diodes.

## PARAMETER MEASUREMENT INFORMATION

When measuring the reverse current of an individual diode of a device having both common-anode and common-cathode sections, the current meter must be placed so that the shunt current through the other diodes is bypassed around the meter. To obtain accurate readings, the voltage drop across the current meter must be less than 10 mV .


FIGURE 2-TEST CIRCUIT FOR COMMON-ANODE DIODES
FIGURE 1-TEST CIRCUIT FOR COMMON-CATHODE DIODES


VOLTAGE WAVEFORMS
FIGURE 3-FORWARD RECOVERY TIME

NOTES: a. The input pulse is supplied by a generator with the following characteristics: $t_{\mathrm{r}} \leqslant 15 \mathrm{~ns}, \mathrm{Z}_{\mathrm{out}}=50 \Omega, \mathrm{t}_{\mathbf{w}}=150 \mathrm{~ns}, \mathrm{duty}$ cycle $\leqslant 2 \%$.
b. The output waveform is monitored on an oscilloscope with the following characteristics: $t_{r} \leqslant 4.5 \mathrm{~ns}, \mathrm{R}_{\mathrm{in}} \geqslant 1 \mathrm{M} \Omega, \mathrm{C}_{\mathrm{in}} \leqslant 5 \mathrm{pF}$.


## TYPICAL CHARACTERISTICS

TID135, TID139, TID141, TID143
FORWARD CONDUCTION CHARACTERISTICS


TID136, TID140, TID142, TID144
FORWARD CONDUCTION CHARACTERISTICS


NOTE 5: This parameter is measured using pulse techniques. $t_{w}=300 \mu \mathrm{~s}$, duty cycte $=2 \%$. Read time is $90 \mu \mathrm{~s}$ from the leading edge of the pulse.

## MECHANICAL DATA

## F flat packages

These hermetic packages feature glass-to-metal seals and welded construction in 10 -pin and 14 -pin configurations. Package body and leads are gold-plated $\mathcal{F}-15 \ddagger$ glass-sealing alloy. Approximate weight is 0.1 gram . All external surfaces are metallic. Devices are shipped mounted in a Mech-Pak carrier.


## N plastic dual-in-line packages

The compound used to mold the dual-in-line packages will withstand soldering temperature with no deformation and circuit performance characteristics remain stable when operated in high-humidity conditions. These packages are intended for insertion in mounting-hole rows on 0.300 -inch centers. Once the leads are compressed to 0.300 -inch separation and inserted, sufficient tension is provided to secure the package in the board during soldering. The silver-plated leads require no additional cleaning or processing when used in soldered assembly.

$\boldsymbol{\$}$ F-15 is the ASTM designation for an iron-nickel-cobalt alloy containing nominally $\mathbf{5 3 \%}$ iron, 29\% nickel, and $\mathbf{1 7 \%}$ cobalt.

## 50-600 VOLTS • 1 AMP AVERAGE

- Rugged Double-plug Construction
- Hermetic Case
- 50-Amp Surge Rating
- TID383 thru TID385 Electrically Similar to 1N4383 thru 1N4385 (DO-29)


## description and mechanical data

These one-amp rectifier diodes are the product of combining the best of both silicon material processing and packaging technologies. The silicon die is a mesa oxide-passivated structure which has additional nitride passivation and glass passivation over the junction. Years of volume production have shown the double-plug package to have the highest inherent mechanical integrity of all hermetic-case diodes. Hot-solder-dipped leads are standard.

*absolute maximum ratings at specified ambient ${ }^{\dagger}$ temperature (unless otherwise noted)

|  |  | TID381 | TID382 | TID383 | TID384 | THD385 | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| VRM | Peak Reverse Voltage from $-65^{\circ} \mathrm{C}$ to $175^{\circ} \mathrm{C}$ (See Note 1) | 50 | 100 | 200 | 400 | 600 | $V$ |
| $V_{R}$ | Steady State Reverse Voltage from $25^{\circ} \mathrm{C}$ to $75^{\circ} \mathrm{C}$ | 50 | 100 | 200 | 400 | 600 | $V$ |
| 10 | Average Rectified Forward Current from $25^{\circ} \mathrm{C}$ to $100^{\circ} \mathrm{C}$ (See Note 1 and 2) | 1 |  |  |  |  | A |
| IFSM | Peak Surge Current, One Cycle, at (or below) $100^{\circ} \mathrm{C}$ (See Note 3) | 50 |  |  |  |  | A |
| ${ }^{\text {T }}$ A(opr) | Operating Ambient Temperature Range | -65 to 175 |  |  |  |  | ${ }^{\circ} \mathrm{C}$ |
| Tstg | Storage Temperature Range | -65 to 200 |  |  |  |  | ${ }^{\circ} \mathrm{C}$ |
|  | Lead Temperature 3/8 Inch from Case for 10 Seconds | 300 |  |  |  |  | C |

These values may be applied continuously under singlephase, $60-\mathrm{Hz}$, half-sine-wave operation with resistive load. Above $100^{\circ} \mathrm{C}$
derate $\mathrm{I}_{\mathrm{O}} \mathrm{a}$ according to Figure 1 .
2. This rectifier is a lead-conduction-cooled device. At (or above) ambient tamperatures of $100^{\circ} \mathrm{C}$, the lead temperature $3 / 8$ inch from case must be no higher than $5^{\circ} \mathrm{C}$ above the ambient temperature for these ratings to apply.
3. These values apply for $60-\mathrm{Hz}$ half sine waves when the device is operating at (or below) rated values of peak reverse voltage and average rectified forward current. Surge may be repeated after the device has returned to original thermal equilibrium.

[^195]
## TYPES TID381 THRU TID385 <br> SILICON RECTIFIERS

electrical characteristics at specified ambient ${ }^{\dagger}$ temperature

| PARAMETER |  | TEST CONDITIONS |  | MAX | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: |
| $I_{R}$ | Static Reverse Current | $\mathbf{V}_{\mathbf{R}}=$ Rated $\mathrm{V}_{\mathbf{R}}$. | $\mathrm{T}_{\mathrm{A}}=25^{\circ} \mathrm{C}$ | 10 | $\mu \mathrm{A}$ |
|  |  | $\mathrm{V}_{\mathrm{R}}=$ Rated $\mathrm{V}_{\mathrm{R}_{\text {}}}$ | $\mathrm{T}_{A}=150^{\circ} \mathrm{C}$ | 250 |  |
| IR(av) | Average Reverse Current | $\begin{aligned} & \mathrm{V}_{\text {RM }}=\text { Rated } \mathrm{V}_{\text {RM }} \\ & \mathrm{f}=60 \mathrm{~Hz}, \end{aligned}$ | $\begin{aligned} & 10=1 A, \\ & T_{A}=100^{\circ} \mathrm{C} \end{aligned}$ | 225 | $\mu \mathrm{A}$ |
| $V_{F}$ | Static Forward Voltage | $I_{F}=1 A_{\text {, }}$ | $\mathrm{T}_{\mathrm{A}}=25^{\circ} \mathrm{C}$ to $100^{\circ} \mathrm{C}$ | 1.1 | V |
| $V_{\text {FM }}$ | Peak Forward Voltage | $\begin{aligned} & V_{\text {RM }}=\text { Rated } V_{R M} \\ & f=60 \mathrm{~Hz}, \end{aligned}$ | $\begin{aligned} & I_{0}=1 \mathrm{~A}, \\ & T_{A}=100^{\circ} \mathrm{C} \end{aligned}$ | 1.3 | V |

## THERMAL INFORMATION



FIGURE 1

NOTE 2: This rectifier is a lead-conduction-cooled device. At (or above) ambient temperatures of $100^{\circ} \mathrm{C}$, the lead temperature $\mathbf{3 / 8} \mathbf{~ i n c h ~ f r o m ~}$ case must be no higher than $5^{\circ} \mathrm{C}$ above the ambient temperature for these ratings to apply.
${ }^{\dagger}$ The ambient temperature is measured at a point 2 inches below the device. Natural air cooling is used.

BULLETIN NO. DL-S 7311745, JANUARY 1973

## VERY-HIGH-SPEED SWITCHING DIODES

- Pico-Second Switching Times
- Small-Size, Double-Plug Construction
- Very Low Junction Capacitance


## mechanical data

Double-plug construction affords integral positive contact by means of a thermal compression bond. Moisture-free stability is ensured through hermetic sealing. The coefficients of thermal expansion of the glass case and the dumet plugs are closely matched to allow extreme temperature excursions. Hot-solder-dipped leads are standard.

absolute maximum ratings at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

|  | TID777 | TID778 |
| :--- | :---: | :---: |
| Working Peak Reverse Voltage | 10 | 20 |
| Average Rectified Current (See Note 1) | V |  |
| Peak Surge Current, One Second (See Note 2) | 50 | mA |
| Continuous Power Dissipation at (or below) $25^{\circ} \mathrm{C}$ Free-Air Temperature (See Note 3) | $\mathbf{2 5 0}$ |  |
| Storage Temperature Range | $\mathbf{2 5 0}$ |  |
| Lead Temperature 1/16 Inch from Case for 10 Seconds | $\mathbf{m W}$ |  |

NOTES: 1. This value may be applied continuously under single-phase $\mathbf{6 0 - H z}$ half-sine-wave operation with resistive load.
2. This value applies for the specified square-wave pulse with the device at nonoperating thermal equifibrium immediately priar to the surge.
3. Derate linearly to $150^{\circ} \mathrm{C}$ free-air temperature at the rate of $2 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$.

# TYPES TIDT7, TIDT78 SILICON SWITCHING DIODES 

electrical characteristics at $\mathbf{2 5 ^ { \circ }} \mathbf{C}$ free-air temperature (unless otherwise noted)

| PARAMETER | TEST CONDITIONS | TID777 |  | TID778 |  | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | MIN | MAX | MIN | MAX |  |
| $V_{\text {(BR) }}$ Breakdown Voltage | $I_{R}=5 \mu \mathrm{~A}$ | 20 |  | 30 |  | V |
| Static Reverse Current | $V_{R}=20 \mathrm{~V}$ |  |  |  | 0.1 | $\mu \mathrm{A}$ |
|  | $\mathrm{V}_{\mathrm{R}}=20 \mathrm{~V}, \quad \mathrm{~T}_{\mathrm{A}}=150^{\circ} \mathrm{C}$ |  |  |  | 100 |  |
|  | $V_{R}=10 \mathrm{~V}$ |  | 0.1 |  |  |  |
|  | $V_{R}=10 \mathrm{~V}, \quad T_{A}=150^{\circ} \mathrm{C}$ |  | 50 |  |  |  |
| VF Static Forward Voltage | $\mathrm{I}_{F}=10 \mu \mathrm{~A}$ | 0.42 | 0.53 | 0.42 | 0.53 | $v$ |
|  | $\mathrm{I}_{\mathrm{F}}=0.1 \mathrm{~mA}$ | 0.52 | 0.64 | 0.52 | 0.64 |  |
|  | $I_{F}=1 \mathrm{~mA}$ | 0.64 | 0.79 | 0.64 | 0.79 |  |
|  | $I_{F}=10 \mathrm{~mA}$ | 0.76 | 0.94 | 0.76 | 0.94 |  |
|  | $I_{F}=20 \mathrm{~mA}$ | 0.81 | 1 | 0.81 | 1 |  |
|  | $I^{\prime} F=50 \mathrm{~mA}$ | 0.89 | 1.35 | 0.89 | 1.35 |  |
| $\mathrm{C}_{\text {T }}$ Total Capacitance | $\mathrm{V}_{\mathrm{R}}=0, \quad \mathrm{f}=1 \mathrm{MHz}$ |  | 1.3 |  | 1 | pF |

switching characteristics at $\mathbf{2 5}{ }^{\circ} \mathrm{C}$ free-air temperature

| PARAMETER | TEST CONDITIONS | 8OTH TYPES | UNIT |
| :---: | :---: | :---: | :---: |
| ${ }_{\text {trr }}$ Maximum Reverse Recovery Time | $\begin{array}{ll} I_{F}=10 \mathrm{~mA}, & I_{R M}=10 \mathrm{~mA}, \\ i_{\mathrm{rr}}=1 \mathrm{~mA}, & R_{\mathrm{L}}=100 \Omega, \\ \text { See Figure } 1 \end{array}$ | 750 | ps |

PARAMETER MEASUREMENT INFORMATION


FIGURE 1-REVERSE RECOVERY TIME

NOTES: a. The input pulse is supplied by a generator with the following characteristics: $\mathrm{t}_{\mathrm{r}} \leqslant \mathbf{0 . 2 5} \mathbf{n s}, \mathrm{Z}_{\text {out }}=50 \Omega, \mathrm{t}_{\mathrm{w}}=100 \mathrm{~ns}$, duty cycle $\leqslant \mathbf{1 \%}$.
b. The output waveform is monitored on an oscilloscope with the following characteristics: $\mathrm{t}_{\mathrm{r}} \leq 0.4 \mathrm{~ns}, \mathrm{R}_{\mathrm{in}}=50 \Omega$.

## MONOLITHIC DIODE MATRICES

## For Application As

- Programmable Read-Only Memories
- Alphanumeric Character Generators
- Frequency Generators
- Logic Interface Circuits


## For Use In

- CRT Displays
- Minicomputers
- Peripheral Equipment
- Solid-State Memories


## description


#### Abstract

These monolithic dielectrically isolated diode matrices are fabricated using epitaxial techniques. The desired matrix patterns are programmed by selectively opening the fusible link in series with each diode. This may be done by the user by following the fusing procedure described herein, or custom-programmed matrices may be ordered by sending in a schematic diagram with circles around the diodes to be deleted. Automatic equipment at Texas Instruments can provide instantaneous code-pattern customizing of devices. Only unprogrammed matrices will be symbolized with the type numbers shown in the table below. Circuits custom-programmed to a particular pattern will be assigned a special device number by Texas Instruments, and this number will appear on the device.


Both the high-speed Series TIDM100 and medium-speed Series TIDM200 matrices are available in hermetically sealed metal flat packages ( $F$ ) or ceramic dual-in-line packages (J).
absolute maximum ratings at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

| $5 \times 5$ MATRICES $6 \times 6$ MATRICES $6 \times 8$ MATRICES $8 \times 5$ MATRICES $8 \times 6$ MATRICES | TIDM155 TIDM166 TIDM168 TIDM185 TIDM186 | TIDM255 <br> TIDM266 <br> TIDM268 <br> TIDM285 <br> TIDM236 | UNIT |
| :---: | :---: | :---: | :---: |
| Peak Reverse Voltage (See Note 1) | 45 | 35 | V |
| Steady-State Reverse Voltage, $\mathrm{V}_{\mathbf{R}}$ | 25 |  | V |
| Peak Forward Current per Diode at (or below) $25^{\circ} \mathrm{C}$ Free-Air Temperature (See Note ${ }^{\circ}$ ) | 100 |  | mA |
| Continuous Power Dissipation at (or below) $25^{\circ} \mathrm{C}$ Free-Air Temperature (See Notes 2 and 3) | 400 |  | mW |
| Operating Free-Air Temperature Range | -65 to 150 |  | ${ }^{\circ}$ |
| Storage Temperature Range | -65 to 200 |  | C |
| Lead Temperature 1/16 Inch from Case for 10 Seconds | 300 |  | C |

NOTES: 1. These values apply for $\mathbf{1 0 0}-\mu$ s pulses, duty cycle $\leqslant \mathbf{2 0 \%}$.
2. The values shown for total device apply for any combination provided the ratings of individual diodes are not exceeded.
3. Derate linearly to $15 \mathbf{0}^{\circ} \mathrm{C}$ free-air temperature at the rate of $\mathbf{3 . 2} \mathbf{~ m W} /{ }^{\circ} \mathrm{C}$.

## SERIES TIDM100, TIDM200 SILICON DIODE MATRICES

## CUSTOMIZED CIRCUITS

To order custom programmed circuits, circle the diodes to be elimated in the appropriate schematic as shown in the example below.


TIDM 155, TIDM255 $5 \times 5$ MATRICES

(9)
(10)

TIDM168, TIDM268 $6 \times 8$ MATRICES
TIDM 166, TIDM266 $6 \times 6$ MATRICES


## SERIES TIDM10O, TIDM200 <br> SILICON DIODE MATRICES

electrical characteristics at $25^{\circ} \mathrm{C}$ free-air temperature

| PARAMETER |  | TEST CONDITIONS | SERIES TIDM100 |  |  | SERIES TIDM200 |  |  | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | MIN | TYP | MAX | MIN | TYP | MAX |  |
| $V_{(B R)}$ | Reverse Breakdown Voltege |  | $I_{R}=100 \mu \mathrm{~A}$ | 45 |  |  | 35 |  |  | V |
| $I_{\text {R }}$ | Static Reverse Current | $V_{R}=25 \mathrm{~V}$ |  |  | 20 |  |  | 50 | nA |
| $I_{R}$ | Static Reverse Current (with Adjacent Diode Conducting) | See Figure 1 |  | 20 |  |  | 50 |  | nA |
| $V_{F}$ | Static Forward Voltage | $I_{F}=1 \mathrm{~mA}$ |  |  | 0.8 |  |  | 0.9 | V |
|  |  | $\mathrm{I}_{\mathrm{F}}=20 \mathrm{~mA}$ |  |  | 1.5 |  |  | 1.7 |  |
| $\mathrm{C}_{\mathbf{T}}$ | Total Capacitance between Any Anode Terminal and Any Cathode Terminal | $\mathrm{V}_{\mathrm{R}}=5 \mathrm{~V}, \quad \mathrm{f}=1 \mathrm{MHz}$ |  |  | 4 |  |  | 4 | pF |

switching characteristics at $\mathbf{2 5}{ }^{\circ} \mathrm{C}$ free-air temperature

| PARAMETER |  | TEST CONDITIONS | SERIES TIDM 100 |  |  | SERIES TIDM200 |  |  | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | MIN | TYP | MAX | MIN | TYP | MAX |  |
| ${ }^{1} \mathrm{rr}$ | Reverse Recovery Time |  | $\begin{aligned} & I_{F}=10 \mathrm{~mA}, \quad I_{R M}=10 \mathrm{~mA}, \\ & R_{L}=100 \Omega, \quad i_{r r}=1 \mathrm{~mA}, \end{aligned}$ <br> See Figure 2 |  |  | 10 |  |  | 25 | ns |

PARAMETER MEASUREMENTINFORMATION


NOTE: D1 and D2 are any two adjacent diodes with a common cathode connection.

FIGURE 1


INPUT VOLTAGE WAVEFORM


OUTPUT CURRENT WAVEFORM

FIGURE 2-REVERSE RECOVERY TIME
NOTES: a. The input pulse is supplied by a generator with the following characteristics: $t_{f} \leqslant 1 \mathbf{n s}, Z_{o u t}=50 \Omega$, $\mathbf{t}_{\mathbf{w}}=200 \mathrm{~ns}, \mathrm{duty}$ cycle $\leqslant 1 \%$.
b. The output waveform is monitored on an oscilloscope with the following characteristics: $\mathrm{t}_{\mathrm{r}}<0.4 \mathrm{~ns}, \mathrm{R}_{\text {in }}=50 \Omega$.

FUSING PROCEDURE


Figure 3
A ramp current generator provides the fusing current. The diode to be eliminated is selected by setting switches S 2 and S 3 . When S 1 is activated to position 2, current through the fusible link opens the link in series with the selected diode. The peak fusing current required to open a fusible link is approximately $\mathbf{7 5 0}$ milliamperes. Switch S 1 in position 1 gives a visual indication of the condition of the selected diode before and after fusing.

## TYPICAL CHARACTERISTICS



## SERIES TIDM100, TIDM200 <br> SILICON DIODE MATRICES

## ORDERING INSTRUCTIONS AND MECHANICAL DATA

## general

Series TIDM100 and Series TIDM200 diode matrices are available in the hermetically sealed metal flat package (outline F) or the ceramic dual-in-line package (outline J). Orders for these circuits should include the package outline letter ( F or J ) at the end of the circuit type number.

## Examples: TIDM155F, TIDM268J

## F package

This hermetic package features glass-to-metal seals and welded construction. Package body and leads are gold-nlated F-15 $\ddagger$ glass-sealing alloy. Approximate weight is 0.1 gram. All external surfaces are metallic. Devices are shipped mounted in a Mech-Pak carrier.


## J package

This hermetically sealed, dual-in-line package consists of a ceramic base, ceramic cap, and 14 -lead frame. The circuit bar is alloy-mounted to the base and hermetic sealing is accomplished with glass. This package is intended for insertion in mounting-hole rows on 0.300 -inch centers. Once the leads are compressed to 0.300 -inch separation and inserted, sufficient tension is provided to secure the package in the board during soldering. Tin-plated ("bright-dipped") leads require no additional cleaning or processing when used in soldered assembly.

$\ddagger$ F. 15 is the ASTM designation for an iron-nickel-cobalt alloy containing nominally $53 \%$ iron, $29 \%$ nickel, and $17 \%$ cobalt.

# TYPES TIV21, TIV22, TIV23 SILICON VOLTAGE-VARIABLE-CAPACITANCE DIODES 

bULLETIN NO. DL-S 7211742 , JUNE 1972

## UHF TUNING DIODES

- Small Size, Double-Plug Construction
- Extremely Stable and Reliable
- Available in Matched Sets ${ }^{\dagger}$


## mechanical data

Double-plug construction affords integral positive contact by means of a thermal compression bond. Moisture-free stability is ensured through hermetic sealing. The coefficients of thermal expansion of the glass case and the dumet plugs are closely matched to allow extreme temperature excursions. Hot-solder-dipped leads are standard.

absolute maximum ratings at $\mathbf{2 5}{ }^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)

## Peak Reverse Voltage

Continuous Power Dissipation at (or below) $25^{\circ} \mathrm{C}$ Free-Air Temperature (see Note 1) 250 mW
Storage Temperature Range $-65^{\circ} \mathrm{C}$ to $150^{\circ} \mathrm{C}$
Lead Temperature $\mathbf{1 / 1 6}$ Inch from Case for 10 Seconds
$260^{\circ} \mathrm{C}$
electrical characteristics at $\mathbf{2 5}{ }^{\circ} \mathbf{C}$ free-air temperature

| PARAMETER |  | TEST CONDITIONS |  | TIV21 |  | TIV22 |  | TIV23 |  | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | MIN | MAX | MIN | MAX | MIN | MAX |  |
| $V_{(B R)}$ | Breakdown Voitage |  |  | $I_{R}=10 \mu \mathrm{~A}$ |  | 30 |  | 30 |  | 30 |  | V |
| $\mathrm{I}_{\mathbf{R}}$ | Reverse Current | $\mathrm{V}_{\mathrm{R}}=25 \mathrm{~V}$ |  |  | 100 |  | 100 |  | 100 | nA |
| $C_{t}$ | Total Capacitance | $V_{R}=3 \mathrm{~V}$, | $\mathrm{f}=1 \mathrm{MHz}$ | 9 | 14 | 9 | 14 | 9 | 14 | pF |
|  |  | $V_{R}=25 \mathrm{~V}$, | $\mathrm{f}=1 \mathrm{MHz}$ | 2 | 2.5 | 2.3 | 2.8 | 1.8 | 2.8 |  |
| 0 | Figure of Merit (See Note 2) | $\mathrm{V}_{\mathrm{R}}=3 \mathrm{~V}$, | $f=100 \mathrm{MHz}$ | 150 |  | 150 |  | 100 |  |  |
| $\frac{C_{t 1}}{C_{t 2}}$ | Capacitance Ratio | $V_{1}=3 V_{1}$ | $V_{2}=25 \mathrm{~V}, \quad f=1 \mathrm{MHz}$ | 4.5 | 6 | 4 | 5 | 4 | 6 |  |

[^196]TYPES TIV21, TIV22, TIV23
SILICON VOLTAGE-VARIABLE-CAPACITANCE DIODES



# TYPES TIV24, TIV25 <br> SILICON VOLTAGE-VARIABLE-CAPACITANCE DIODES 

VHF TUNING DIODES

- Small Size, Double-Plug Construction
- Extremely Stable and Reliable
- Available in Matched Sets ${ }^{t}$


## mechanical data

Double-plug construction affords integral positive contact by means of a thermal compression bond. Moisture-free stability is ensured through hermetic sealing. The coefficients of thermal expansion of the glass case and the dumet plugs are closely matched to allow extreme temperature excursions. Hot-solder-dipped leads are standard.

absolute maximum ratings at $\mathbf{2 5}{ }^{\circ} \mathbf{C}$ free-air temperature (unless otherwise noted)
Peak Reverse Voltage
30 V
Continuous Power Dissipation at (or below) $25^{\circ} \mathrm{C}$ Free-Air Temperature (see Note 1) 250 mW
Storage Temperature Range . . . . . . . . . . . . . . . . . . . . . . . . . . . $-65^{\circ} \mathrm{C}$ to $150^{\circ} \mathrm{C}$
Lead Temperature $\mathbf{1 / 1 6}$ Inch from Case for 10 Seconds
$260^{\circ} \mathrm{C}$
electrical characteristics at $\mathbf{2 5}{ }^{\circ} \mathrm{C}$ free-air temperature

| PARAMETER |  | TEST CONDITIONS |  | TIV24 |  | TIV25 |  | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | MIN | MAX | MIN | MAX |  |
| $V_{\text {(BR) }}$ | Breakdown Voltage |  |  | $I_{R}=10 \mu \mathrm{~A}$ |  | 30 |  | 30 |  | V |
| IR | Reverse Current | $\mathrm{V}_{\mathrm{R}}=25 \mathrm{~V}$ |  |  | 100 |  | 100 | nA |
| $C_{t}$ | Total Capacitance | $V_{R}=3 \mathrm{~V}$, | $\mathrm{f}=1 \mathrm{MHz}$ | 22 | 34 | 23 | 34 | pF |
|  |  | $\mathrm{V}_{\mathrm{R}}=25 \mathrm{~V}$, | $\mathrm{f}=1 \mathrm{MHz}$ | 5.2 | 7.5 | 4.2 | 6.5 |  |
| 0 | Figure of Merit (See Note 2) | $V_{R}=3 \mathrm{~V}$, | $\mathrm{f}=100 \mathrm{MHz}$ | 80 |  | 80 |  |  |
| $\frac{\mathrm{C}_{\text {t1 }}}{\mathrm{C}_{\mathrm{t} 2}}$ | Capacitance Ratio | $\mathrm{V}_{1}=3 \mathrm{~V}$ | $V_{2}=25 \mathrm{~V}, \quad f=1 \mathrm{MHz}$ | 3.5 | 6 | 4.5 | 6 |  |

[^197]SILICON VOLTAGE-VARIABLE-CAPACITANCE DIODES


NOTES: 2. Figure of Merit, $Q$, is defined by the equation $Q=\frac{1}{2 \pi f C_{t} r_{s}}$ where $r_{s}$ is the equivalent series resistance.
3. Average temperature coefficient, $\alpha^{C}$, is determined by the formula: $\alpha_{C}=\left[\frac{\left(C_{t} @ 125^{\circ} \mathrm{C}\right)-\left(C_{t} @-50^{\circ} \mathrm{C}\right)}{\mathrm{C}_{\mathrm{t}} @ 25^{\circ} \mathrm{C}}\right] \frac{100 \%}{175^{\circ} \mathrm{C}}$

# TYPES TIV306, TIV307, TN308 SILICON VOLTAGE-VARIABLE-CAPACITANCE DIODES 

## AFC TUNING DIODES

(Replaces TIV300 and TIV301)

- Small Size, Double-Plug Construction
- Extremely Stable and Reliable


## mechanical data

Double-plug construction affords integral positive contact by means of a thermal compression bond. Moisture-free stability is ensured through hermetic sealing. The coefficients of thermal expansion of the glass case and the dumet plugs are closely matched to allow extreme temperature excursions. Hot-solder-dipped leads are standard.

absolute maximum ratings at $25^{\circ} \mathrm{C}$ free-air temperature (unless otherwise noted)
Peak Reverse Voltage
Continuous Device Dissipation at (or below) $25^{\circ} \mathrm{C}$ Free-Air Temperature
(See Note 1)
250 mW
Operating Free-Air Temperature Range . . . . . . . . . . . . . . . . $-65^{\circ} \mathrm{C}$ to $150^{\circ} \mathrm{C}$
Storage Temperature Range . . . . . . . . . . . . . . . . . . . . $-65^{\circ} \mathrm{C}$ to $200^{\circ} \mathrm{C}$
electrical characteristics at $\mathbf{2 5}^{\circ} \mathrm{C}$ free-air temperature

| PARAMETER |  | TEST CONDITIONS | TIV306 |  | TIV307 |  | TIV308 |  | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | MIN | MAX | MIN | MAX | MIN | MAX |  |
| $V_{\text {(0x) }}$ | Breakdown Voltage |  | $\mathrm{I}_{\mathrm{R}}=100 \mu \mathrm{~A}$ | 20 |  | 20 |  | 20 |  | $V$ |
| $\mathrm{I}_{\mathrm{R}}$ | Reverse Current | $\mathrm{V}_{\mathrm{R}}=15 \mathrm{~V}$ |  | 50 |  | 50 |  | 50 | nA |
| $C_{+}$ | Total Capacitance | $\mathrm{V}_{\mathrm{R}}=4 \mathrm{~V}, \mathrm{f}=1 \mathrm{MHz}$ | 5 | 9 | 7 | 11 | 9 | 14 | pf |
| Q | Figure of Merit (Mote 2) | $\mathrm{V}_{\mathrm{R}}=4 \mathrm{Y}, \quad \mathrm{l}=50 \mathrm{MHz}$ | 200 |  | 200 |  | 200 |  |  |
| $\frac{C_{1}}{C_{12}}$ | Capatitance Ratio | $V_{1}=1 \mathrm{~V}, \mathrm{~V}_{2}=12 \mathrm{~V}, f=1 \mathrm{mHz}$ | 2.2 |  | 2.3 |  | 2.4 |  |  |



## Sensistors ${ }^{\circ}$

 TYPES TG 1/8, TM 1/8 POSITIVE-TEMPERATURE-COEFFICIENT SILICON THERMISTORSBULLETIN NO. DL-S 7312014, MARCH 1973

## TEMPERATURE-SENSING, TEMPERATURE-COMPENSATING

- Designed to Meet or Exceed all Electrical Requirements of MIL-T-23648A for Positive-TC Thermistors
- TG1/8 . . . Similar to RTH42 (MIL-T-23648A/19)
- TM1/8 . . . Similar to RTH22 (MIL-T-23648A/9)
- Large Positive Temperature Coefficient of Resistance (Approx 0.7\% ${ }^{\circ} \mathrm{C}$ )
- Wide Resistance Value Ranges Available in $\pm \mathbf{5 \%}$ or $\pm \mathbf{1 0 \%}$ Tolerances
mechanical data
The TG1/8 thermistor is encapsulated in a glass, hermetically sealed package with hot-solder-dipped leads.
The TM1/8 thermistor is encapsulated in a molded package with hot-solder-dipped leads

| TG 1/8 | WITHIN THIS O.OSO INCH ZONE. <br> DIMENSIONS ARE IN INCHES | 1 |
| :---: | :---: | :---: |
| TM 1/8 |  | 1 |

maximum ratings
TG 1/8 TM 1/8
Power Dissipation at (or below) $25^{\circ} \mathrm{C}$ Free-Air Temperature (See Figures 1 and 2) . . . . . . 300 mW 500 mW
Power Dissipation at (or below) $100^{\circ} \mathrm{C}$ Free-Air Temperature (See Figures 1 and 2) . . . . . 125 mW 125 mW
Operating Free-Air Temperature Range ... . . . . . . . . .
Storage Temperature Range $-55^{\circ} \mathrm{C}$ to $125^{\circ} \mathrm{C}$
$-65^{\circ} \mathrm{C}$ to $150^{\circ} \mathrm{C}$
electrical and thermal characteristics

|  | PARAMETER | TG 1/8 | TM 1/8 | UNIT |
| :--- | :--- | :---: | :---: | :---: |
| $\mathrm{R}_{25^{\circ} \mathrm{C}} / \mathrm{R}_{125^{\circ} \mathrm{C}} \mathrm{Zero-Powar}$ Resistance Ratio | $0.55 \pm 15 \%$ | $0.55 \pm 15 \%$ |  |  |
| $\tau$ | Thermai Time Constant | 35 typ | 35 typ | s |

Raplaces TG 1/8, TM 1/8, TM 1/4 data sheet, Bulletin No. DL-S 6910909, revised August 1969

## dissipation derating curves

TG 1/8

TM 1/8

FIGURE 2
factors for determining nominal resistance at various temperatures

TABLE I-TG 1/8

| Temperature <br> ( ${ }^{\circ}$ ) | $10 \Omega-68 \Omega$ | $82 \Omega-150 \Omega$ | $180 \Omega-470 \Omega$ | $560 \Omega-1.2 \mathrm{k} \Omega$ | $1.5 \mathrm{k} \Omega-5.6 \mathrm{k} \Omega$ | $6.8 \mathrm{k} \Omega-10 \mathrm{k} \Omega$ |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| -55 | 0.615 | 0.582 | 0.560 | 0.550 | 0.515 | 0.510 |
| -15 | 0.790 | 0.770 | 0.755 | 0.740 | 0.730 | 0.730 |
| 0 | 0.863 | 0.847 | 0.838 | 0.835 | 0.825 | 0.825 |
| 25 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |
| 50 | 1.160 | 1.170 | 1.180 | 1.200 | 1.230 | 1.190 |
| 75 | 1.350 | 1.370 | 1.400 | 1.420 | 1.450 | 1.400 |
| 100 | 1.545 | 1.584 | 1.623 | 1.656 | 1.670 | 1.610 |
| 125 | 1.750 | 1.800 | 1.860 | 1.920 | 1.960 | 1.830 |

TABLE II - TM 1/8

| Tempeatture <br> $\left({ }^{\circ} \mathrm{C}\right)$ | $10 \Omega-68 \Omega$ | $82 \Omega-150 \Omega$ | $180 \Omega \iota-560 \Omega$ | $680 \Omega-1.5 \mathrm{k} \Omega$ | $1.8 \mathrm{k} \Omega-12 \mathrm{k} \Omega$ | $15 \mathrm{k} \Omega-39 \mathrm{k} \Omega$ |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| -55 | 0.615 | 0.582 | 0.560 | 0.550 | 0.515 | 0.481 |
| -15 | 0.790 | 0.770 | 0.755 | 0.740 | 0.730 | 0.712 |
| 0 | 0.863 | 0.847 | 0.838 | 0.835 | 0.825 | 0.814 |
| 25 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |
| 50 | 1.160 | 1.170 | 1.180 | 1.200 | 1.230 | 1.210 |
| 75 | 1.350 | 1.370 | 1.400 | 1.420 | 1.450 | 1.430 |
| 100 | 1.545 | 1.584 | 1.623 | 1.656 | 1.670 | 1.670 |
| 125 | 1.750 | 1.800 | 1.860 | 1.920 | 1.960 | 1.900 |

# TYPES TG 1/8, TM 1/8 POSITIVE-TEMPERATURE-COEFFICIENT SILICON THERMISTORS 

## using tables I and II

Factors for determining the resistance of Sensistor thermistors at temperatures other than $25^{\circ} \mathrm{C}$ are tabulated in Table I and II. To determine the resistance of a thermistor at a temperature other than $25^{\circ} \mathrm{C}$, first select the appropriate table (Table I for TG $1 / 8$, Table II for TM 1/8), then select the column that is headed by the resistance range that includes the nominal resistance at $25^{\circ} \mathrm{C}$ of the thermistor in question. The resistance at $25^{\circ} \mathrm{C}$ of the thermistor is then multiplied by the factor in that column that corresponds with the temperature in question to determine the new resistance.

EXAMPLES: Given a TG1/8221J* Sensistor thermistor whose zero-power resistance value at $25^{\circ} \mathrm{C}$ is $228 \Omega$, find the resistance value for $75^{\circ} \mathrm{C}$. The proper table is Table $I$ and the proper column is the one headed " $180 \Omega-470 \Omega$ ". The factor in the $75^{\circ} \mathrm{C}$ row of this column is 1.400 , which when multiplied by the zero-power resistance value at $25^{\circ} \mathrm{C}$ gives $1.400 \times 228 \Omega=319 \Omega$ (at $75^{\circ} \mathrm{C}$ ).

## effects of tolerances

In the previous example a 228 -ohm Sensistor thermistor is computed to have a nominal resistance of 319 ohms at $75^{\circ} \mathrm{C}$. The actual resistance of the thermistor at $75^{\circ} \mathrm{C}$ may vary from the calculated value by an amount not exceeding the tolerances tabulated in Table III.

TABLE III
RESISTANCE TOLERANCE w TEMPERATURE

| TEMPERATURE <br> $\left({ }^{\circ} \mathrm{C}\right)$ | $\pm 5 \%$ | $\pm 10 \%$ |
| :---: | :---: | :---: |
| $(\mathrm{~J})$ | $(\mathrm{K})$ |  |
| -55 | $\pm 15 \%$ | $\pm 20 \%$ |
| -15 | $\pm 9 \%$ | $\pm 14 \%$ |
| 0 | $\pm 7 \%$ | $\pm 12 \%$ |
| 25 | $\pm 5 \%$ | $\pm 10 \%$ |
| 50 | $\pm 7 \%$ | $\pm 12 \%$ |
| 75 | $\pm 9 \%$ | $\pm 14 \%$ |
| 100 | $\pm 12 \%$ | $\pm 17 \%$ |
| 125 | $\pm 15 \%$ | $\pm 20 \%$ |

[^198]
## TYPES TG 1/8, TM 1/8

## POSITIVE-TEMPERATURE-COEFFICIENT SILICON THERMISTORS

## typical characteristics with power applied

To determine resistance value with power applied, obtain a multiplying factor from the applicable curve below. The free-air curve is for the condition of heat removal by free-air convection only. The heat-sink curve is for the maximum-cooling-rate condition of a heat-sink strap, with leads attached to an infinite heat sink. Actual conditions encountered will be between these two extremes. After selecting an applicable multiplying factor from Figure 3 or 4, multiply this by the $25^{\circ} \mathrm{C}$ zero-power resistance. This product is then corrected for the actual ambient temperature by use of the appropriate factor from Table I or II.

TG $1 / 8$
PERCENT RESISTANCE CHANGE
vs


Figure 3

TM 1/8
PERCENT RESISTANCE CHANGE


FIGURE 4
${ }^{\dagger} \boldsymbol{T}_{\mathrm{L}}$ is lead temperature measured $\mathbf{1 / 1 6}$ inch from the body.
standard zero-power resistance values (ohms) at $25^{\circ} \mathrm{C}$ free-air temperature

| 10 | 12 | 15 | 18 | 22 | 27 | 33 | 39 | 47 | 50 | 56 | 68 | 82 |
| ---: | ---: | ---: | ---: | ---: | ---: | ---: | ---: | ---: | ---: | ---: | ---: | ---: |
| 100 | 120 | 150 | 180 | 220 | 270 | 330 | 390 | 470 | 500 | 560 | 680 | 820 |
| 1000 | 1200 | 1500 | 1800 | 2200 | 2700 | 3300 | 3900 | 4700 | 5000 | 5600 | 6800 | 8200 |
| 10000 | $12000^{*}$ | $15000^{*}$ | $18000^{*}$ | $22000^{*}$ | $27000^{*}$ | $33000^{*}$ | $39000^{*}$ |  |  |  |  |  |

These values apply to types TM $1 / 8$ only.
part-number designation

TM1/8272K


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[^0]:    OPTO-Refer to The Optoelectronics Data Book for Design Engineers, First Edition (CC-405)

[^1]:    *Not shown in this data book but still available from Texas instruments.
    POWER-Refer to The Power Semiconductor Data Book for Design Engineers, First Edition (CC-404).

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    OPTO-Rafer to The Optoelectronics Data Book for Design Engineers, First Edition (CC-405).
    POWER-Refer to The Power Semiconductor Date Book for Design Engineers, First Edition (CC-404).

[^3]:    Definition
    The respective input or output reflection coefficient with the transistor in the indicated configuration. See page 1-4.

    See page 1-4.
    See pages 1-5 and 1-6.
    See pages 1-5 and 1-6.
    The sum of $\mathrm{t}_{\mathrm{s}}+\mathrm{t}_{\mathrm{f}}$. See pages 1-5 and 1-6.
    The sum of $t_{d}+t_{r}$. See pages 1-5 and 1-6.
    See pages 1-5 and 1-6.
    See pages 1-5 and 1-6.
    See pages 1-5 and 1-6.
    See page 1-6.

    The dc supply voltage applied to a circuit connected to the reference terminal.

    The dc voltage between the terminal indicated by the first subscript and the reference terminal (stated in terms of the polarity at the terminal indicated by the first subscript).

    The instantaneous value of ac voltage between the terminal indicated by the first subscript and the reference terminal.

[^4]:    *See package drawings on page 2-20.

[^5]:    -See package drawings on page 2-20.

[^6]:    *See package drewings on page 2-20. $\quad{ }^{\dagger} V_{(B R) C E O}$ approximated from $V_{(B R) C E R} \quad \ddagger V_{(B R) C E R}$

[^7]:    "See package drawings on page 2-20.

[^8]:    *See package drawings on page 2-20

[^9]:    *See package drawings on page 2-20.

[^10]:    - See package drawings on page 2-20.

[^11]:    *See package drawings on page 2-20.

[^12]:    *See package drawings on page 2-20.

[^13]:    - See package drawings on paga 2-20.

[^14]:    *See package drawings on page 2-20.

[^15]:    *Sae package drawings on page 2-20.

[^16]:    -See pack sge drawings on pege 2-20.

[^17]:    *See package drawings on page 2-20.

[^18]:    

[^19]:    *Common Emitter
    $\mathrm{t}_{\mathrm{g}}=\mathbf{1 k} ; \mathrm{R}_{\mathrm{L}}=\mathbf{2 0 k}$
    IConventional Moise-Compared to 1000 ohm resistor, 1000 cpe and 1 cycle band width

[^20]:    *absolute maximum ratings at $25^{\circ} \mathrm{C}$ case temperature (unless otherwise noted)
    Collector-Base Voltage . . . . . . . . . . . . . . . . . . . . . . . . 60 v
    Collector Current . . . . . . . . . . . . . . . . . . . . . . . . . . 60 ma
    Total Device Dissipation (see note 1) . . . . . . . . . . . . . . . . . . 750 mw
    Collector Junction Operating Temperature . . . . . . . . . . . . . . . . . $+150^{\circ} \mathrm{C}$
    Storage Temperature Range . . . . . . . . . . . . . . . . . . . . $-55^{\circ} 10+150^{\circ} \mathrm{C}$

[^21]:    - JEDEC malistord dala

[^22]:    ${ }^{\bullet}$ Common Emittor tialke tConventional Nolso-Compered to 1000 ohm resistor, 1000 cps and $\mid$ eyele band width

[^23]:    -Common Emifter $\dagger \ddagger=1$ ke. $\ddagger$ Conventional Nolto-Compared to 1000 ohm retintor, 1000 cps and $i$ eycle band width

[^24]:    * Common Emitter $\quad f=1 k c \quad \ddagger$ Conventional Noise-Compared to 1000 ohm resistor, 1000 eps and 1 cycle band width

[^25]:    - Indicates JEDEC ragistered data.

[^26]:     a chonge groater than thy required acewrecy of the measurament.

[^27]:    *Indicales JEDEC raghtrored data.

[^28]:    *Indicates JEDEC registered data

[^29]:     a chege grouter then the rayurad ectorecy of the mosswament.

[^30]:    *Iallicates JEOEC mpistorad defa

[^31]:    JEDEC registered data. This deta sheet contains all applicable registered data in effect at the time of publication.

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[^33]:    -Indicates JEDEC registered tata.

[^34]:    *JE DEC registered data. This data sheet contains all applicable registered data in effect at the time of publication

[^35]:    *Indicater JEDEC rogistored data

[^36]:    -The JEDEC registared outline for this device is TO-5. TO-39 falls within TO-5 with the exception of lead length.

[^37]:    -Indicates JEDEC rapisitered dito.

[^38]:    -Indicates JEDEC registered daia.

[^39]:    *The JEDEC registered outline for these devices is TO-5. TO-39 falls within TO-5 with the exception of lead fength.
    *JEDEC registered data. This data sheet contains all applicable registered data in effect at the time of publication.
    ${ }^{\dagger}$ This value is guaranteed by Texas Instruments in addition to the JEDEC registered value which is also shown.

[^40]:    - JEDEC registared data.

[^41]:    *The JEDEC registered outline for these devices is TO-5. TO-39 falis within TO. 5 with the exception of lead length
    *JEDEC registered data. This data sheet containa all applicable registered data in effect at the time of publication.
    $\dagger$ This value is guaranteed by Texes instruments in addition to the JEDEC registered value which is also shown.

[^42]:    *ladicetus JEDEC reglatered data

[^43]:    $\dagger$ Voltage and current values shown are nominal; exact values vary slightly with transistor parameters.
    *JEDEC registered data

[^44]:    NOTES: 1. These values apply between 0 and 10 mA collector current when the base-emitter diode is open-circuited.
    2. Derate linearly to $180^{\circ} \mathrm{C}$ free-air temperature at the rate of $5 \mathrm{~mW} /^{\circ} \mathrm{C}$
    3. Derate linearly to $180^{\circ} \mathrm{C}$ iead temperature at the rata of $10 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$. Lead temperature is measured on the collector lead $1 / 16$ inch

[^45]:    Trademark of Texes Instruments
    $\ddagger$ U.S. Patent No. 3,439,238

[^46]:    tVoltege and current values shown are nominal; exact values vary slightiy with transistor parameters.

    - The referenced figures are shown under Parameter Measurement Information for types 2 N2217 through 2 N2222 or TiS109, page 4-96.

[^47]:    tPrevious editions of this date sheet showed higher power disslpation ratinge which have been found to be in error. The new ratinge correct these errors and do not represent product changes.

[^48]:    - JEDEC registared data

[^49]:    -The JEDEC registered outline for these devices is TO-5. TO-39 falls within TO-5 with the exception of lead length.
    -JEDEC registered data. This data sheet contains all applicable registered data in effect at the time of publication.
    ${ }^{\text {t This value is guaranteed by Texes instrumente in addition to the JEDEC registered value which is also shown. }}$

[^50]:    NOTES: a. Waveforms are monitored on ancilloscope with the following characteristics: $t_{r} \leqslant 14 \mathrm{nsec}, \mathrm{R}_{\mathrm{in}}=10 \mathrm{M} \Omega, \mathrm{C}_{\mathrm{in}}=11.5 \mathrm{pF}$. b. The relay is Clare HG 1005 (or equivaient).

[^51]:    ${ }^{\dagger}$ Tradernark of Texas Instruments
    +U.S. Patent No. 3,439,238
    USES CHIP N23

[^52]:    *Indicates Jepec ragisterad data

[^53]:    MOTES, I. This value appites whon bese-omititer diode it apen-elinultod.
    2. Dorain linvarly to $175^{\circ} \mathrm{C}$ free-alr temperature at the rate of $\mathrm{a} m \mathrm{mw} / \mathrm{C}^{\circ}$.
    3. Derate Hinearly to $175^{\circ} \mathrm{C}$ case tomptrature of the rate of $10 \mathrm{~mm} / \mathrm{C}^{\circ}$.

    - Indienoles SEDEC ragistored date.

[^54]:    -Indiceles JEDEC magistorod data.

[^55]:    -Indicates JEBEC regisfored deta.

[^56]:    *Iadicales JEDEC registerad date

[^57]:    *Indicater JEDEC magistrone data.

[^58]:    -Indieata JEBEC mphomad data

[^59]:    *JEDEC registered data

[^60]:    -JEDEC registered date

[^61]:    *JEDEC registered data

[^62]:    ${ }^{\dagger}$ Previous editions of this data sheet showed higher power distipation ratings which have been found to be in error. The new ratings correct these errors and do not represent product changes.

    USES CHIP P20

[^63]:    *JEDEC registered data. This data sheet contains all applicable registered data in effect at the time of publication.

[^64]:    -JEDEC registored data. Thls data sheet contalns all applicable reglaterad data in effect at the time of publication.

[^65]:    - JEDEC registersed date
    tThase values apply to types 2N2915A, 2N2916A, 2N2919A. and 2N2920A only.
    $\ddagger$ This value applies to type 2N2916A only.

[^66]:    -Indicates JEDEC registered data

[^67]:    OTES: 1. This value appliss between 0 and 100 ma collector current when the base-omition diede is open-circuited.
    . Derato lincorly to $175^{\circ} \mathrm{C}$ treo-air temparature of the rote of $1.67 \mathrm{~mm} / \mathrm{C}^{\circ}$ for ach triode and $2.33 \mathrm{mw} / \mathrm{C}^{\circ}$ for fotal device.
    . Berate linearly to $175^{\circ} \mathrm{C}$ cese temperature at the rate of $4.67 \mathrm{mw} / \mathrm{C}^{\circ}$ for eoch triede and $9.33 \mathrm{~mm} / \mathrm{C}^{\circ}$ for folal device.
    4. The fermiaals of the tricde nof under test ory epen-circuited for the measurement of these characteristics.
    5. These marameters must be meeserve wing pulse fechniaues. $\mathrm{PW}=\mathbf{3 0 0} \mu \mathrm{sec}$, Duty Cycle $\leq \mathbf{2 \%}$.
    *Indicatos JEDEC registared data.

[^68]:    T Previous editions of this date sheat showed highar power dissipation ratings which hava been found to be in error. The new ratings correct theee arrors and do not represent product changes.

    USES CHP P12

[^69]:    *Indicates Jebec registered data

[^70]:    NOTES: 1. These values apply between 0 and 100 mA collector current when the base-amitter diode is open-circuited.
    2. Derate linearly to $150^{\circ} \mathrm{C}$ free-air temperature at the rate of $5 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$. Ste Figure 3 .
    ${ }^{\dagger}$ Tradiemark of Texas instruments
    $\boldsymbol{\Psi}$ U.S. Patent Number $3,439,238$

[^71]:    tVoltwge and current values shown are nominal; exact values vary slightly with transistor parameters. Nominal base current for turn-on time is

[^72]:    NOTE 4: These paramelers must be measured using pulse techniques. $t_{w}=300 \mu \mathrm{~s}$, duty cycle $\leq \mathbf{2 \%}$.

[^73]:    ${ }^{\text {t }}$ Voitage and current values shown are nominal; exact values vary slightly with transistor parameters.

[^74]:    The asterlsk identifies JEDEC registered data for the 2 N3702 and 2 N3703 only. This data sheet containa all applicable registered data in effect at the time of publication.
    Trademark of Texas instruments
    $\ddagger$ U.S. Patent No. 3,439,238
    \& Texas Instruments guarantees these values in addition to the JEDEC reglstered values which are also shown.
    USES CHIP P20

[^75]:    ${ }^{\dagger}$ Previlous editions of this data sheet showed higher power dissipation ratings which have been found to be in error. The new ratings correct these errors and do not represant product changes.

[^76]:    NOTES: 1. These values apply between 0 and 100 mA collector current for 2 N 3734 or 0 and 40 mA for 2 N 3735 when the base-emitter diode is open-circuited.
    2. Derate linearly to $200^{\circ} \mathrm{C}$ free-air temperature at the rate of $5.71 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$.
    3. Derate the 10 -watt rating linearly to $200^{\circ} \mathrm{C}$ case temperature at the rate of $57.1 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$. Derate the 4 -watt (JEDEC registered) rating linearly to $200^{\circ} \mathrm{C}$ case temperature at the rate of $22.8 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$.

[^77]:    - JEDEC registered data

[^78]:    *JEDEC registered data. This data sheat contains all applicable registered data in effect at the time of publication.

[^79]:    SGD

[^80]:    *JEDEC registered date
    ${ }^{\dagger}$ The fourth lead (case) is connected to the source for all measurements.

[^81]:    $\dagger$ Trademark of Texas Instruments
    $\ddagger$ U.S. Patent No. 3,439,238

[^82]:    
    

[^83]:    NOTE 1: Derate linearly to $200^{\circ} \mathrm{C}$ free-air temperature at the rate of $1.71 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$.
    -JEDEC registered data. This data sheet contains all applicable registered data in effect at the time of publication.
    ${ }^{\dagger}$ The fourth lead (case) is connected to the source for all measurements.

[^84]:    -Indicates JEDEC registorad date

[^85]:    NOTE: 1. Derate linearly to $175^{\circ} \mathrm{C}$ free-air temperature at the rate of $\mathbf{2 m W} /{ }^{\circ} \mathrm{C}$.

    - Indicates JEDEC registered data

[^86]:    †Votrage and current values shown are nominal; exact values vary allghtiv wieth tranaiteor perameters.

[^87]:    *JEDEC registered date

[^88]:    t Voltage and current values shown are nominal; exact values vary slightly with transistor parameters. Nominal base current for deley and rise times is calculated using the minlmum value of $V_{B E}$. Nominal base currents for storage and fall times are calculated using the maximum value
    of $V_{B E}$.

[^89]:    ${ }^{\dagger}$ Trademark of Texas Instruments
    ¥u.S. Patent No. 3,439,238

[^90]:    FThe fourth lead (cose) is connected to the source for all measurements
    *indicales JEDEC regisfered daida

[^91]:    *JEDEC registered data. This data sheet contains all applicable data in effect at the time of publication.

[^92]:    mote 3: This parameter musi be measured esing pulse tockniquos. $\boldsymbol{t}_{\mathrm{w}} \approx 100 \mathrm{~ms}$, duty cycle $\leq 10 \%$.

    - JEDEC registored data (typical data axeluded).
    $\dagger$ These are nominal velues; oxect valuss vary silghtily with transister paremeters.

[^93]:    - JEDEC registered data
    ${ }^{\dagger}$ Trademark of Texas Instruments
    $\ddagger$ U.S. Patent No. $\mathbf{3 , 4 3 9 , 2 3 8}$

[^94]:    NOTES: 1. This value applies between 0 and 30 mA collector current when the base-emitter diode is open-circuited.
    2. Derate innearly to $175^{\circ} \mathrm{C}$ free-air temperature at the rate of $6.67 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$.
    3. Derate the 10 -watt rating linearly to $175^{\circ} \mathrm{C}$ case temperature at the rate of $66.7 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$. Derate the 5 -watt (JEDEC registered) rating linearly to $175^{\circ} \mathrm{C}$ case temperature at the rate of $33.3 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$.
    The JEDEC registered outline for these devices is TO-5. TO-39 falls within TO-5 with the exception of lead length.
    *JEDEC registered data. This data sheet contains all applicable registered data in effact at the time of publication.
    ${ }^{\dagger}$ This value is guaranteed by Texas Instruments in addition to the JEDEC registered value which is also shown.

[^95]:    * Indicates JEDEC registorol dała

[^96]:    ${ }^{\dagger}$ Trademark of Texas Instruments
    $\ddagger$ U.S. Patent No. 3,439,238

[^97]:    ${ }^{\dagger}$ Trademark of Texas Instruments

[^98]:    - The asterisk identifies JEDEC registered date for the 2N5220 only.

[^99]:    -Indicates JEDEC rogistered data'

[^100]:    $\ddagger$ Voltage and current values shown are nominal; exact values vary slightly with transistor and diode parameters.

    * Indicatos JEDEC registered data

[^101]:    NOTE 1: Derate linearly to $200^{\circ} \mathrm{C}$ free-air temperature at the rate of $1.7 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$.

[^102]:    NOTE 1: Derate linearly to $135^{\circ} \mathrm{C}$ free-alr temperature at the rate of $2.82 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$.
    *The asterisk identifies JEDEC registered data for the 2 N5460, 2 N5461, and 2 N5462 only. This data sheet contains all applicable registered data in effect at the time of publication.
    ${ }^{\top}$ Trademark of Texas Instruments
    $\ddagger$ U. S. Patent No. 3,439,238

[^103]:    NOTE 2: This parameter must be masured using pulse techniques. $\mathbf{t}_{\mathbf{w}}=\mathbf{3 0 0} \mu$ s, duty cycle $\leqslant \mathbf{2 \%}$.
    "The asterisk indicates JEDEC registered data for the 2N5460, 2N5461, and 2N5462 only.

[^104]:    *JEDEC registered data. This date sheet contains all applicabie registered data in effect at the time of publication.
    ${ }^{\dagger}$ Tradernark of Texes Instruments.
    $\ddagger \mathbf{U}$. S. Patent No. 3,439,238

[^105]:    NOTE 1: Derate linearly to $125^{\circ} \mathrm{C}$ froe-sir temperature at the rate of $3 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$.
    tTrademark of Texas Instruments

[^106]:    -JEDEC registered data

[^107]:    NOTE 1: Derate linearly to $125^{\circ} \mathrm{C}$ free-air temperature at the rate of $3 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$.
    t Trademark of Texas instruments
    FU.S. Patent No. 3,439,238

[^108]:    - JEDEC registered data. This deta sheet contains all applicable registered data in effect at the time of publication.

[^109]:    TTrademark of Texas Instruments

[^110]:    ${ }^{\dagger}$ All masauramente are made with the case and eubstrate connected to the source.
    *JEDEC ragistered data

[^111]:    NOTE 3: This parameter must be measured using pulse techniques. $\mathrm{t}_{\mathbf{w}}=\mathbf{3 0 0} \mu \mathrm{s}$, dutv cycle $\leqslant \mathbf{2 \%}$.

[^112]:    ${ }^{\dagger} \Delta G_{p s}$ is defined as the change in $G_{p s}$ from the value at $V_{G G}=7$ volts.
    -JEDEC registered data

[^113]:    - JEDEC reglatered data

[^114]:    JEDEC registered data

[^115]:    -JEDEC registered data

[^116]:    - JEDEC raglatered data

[^117]:    - JEDEC registered deta
    $\ddagger$ For ald measurements except $C_{d s}$, the drain, source, and gate leads of the transistor not under test and the common substrate are grounded. For testing ISDS, ground is the drain of the transistor under test but for all other measurements, it is the source.

[^118]:    -JEDEC raglatered data

[^119]:    ${ }^{+} \Delta G_{p s}$ at 45 MHz is defined as the change in $G_{p s}$ from the value at $V_{G G}=6$ volts.
    $\ddagger \Delta G_{p g}$ at 200 MHz is dofined as the change in $G_{p s}$ from the value at $V_{G G}=7$ volts.

[^120]:    JEDEC registered data

[^121]:    TABLE 2-TIS59

[^122]:    TTrademark of Texas instruments
    $\ddagger$ U.S. Patent No. 3,439,238

[^123]:    tTrademark of Texas Instruments
    $\ddagger$ U. S. Patent No. 3,439,238

[^124]:    ${ }^{\dagger}$ Trademark of Texas Instruments

[^125]:    tVoltage and current values shown are nominal; exact values vary slightly with transistor parameters.

[^126]:    ${ }^{\dagger}$ Tradamark of Texae Instruments
    ${ }^{-}$This value does not modify guaranteed Ilmite for apecific dowices and does not justify operation in oxcese of absolute maximum ratinge.
    NOTES: 1. Thia parameter was meseured uaing pute techniquas. $t_{w}=300 \mu s$, dutv ovele $<\mathbf{2 \%}$.
    2. Capacitance measurements were made using enlpi mounted in Silect packages.

[^127]:    +Data is for devices having indicated value of loss at $V_{D S}=15 \mathrm{~V}, \mathrm{~V}_{\mathrm{GS}}=0, \mathrm{~T}_{\mathrm{A}}=25^{\circ} \mathrm{C}$.
    NOTE 2: Capacitance measurements were made using chips mounted In Silect packages.

[^128]:    This value does not modify guaranteed limits for specific devices and does not justify operation in excess of absolute maximum ratings. NOTES: 1. These parameters were measured using pulse techniques. $t_{w}=300 \mu \mathrm{~s}$, duty cycle $\leqslant 2 \%$.
    2. To avoid overhesting the transistor, these parameters were measured with bias conditions applied for less than five seconds.
    3. Capacitance measurements were made using chips mounted in TO-18 packages.

[^129]:    ${ }^{\dagger}$ Trademark of Texas instruments
    ${ }^{*}$ This value does not modify guaranteed limits for specific devices and does not justify operation in excess of absolute maximum ratings. NOTES: 1. This parameter was measured using pulse techniques. $t_{w}=300 \mu s$, duty cycle $<\mathbf{2 \%}$.
    2. Capacitance measuraments were made using chlps mounted in Silect packages.

[^130]:    ${ }^{\dagger}$ Trademark of Texas Instruments
    This value does not modify guaranteed limits for specific devices and does not justify operation in excess of absolute maximum ratings. NOTES: 1. This parameter was measured using pulse techniques. $t_{w}=300 \mu \mathrm{~s}$, duty cycle $\leqslant 2 \%$.
    2. Capacitance measurements were made using chips mounted in Silect packages.

[^131]:    NOTES: 1. This parameter was measured using pulse techniques. $t_{w}=\mathbf{3 0 0} \mu$, duty cycle $\leqslant 2 \%$.
    2. Capacitance measurements were made using chips mounted in Silect packages.

[^132]:    These values do not modify guaranteed limits for epecific devices and do not justify operation in excess of absolute maximum ratings.
    NOTES: 1. These parameters were measured using pulse techniques. $t_{w}=300 \mu s$, duty cycle $<2 \%$.
    2. Capacitance measurements were made using chips mounted in TO-72 packages.

[^133]:    ${ }^{t}$ Trademark of Texas Instruments
    -This value does not modify guaranteed limits for specific devices and does not justify operation in excess of absolute maximum ratings.
    NOTES: 1. This parameter was measured using pulse techniques. $t_{w}=\mathbf{3 0 0} \mu \mathrm{s}$, duty cycle $\leq 2 \%$.
    2. Capacitance measurements were made using chips mounted in Silect packages.

[^134]:    ${ }^{\dagger}$ Data is for devices having the indicated value of ${ }^{\prime}$ DSS at $V_{D S}=-15 V_{0} V_{G S}=0, T_{A}=25^{\circ} \mathrm{C}$.
    NOTE 1: This parameter was measured using pulse techniques. $\tau_{w}=300 \mu_{s}$, duty cycle $\leq 2 \%$.

[^135]:    This value does not modify guaranteed limits for specific devices and does not justify operation in excess of absolute maximum ratings. NOTES: 1. This parameter was measured using pulse techniques. $t_{w}=300 \mu s$, duty cycle $\leqslant 2 \%$
    2. To obtain reproducible results, this parameter was measured with bias conditions applied for less than five seconds.
    3. Capacitance measurements ware made using chips mounted in TO-72 packages.

[^136]:    $\dagger_{\text {Data }}$ is for devices having the indicated value of ${ }_{\mathrm{DS}}$ at $\mathrm{V}_{\mathrm{DS}}=15 \mathrm{~V}, \mathrm{~V}_{\mathrm{G} 1 \mathrm{~S}}=0, \mathrm{~V}_{\mathrm{G} 2 \mathrm{~S}}=4 \mathrm{~V}$.

[^137]:    ${ }^{\dagger}$ Data is for devices having the indicated value of $I_{D S S}$ at $V_{D S}=15 \mathrm{~V}, V_{G S}=0$, and $T_{A}=25^{\circ} \mathrm{C}$.

[^138]:    NOTES: 1. This parameter was measured using pulse techniques. $t_{w}=300 \mu \mathrm{~s}$, dutv cvcle $\leqslant 2 \%$.

[^139]:    ${ }^{\dagger}$ All measurements, except ISDS, are made with the case and substrate connected to the source.
    -This value does not modify guaranteed limits for specific devices and does not justify operation in excess of absolute maximum ratings. CAUTION: The measurement of $V_{\text {(BR) }}$ DSS may be destructive.
    NOTES: 1. This parameter was measured using pulse techniques. $\mathbf{t}_{\mathbf{w}}=300 \mu \mathrm{~s}$, duty cycle $\leqslant \mathbf{2 \%}$.
    2. Capacitance measurements were made using chips mounted in TO-72 packages.

[^140]:    ${ }^{\dagger}$ All measurements except ISDS are made with the case and substrate connected to the source.
    This value does not modify guaranteed limits for specific devices and does not justify operation in excess of absolute maximum ratings.
    These parameters apply only for chips having protective diodes.

    - This parameter applies only for chips not having protective diodes.

    NOTES: 1. To ensure that the protective diode is functioning properly, this voltage is measured while the device is conducting rated forward gate current
    2. This parameter was measured using pulse techniques. $t_{w}=300 \mu s$, duty cycle $\leqslant 2 \%$.
    3. Capacitance measurements were made using chips mounted in TO-72 packages,

[^141]:    NOTES: 3. Capacitance measurements were made using chips mounted in TO-76 packages

[^142]:    Thase values do not modify guarsnteed limits for apecific devices and do not justify operation in excess of absolute maximum ratings.
    ${ }^{\top}$ Offeat Voltage Change is defined es the magnitude of the algebraic difference between the offeet voltages at two specified batings.
    NOTES: 1. Thase values apply seperately for each emitter with the other emitter open-circuited.
    2. These paramaters were measured with the collector short-elreulted to the base but

    The values epply for both polerities of emitter-to-emlter volrace
    3. Capacitence menauromente wers made using ohipe mounted in TO-72 packages.

[^143]:    Trademark of Texas Instrument
    These values do not modify guaranteed limits for specific devices and do not Justify operation in excess of absolute maximum ratings.
    NOTES: 1. These parameters were mearured using pulse techniques. $t_{w}=300 \mu s$, duty cycle $\leqslant 2 \%$.
    2. Capacitance measurements were made using chips mounted in TO-39 packeges.

[^144]:    TTrademark of Texes Instruments
    -These values do not modify guaranteed limite for apecific devices and do not Juatify operation In axcesi of absolute maximum ratinge.
    NOTES: 1. This parameter was measured using pulce techniquan. tw = $\mathbf{3 0 0} \mu$, duty evcle $\leqslant \mathbf{2 \%}$.
    2. Capacitance measurementa were made uaing chips mounted in TO-39 packages.
    3. $\mathrm{C}_{\mathrm{cb}}$ and $\mathrm{C}_{\mathrm{ab}}$ measuremente amploy a three-tarminal apacitance bridge incopporating a guard eircult. The third electrode femitter or collector, reepectlvely) is connected to the guard tarminal of the bridge. Cabo and $C_{\text {ibe }}$ measurementi are made with the third terminal floating.

[^145]:    ${ }^{+}$Trademark of Texas instruments
    These values do not modify guaranteed limits for specific devices and do not justify operation in excess of absolute maximum ratings. NOTES: 1. These parameters were measured using pulse techniques. $\mathbf{t}_{\mathbf{w}}=\mathbf{3 0 0} \boldsymbol{\mu s}$, duty cycle $\leqslant \mathbf{2 \%}$.
    2. Cepacitance and $r_{b}{ }^{\prime} C_{c}$ masarurements were made using chips mounted in Silect packages.
    3. $\mathrm{C}_{\mathrm{cb}}$ measurement employs a three-terminal cepacitence bridge incorporating a guard circuit. The emitter is connected to the guard terminal of the bridge.

[^146]:    $\dagger$ Trademark of Texas Instruments
    -These values do not modify guaranteed limits for specific devices and do not justify operation in excess of absolute maximum ratings.
    NOTES: 1. These parameters were measured using pulse techniques. $t_{w}=300 \mu s$, duty cycle $\leqslant 2 \%$.
    2. Capacitance measurements were made using chips mounted in Silect packages.
    3. $\mathrm{C}_{\mathrm{cb}}$ measurement employs a three-terminal capacitance bridge incorporating a guard circuit. The emitter is connected to the guard terminal of the bridge.

[^147]:    These values do not modify guaranteed limits for specific devices and do not justify operation in excess of absolute maximum ratings.
    NOTES: 1. These parameters were measured using pulse techniques. $t_{w}=300 \mu s, d u t y ~ c y c l e ~ \leqslant ~ 2 \% . ~$
    2. Capacitance measurements were made using chips mounted in TO-5 packages.

[^148]:    ${ }^{\dagger}$ Trademark of Texas Instruments
    This value does not modify guaranteed limits for specific devices and does not justify operation in excess of absolute maximum ratings.
    $\ddagger \mathrm{C}_{\text {ies }}$ and $\mathrm{C}_{\text {oes }}$ are defined as the imaginary parts of the small-signal, common-emitter, short-circuit admittances divided by $2 \pi \mathrm{\pi f}$.
    NOTES: 1. This parameter was measured using pulse techniques. $t_{w}=300 \mu \mathrm{~s}$, duty cycle $\leqslant 2 \%$.
    2. Capacitance measurements were made using chips mounted in Silect packages.
    3. $\mathrm{C}_{\mathrm{cb}}$ maasurement employs a three-terminal capacitance bridge incorporating a guard circuit. The emitter is connected to the guard terminal of the bridge.

[^149]:    Trademark of Texas Instruments
    *These values do not modify guaranteed limits for specific devices and do not justify oper ation in excess of absolute maximum ratings.
    NOTES: 1. These parameters ware measured using pulse techniques. $t_{w}=\mathbf{3 0 0} \mu \mathrm{s}$, duty cycle $\leqslant \mathbf{2 \%}$.
    2. Capacitance maasurements were made using chips mounted in Silect packages.
    3. $\mathrm{C}_{\mathrm{cb}}$ and $\mathrm{C}_{\text {eb }}$ measurements amploy a three-terminal capacitance bridge incorporating a guard circuit. The third electrode (emitter or collector, respectively) is connected to the guard terminal of the bridge.
    4. Average Noise Figure was measured in an amplifier with response down 3 dB at 10 Hz and 10 kHz and a high-frequency roll-off of 6 de/octeve.

[^150]:    ${ }^{\dagger}$ Trademerk of Texas Instruments
    $\ddagger$ All dynamic characteristics were measured using chips mounted in Silect packagas.
    -These values do not modify guaranteed limits for specific devices and do not justify operation in excess of absolute maximum ratings.
    $\S_{p_{f}}{ }^{2}$ is equal to the insertion power gain of the transistor alone.
    NOTES: 1. These parameters were measured using pulse tech niques. $\mathrm{t}_{\mathrm{w}}=\mathbf{3 0 0} \mu \mathrm{s}$, duty cycle $\leqslant 2 \%$.
    2. $\mathrm{C}_{\mathrm{cb}}$ measurement employs a three-terminal capacitance bridge incorporating a guard circuit. The emitter is connected to the guard terminal of the bridge.

[^151]:    Thase messurements were mede using chips mounted in Silect packages.

[^152]:    †Trademark of Texas Instruments
    These values do not modify guaranteed limits for specific devices and do not justify operation in excess of absolute maximum ratings.
    NOTES: 1. These parameters were measured using pulse techniques. $t_{w}=300 \mu \mathrm{~s}$, duty cycle $\leqslant \mathbf{2 \%}$.
    2. Capacitance measurements were made using chips mounted in TO-39 packages.

[^153]:    ${ }^{\dagger}$ Trademark of Texes Instruments
    -These values do not modify guaranteed limits for specific devices and do not justify operation in excess of absolute maximum ratings.
    $\left.\ddagger p_{\text {fb }}\right|^{2}$ is equal to the insertion power gain of the transistor alone.
    NOTES: 1. These parameters were measured using puise techniques. $t_{w}=300 \mu$ s, duty eycle $<\mathbf{2 \%}$.
    2. Capacitance and s-parmeter measurements were made using chlps mounted in TIS 125 packages.
    3. $\mathrm{C}_{\mathrm{cb}}$ and $\mathrm{C}_{\mathrm{ce}}$ measurements employ a three-terminal capacitance bridge incorporating aguard circuit. The third electrode (emitter or base, respectively) is connected to the guard terminal of the bridge.

[^154]:    ${ }^{\dagger}$ Trademark of Texas Instruments
    These values do not modify guaranteed limits for specific devices and do not justify operation in excess of absolute maximum ratings.
    $\mp{ }^{\operatorname{sff}} \mathrm{F}^{2}$ is equal to the insertion power gain of the transistor alone.
    NOTES: 1. These parameters were measured using pulse techniques. $\mathrm{t}_{w}=\mathbf{3 0 0} \mu \mathrm{s}$, duty cycle $<\mathbf{2 \%}$.
    2. Capacitance, $r_{b} \cdot C_{c}$, and s-parameter measurements were made using chips mounted in TO-72 packages.
    3. $\mathrm{C}_{c b}$ and $\mathrm{C}_{e b}$ measurements employ a three-terminal capacitance bridge incorporating a guard circuit. The third electrode femitter or collector, respectively) is connected to the guard terminal of the bridge.

[^155]:    tTradernark of Texas Instruments
    $\ddagger$ These values do not modify guaranteed limits for specific clevices and do not justify operation in excess of absolute maximum ratings. $\ddagger$ He $\boldsymbol{F}$ is equal to the insertion power gain of the transistor atone.
    NOTES: 1. These paremeters were measured using pulse techniques. $t_{w}=300 \mu s$, duty cycle $<2 \%$.
    2. Capacitance, $r_{b}{ }^{\prime} C_{c}$, and s-parameter measurements were made using chips mounted in Silect packages.
    3. $C_{c b}$ and $C_{c e}$ measurements employ a three-terminal capacitance bridge incorporating a guard circuit, The third elactrode (emitter or base, respectively) is connected to the quard terminal of the bridge.

[^156]:    ${ }^{\dagger}$ Trademark of Texas Instruments
    -These values do not modify guaranteed limits for specific devices and do not justify operation in excess of absolute maximum ratings.
    NOTES: 1. This parameter was measured using pulse techniques. $\mathrm{t}_{\mathrm{w}}=\mathbf{3 0 0} \mu \mathrm{s}$, duty cycle $\leq 2 \%$.
    2. Cepacitance measuraments were made using chips mounted in TO-39 packages.
    3. $\mathrm{C}_{\mathrm{cb}}$ and $\mathrm{C}_{\text {eb }}$ messurements employ a three-terminal capacitance bridge incorporating a guard circuit. The third electrode femitter or collector, respectivaly) is connected to the guard terminal of the bridge.

[^157]:    - These values do not modify guaranteed limits for specific devices and do not justify operation in excess of absolute maximum ratings.

    NOTES: 1. These parameters were measured using pulse techniques. $t_{w}=300 \mu s$, duty cycle $\leqslant 2 \%$.
    2. Capacitance measurements were made using chips mounted in TO-18 packages.

[^158]:    ${ }^{\dagger}$ Trademark of Texas Instruments
    These values do not modify guaranteed limits for specific devices and do not justify operation in excess of absolute maximum ratings.
    NOTE 1: Capacitance measurements ware made using chips mounted in TO-46 packages.

[^159]:    ${ }^{\dagger}$ Trademark of Texas Instruments
    These values do not modify guaranteed limits for specific devices and do not justify operstion in excess of absolute maximum ratings.
    NOTES: 1. These parameters were measured using pulse techniques. $t_{w}=300 \mu s$, duty cycle $\leqslant 2 \%$.
    2. Capacitance measurements were made using chips mounted in Silect packages.
    3. $\mathrm{C}_{\mathrm{cb}}$ messurement employs a three-terminal capacitance bridge incorporating a guard circuit. The emitter is connected to the guard terminal of the bridge. Cobo and $\mathrm{C}_{\mathrm{ib}}$ measurements are made with the third terminal floating.
    4. Average Noise Figure is measured in an amplifier with response down 3 dB at 10 Hz and 10 kHz and a high-frequaney roll-off of $6 \mathrm{~dB} /$ octave.

[^160]:    ${ }^{\dagger}$ Trademark of Texas Instruments
    -These values do not modify guaranteed limits for specific devices and do not justify operation in excess of absolute maximum ratings.
    NOTES: 1. These parameters were measured using pulse techniques. $t_{w}=300 \mu s$, duty cycle $\leqslant 2 \%$.
    2. Capacitance measurements were made using chips mounted in Silect packages.

[^161]:    NOTE 2: Capacitance measurements were made using chips mounted in Silect packagas.

[^162]:    ${ }^{\dagger}$ Trademark of Texas Instruments
    These values do not modify guaranteed limits for specific devices and do not justify operation in excess of absolute maximum ratings.
    NOTES: 1. These parameters were measured using pulse tehniques. $\mathbf{t}_{\mathbf{w}}=300 \mu \mathrm{~s}$, duty cycle $\leqslant 2 \%$.
    2. Capacitance measurements were made using chips mounted in TO-18 packages.

[^163]:    tTrademark of Texes Instruments
    Thees values do not modify guaranteed Imits for epecific deviess and do not justify operation in excess of absolute maximum ratings.
    NOTES: 1. These parameters were measured using pulse techniques. $t_{w}=300 \mu s$, duty cycle $<2 \%$.
    2. Cepacitance medurements were made using chips mounted in TO-92 packages.

[^164]:    -These values do not modify guaranteed limits for specific devices and do not justify oparation in excess of absolute maximum ratings.
    NOTES: 1. These parameters were meesured using pulse techniques. $t_{w}=\mathbf{3 0 0} \mu \mathrm{s}$, duty cycle $\leqslant 2 \%$.
    2. Capacitance measurements were made using chips mounted in TO-18 packages.
    3. $C_{c b}$ and $C_{e b}$ measuremants employ a three-terminal capacitance bridge incorporating a guard circuit. The third electrode (emitter or collector, respectivelv) is connected to the guard terminal of the bridge. Cobo and $C_{i b o}$ measurements are made with the third terminal floating.
    4. Average Noise Figure is measured in an amplifier with response down 3 dB at 10 Hz and 10 kHz and a high-frequency roll-off of 6 dB/octave.

[^165]:    NOTE 1: These parameters were measured using pulse techniques. $\mathbf{t}_{w}=\mathbf{3 0 0} \mu \mathrm{s}$, duty cycle $\leqslant 2 \%$.

[^166]:    ${ }^{T}$ Trademark of Texas Instruments
    *These values do not modify guaranteed limits for specific devices and do not justify operation in excess of absolute maximum ratings.
    NOTES: 1. These parameters were measured using pulse techniques. $\mathrm{t}_{\mathrm{w}}=300 \mu \mathrm{~s}$, duty cycle $\leqslant 2 \%$.
    2. Capacitance measurements were made using chips mounted in TO-5 packages.

[^167]:    tTrademark of Texas Instruments
    These values do not modify guaranteed limits for specific devices and do not justify operation in axcess of absolute maximum ratings.
    NOTES: 1. These parameters were measured using pulse techniques. $t_{w}=300 \mu s$, duty cycle $\leqslant \mathbf{2 \%}$.
    2. Capacitance measurements were made using chips mounted in TO-92 packages.
    3. Average Noise Figure was measured in an amplifler with response down 3 dB at 10 Hz and 10 kHz and a high-frequency roll-otf of 6 dB/octave.

[^168]:    TTrademark of Texas Instrumenta
    Thase values do not modify guaranteed limits for specific devices and do not justify operation in excess of absolute maximum ratings.
    NOTES: 1. These parameters were measured using pulse techniques. $\mathrm{t}_{\mathrm{w}}=300 \mu \mathrm{~s}$, duty cycle $\leqslant 2 \%$.
    2. Capscitance measurements were made using chips mounted in TO.92 packages.
    3. $\mathrm{C}_{\mathrm{cb}}$ and $\mathrm{C}_{\text {eb }}$ measurements amploy a three-terminal capacitance bridge incorporating a guard circuit. The third electrode (emitter or collector, respectively) is connected to the guard terminal of the bridge.

[^169]:    ${ }^{\dagger}$ Trademark of Texas Instruments

[^170]:    $\dagger$ Items in parentheses are the gross-leak test conditions performed by Environmental Laboratory.
    $\ddagger$ Also can perform mechanical shock per MIL-STD-810B, Method 516, Procedures I, III and IV.
    ${ }^{4}$ Also can perform random vibration and vibration variable frequency per MIL-STD-8108, Method 514.1, Procedures I, II, III, IV, and VII. Omit paragraph 4.5.1.1, Resonant Search, and paragraph 4.5.1.2, Resonant Dwell for Electronic Components.
    ICapability for testing approximately 15 major microelectric package types per MIL-STD-883, Method 2001, Conditions G and H (sustained accelaration) and for testing approximately 30 major microelectronic packsges per MIL-STD-883, Mathod 2002, Conditions $F$ and $G$ (mechanical shock) are presently available. These high " $G$ " level conditions are used primarlly for evaluation tests on small packages such as C-DIP, P-DIP, TO-5, TO-18, etc.
    *Radiographic inspection is performed in accordance with many other goverment and customer apecifications. Before any new radiographic specification is acceptance for use as a test stendard with Components Group, it must be approved by Environmental Laboratory.

[^171]:    ${ }^{\dagger}$ See package drawing on page 8-14.

[^172]:    - See package drawings on page 8-14.

[^173]:    *See package drawings on page 8-14.

[^174]:    -See package drawings on page 8-14.

[^175]:    *See package drawings on page 8-14.

[^176]:    *See package drawings on page 8-14.

[^177]:    -See package drawings on page 8-14.

[^178]:    *See package drawings on page 8-14.

[^179]:    *See package drawings on page 8-14.

[^180]:    *See package drawings on page 8-14

[^181]:    *JE DEC registered data. This data sheet contains all applicable registered data in effect at the time of publication.

[^182]:    *JEDEC registered data. This data sheet contains all applicable registered data in effect at the time of publication.

[^183]:    *JEDEC registered data (nominal values excluded).

[^184]:    *JEDEC registered data

[^185]:    * JEDEC regisliored data

[^186]:    *JEDEC malisterad date

[^187]:    * JEDEC registered data

[^188]:    -JEDEC registered data. This data sheet contains all applicable registered data in effect at the time of publication.

[^189]:    - JE DEC registered data

[^190]:    *JEDEC registered data. This data sheet contains all applicable registered data in effect at the time of publication.

[^191]:    - JEDEC registered data

[^192]:    NOTE 1: Derate linearly to $200^{\circ} \mathrm{C}$ free-air temperature at the rate of $1.43 \mathrm{mw} /{ }^{\circ} \mathrm{C}$. See F igure 2.

[^193]:    NOTES: c. The input pulse is supplied by generator with the following characteristics: $\mathrm{t}_{\mathrm{f}} \leqslant \mathbf{1} \mathrm{ns}, \mathrm{Z}_{\text {out }}=50 \Omega$, $\mathrm{t}_{\mathbf{w}}=200 \mathrm{~ns}$, duty cycle $<1 \%$.
    d. Output waveform is monitored on an ascilloscope with the following characteristics: $t_{r} \leq 0.4 \mathrm{~ns}, \mathrm{R}_{\mathrm{in}} \geqslant 50 \Omega$.

[^194]:    ${ }^{\dagger} C_{T}$ is the total pin-to-pin cepacitance measured across any of the diodes. For arrays having both common-anode and common-cathode sections, the interaction of the other diodes cannot easily be separated out unless three-terminal guarded measurement techniques are used. The actual capacitance of a single isolated diode will typically be $30 \%$ of the measured pin-to-pin value for the common-cathode diodes, and $75 \%$ of the measured value for the common-anode diodes.

[^195]:    the ambient temperature is measured at a point 2 inches below the device. Natural air cooling is used.

[^196]:    †The capacitance of diodes in matched sets is matched at all voltages between 3 and 25 volts to within $\mathbf{1 . 5 \%}$ or 0.1 pF, whichever is oreater. For ordering matched sets, add dash number to basic part number to indicate the quantity of diodes in the set. For example, TIV21-4 indicates a matched set of 4 diodes.
    NOTES: 1. Derate linearly to $150^{\circ} \mathrm{C}$ at the rate of $2 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$.
    2. Figure of Merit, $Q$, is defined by the equation $Q=\frac{1}{2 \pi f C_{\tau} r_{s}}$ where $r_{s}$ is the equivalent saries resistance.

[^197]:    t The capacitance of diodes in matched sets is matched at all voltages between 3 and 25 volts to within $1.5 \%$ or 0.1 pF, whichever is greater. For ordering matched sats, add dash number to basic part number to indicate the quantity of diodes in the set. For axample, TIV24-4 indicates a matched set of 4 diodes.
    NOTES: 1. Derate linearly to $150^{\circ} \mathrm{C}$ at the rate of $2 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$.
    2. Figure of Merit, $Q$, is defined by the equation $O=\frac{1}{2 \pi f} C_{t} r_{s}$ where $r_{s}$ is the equivalant series resistance.

[^198]:    *See "Part Number Designation" on last page.

