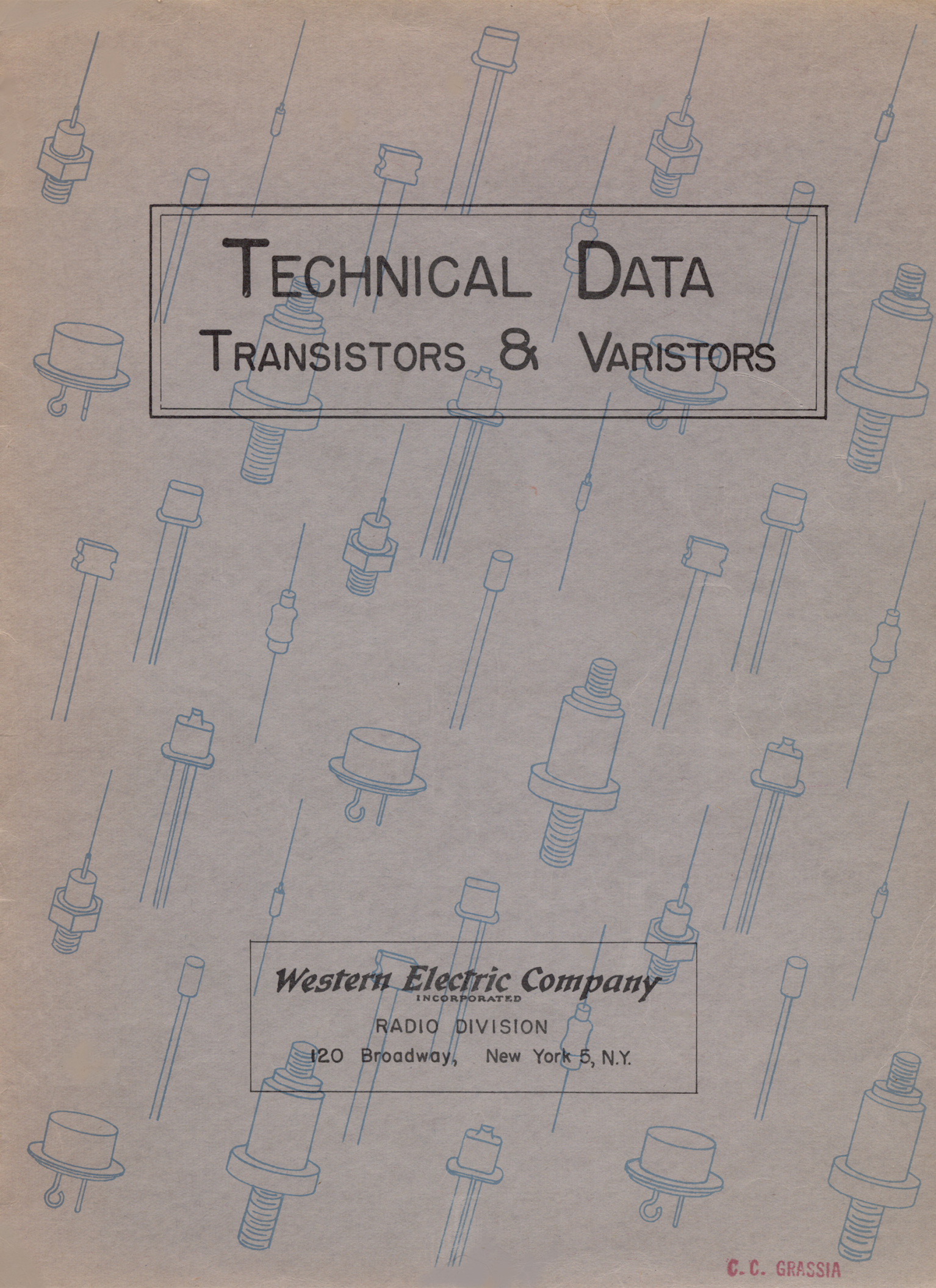


TECHNICAL DATA
TRANSISTORS & VARISTORS

Western Electric Company
INCORPORATED
RADIO DIVISION
120 Broadway, New York 5, N.Y.

F O R E W O R D

Enclosed in this folder are data sheets on the Semi-Conductor Devices currently in production at the Laureldale Shops of the Western Electric Company, Incorporated.

These devices are being made available solely to the United States Military Services and their Contractors. The white sheets cover units that are included in our regular production program whereas the blue sheets cover units that are in exploratory development and production and are available only on a limited quantity basis.

The codes listed below meet Signal Corps specification MIL-T-12679A:

1N330	MIL-T-12679/15 (SigC)
1N331	MIL-T-12679/16 (SigC)
2N21	MIL-T-12679/3B (SigC)
2N21A	MIL-T-12679/4B (SigC)
2N29	MIL-T-12679/29 (SigC)

If you desire further technical information on any semi-conductor device, price and delivery, or wish to be advised of new types available, address your request to:

Mr. J. E. Tweeddale
Western Electric Company, Incorporated
Radio Division
120 Broadway
New York 5, New York

If sizeable quantities of any code are desired, it would be appreciated if you could give us as much advance information as possible. It may be necessary for us to provide additional facilities and tools to produce quantities required. Advance information from you will enable us to more adequately meet your requirements.

Issue No. 3
May 1, 1956

Issue 2
May 20, 1955

TRANSISTOR DATA SHEET

WESTERN ELECTRIC IN85 PHOTOTRANSISTOR

(REPLACES A1818)

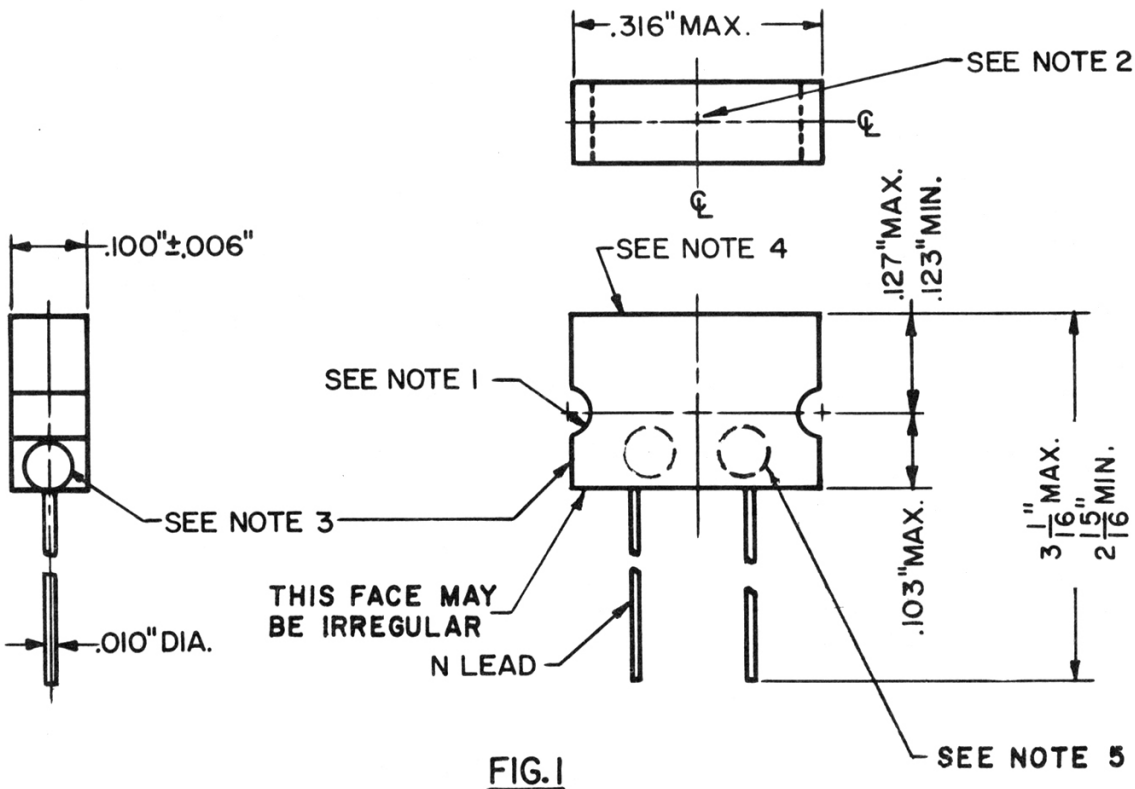


FIG. 1

NOTES:-

1.- RADIUS FOR SNUG FIT ON GAUGE WITH TWO(2) .0625" DIA. MOUNTING PINS SPACED .312" CENTER-TO-CENTER.

2.-REGION OF MAXIMUM SENSITIVITY.

3.-POLARITY—YELLOW DOT DENOTES N LEAD (TO BE BIASED POSITIVE)

4.-ALL SURFACES EXCEPT THIS SURFACE AND SURFACES CONTACTED BY MOUNTING PINS (SEE NOTE 1) ARE COATED WITH A DENSE BLACK LACQUER. MAXIMUM DIMENSIONS ARE AFTER COATING.

5.- GRAY AND GREEN 1/16" DIA. DOTS, IN THAT ORDER, IDENTIFY THE LAST TWO NUMBERS OF CODE NO. IN85 PER RTMA STANDARD COLOR CODE.

DESCRIPTION

The 1N85 is a phototransistor featuring low dark current, high output, wide band operation, broad spectral response and compact construction adaptable to stacking.

GENERAL CHARACTERISTICS

MECHANICAL DATA

Mounting Position - - - - - - - - - - - - - - - - any
Mounting - - - - - - - - - - - - - - - - See outline-Note 1
Dimensions and Connections - - - - - - - - - See outline

MAXIMUM RATINGS[1]

Reverse Voltage (D-C) - - - - - - - - - - - 90 volts
Reverse Current (D-C) - - - - - - - - - - - 1 milliampere
Forward Current - - - - - - - - - - - - - - 0 microamperes
Dissipation - - - - - - - - - - - - - - - - 50 milliwatts
Ambient Temperature - - - - - - - - - - - - 85° Centigrade

TYPICAL A-C EQUIVALENT CIRCUIT PARAMETERS

Low Frequency Equivalent Circuit (1CK.C.)- - See Fig. 6
Junction Resistance (r_j) Averaged
at 10 - 90 Volts - - - - - - - - - - - 100 megohms
Body Resistance (r_b) - - - - - - - - - - 200 ohms
C_j at 90v. bias, including parallel
leads full length - - - - - - - - - - - 5μμf
Transfer Constant[2] (K_i) (minimum) - - .35 microamperes/microwatt

TYPICAL OPERATING CONDITIONS

	Min.	Typical	Max.	
Dark Current, D-C Reverse Voltage = 90 Volts (Fig. 3)				
At 25° ± 3°C - - - - -	---	6	20	microamperes
At 50° ± 3°C - - - - -	---	30	100	microamperes
Light Current,[2] D-C Reverse Voltage = 90 Volts (Fig. 4) Light power = 1 mw				
At 25° ± 3°C - - - - - -	350	385	---	microamperes

Noise

The short circuit noise currents in a 1 cycle per second band at 1000 cycles per second with a reverse voltage of 90 volts are as follows:

Conditions	R.M.S. Noise Current
I_{dark} = 6 microamperes	2×10^{-6} microamperes
I_{light} = 400 microamperes	2×10^{-5} microamperes

Frequency Response

Under typical operating conditions the frequency for which the response is down 3 db below its low frequency value is greater than 25 kc.

OPERATING PRECAUTIONS

Application of operating voltage in the incorrect polarity may result in permanent damage to the unit.

Operating the phototransistor at high light currents for prolonged periods will result in internal heating which causes the dark current to be high until the unit cools.

Notes:

1. Not all ratings may hold simultaneously. See figure 2 for voltage rating vs temperature.

2. Light source is a tungsten lamp with color temperature of 2870°K. The light is focussed into a spot size of .010" vertical x .020" horizontal, the location of which is shown in Fig. 1, Note 2.

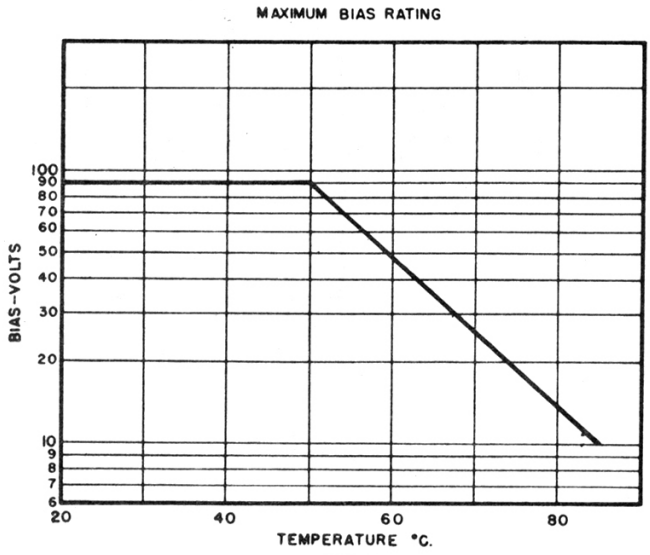


FIG. 2

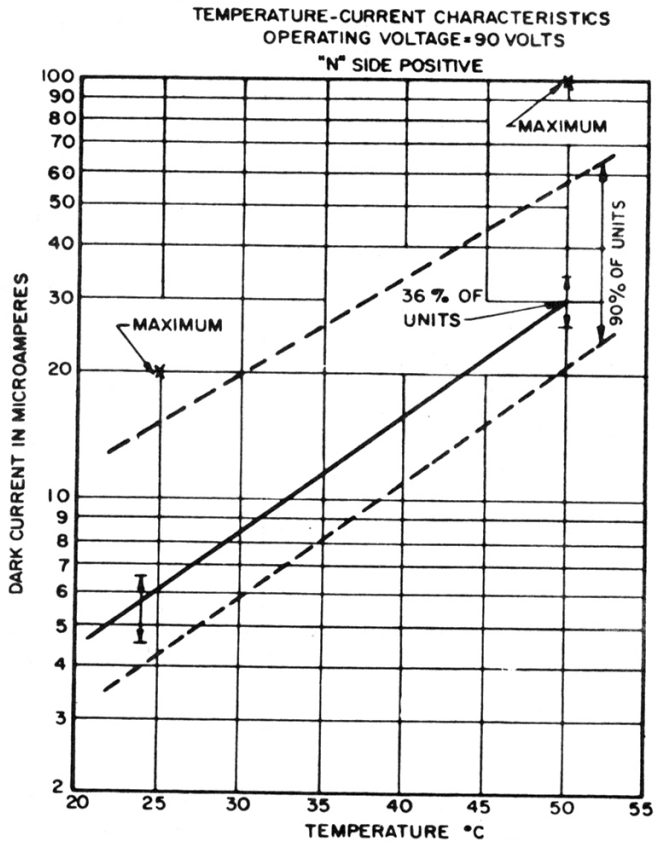
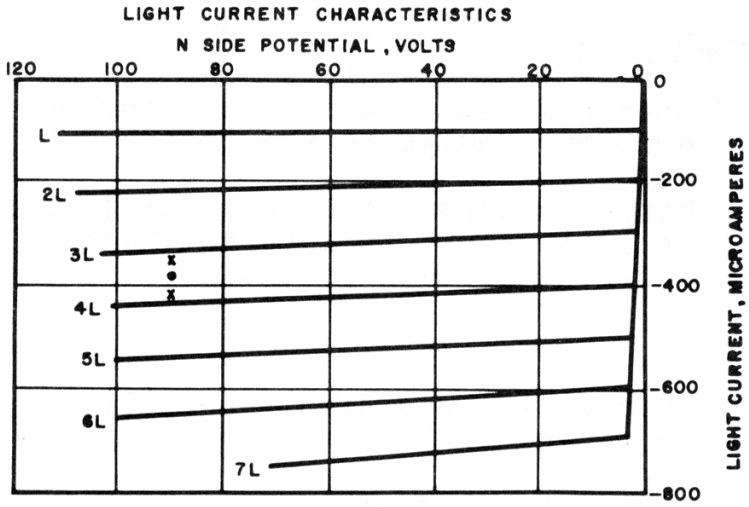


FIG. 3



LIGHT FROM TUNGSTEN SOURCE WITH COLOR TEMPERATURE OF 2870°K.
LIGHT SPOT: SIZE = .010"X.020" CENTERED ON NOMINAL CENTER OF ACTIVE SURFACE.
• = TYPICAL UNIT — LIGHT POWER = 1mw.
X = LIMITS FOR 90 % OF UNITS — LIGHT POWER = 1 mw.

FIG. 4

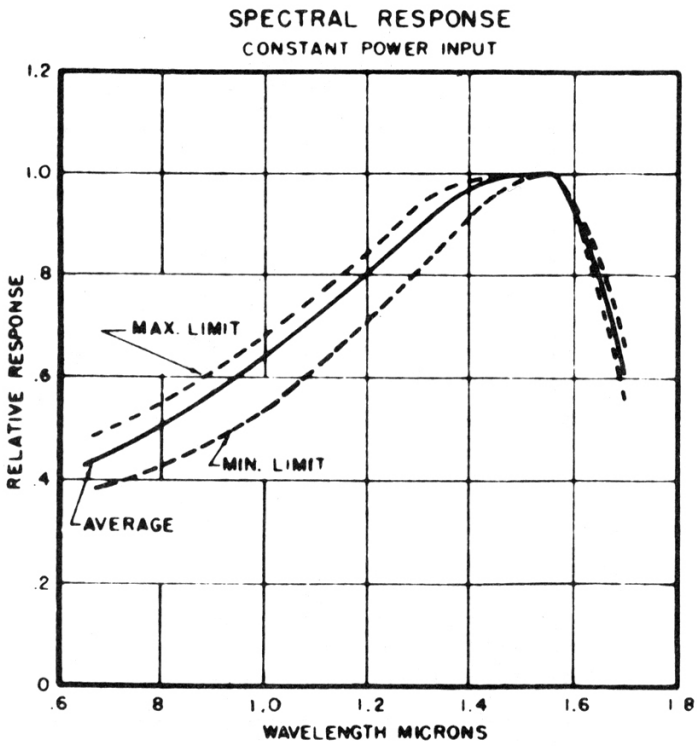


FIG. 5

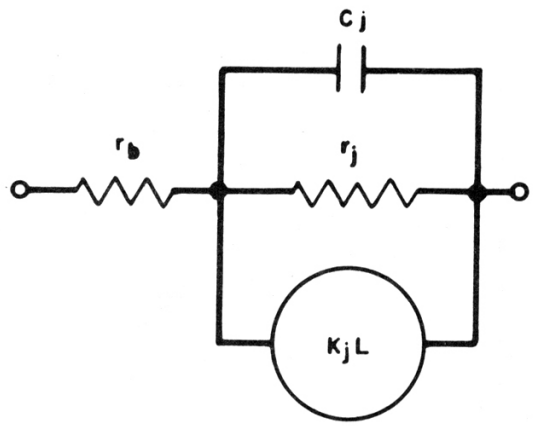


FIG. 6

A development of Bell Telephone Laboratories, the research laboratories of the American Telephone and Telegraph Company and the Western Electric Company

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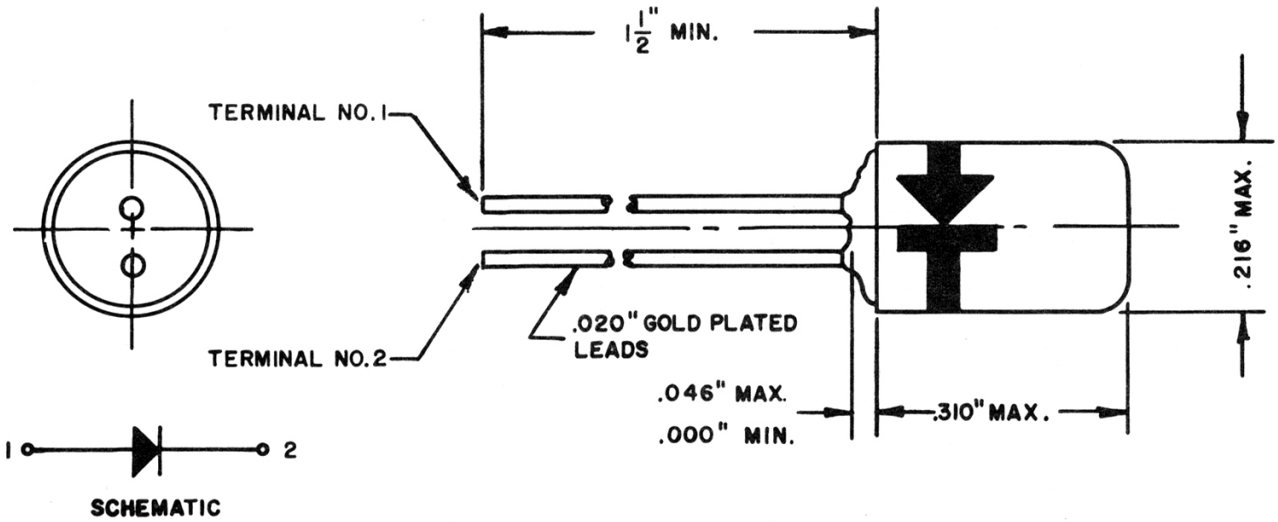
Issue 1
May 20, 1955

VARISTOR DATA SHEET
WESTERN ELECTRIC 1N330 VARISTOR



DESCRIPTION

The 1N330 is a silicon alloy junction type varistor. Its mechanical features are such that it is suitable for military use.

For data applying to all codes of this type varistor see General Data Sheet for Silicon Alloy Junction Varistors, type A.

GENERAL CHARACTERISTICS

MAXIMUM RATINGS, Absolute Values (See Note 1)

Reverse Voltage	32 volts
Forward Current	
Steady State (D-C)	30 milliamperes
Instantaneous Peak (See Note 2)	150 milliamperes
Breakdown Current	
Steady State (D-C)	1.5 milliampere
Instantaneous Peak (See Note 2)	5 milliamperes

ELECTRICAL CHARACTERISTICS (See Note 1)

Breakdown Voltage	(40 min. volts (70 max. volts
Forward Voltage at +3 mAdc	1.0 max. volt
Reverse Current at -20 Vdc	3×10^{-8} max. ampere
Reverse Slope at 0.5 to 1.0 mAdc	1.0 max. volt

Note 1: Ratings and limits given are for an ambient temperature of 25°C. On this varistor ambient and storage temperature range is -55°C to +100°C.

Note 2: The peak Breakdown current and peak forward current values may be applied for periods not to exceed five milliseconds.

Note 3: The use of these diodes as voltage regulators at reverse current below 0.5 ma is not recommended. The impedance of the device for currents greater than 200 microamperes in the Breakdown region is in the order of 1000 ohms.

SPECIAL MECHANICAL AND ELECTRICAL TESTS

The mechanical tests are non-operating destructive tests performed on a sampling basis except the temperature cycling test, paragraph 6, which is not considered destructive.

The electrical test is an operating destructive test also performed on a sampling basis.

Mechanical Tests

The varistor shall meet the requirements specified in paragraph 9 after being subjected to the mechanical tests per paragraphs 2 to 8 inclusive.

1. Lead Fatigue Test

Each lead must withstand three 90° arcs while the ends are weighted with 15-17 ounces without breaking.

2. Vibration Test, High Acceleration

The varistor shall be subjected to a vibration test in each of three orientations at frequencies from 100 to 1000 cps with a constant peak acceleration of 10G's.

SPECIAL MECHANICAL AND ELECTRICAL TESTS (Cont'd.)

3. Vibration Fatigue Test

The varistor shall be vibrated at any single frequency between 45 and 100 cps, with a constant peak acceleration of 10G's, 32 hours in each of three orientations.

4. Shock Test

The varistor shall be subjected to three 500G's shocks of approximately 1 millisecond duration in each of three orientations.

5. Centrifuge Test

The varistor shall be subjected to a centrifugal acceleration of 20,000G's in each of three orientations.

6. Temperature Cycling Test

The varistor shall be subject to five temperature cycles between -55°C and +85°C, remaining at the end temperatures until thermal equilibrium is reached. The transition from one temperature to the other shall be gradual but shall not exceed one hour.

7. Moisture Resistance Test

The varistor shall be subjected to the moisture resistance test outlined in Method 106, Mil-Std-202 dated January 29, 1953.

8. Salt Spray Corrosion

The varistor shall be subjected for 96 hours to a salt spray test performed in accordance with Method 101, Mil-Std-202 dated January 29, 1953.

9. Mechanical Test End Point Requirements

	Max.
Forward Voltage at +3 mAdc - -	1.05 volt
Reverse Current at -20 Vdc - -	3×10^{-8} μa

SPECIAL MECHANICAL AND ELECTRICAL TESTS (Cont'd.)

Electrical Tests

The varistor shall meet the requirements specified in paragraph 11 after the life test per paragraph 1.

1. Life Test

The varistor shall be subjected to a life test of 1000 hours operating as a half-wave unbypassed rectifier into a load resistance of 300 ohms and 20 volts AC, 60 cycle input voltage.

2. Life Test End Point Requirements

	Max.
Forward Voltage at +3 mAdc - -	1.05 volt
Reverse Current at -20 Vdc - -	3×10^{-8} μa

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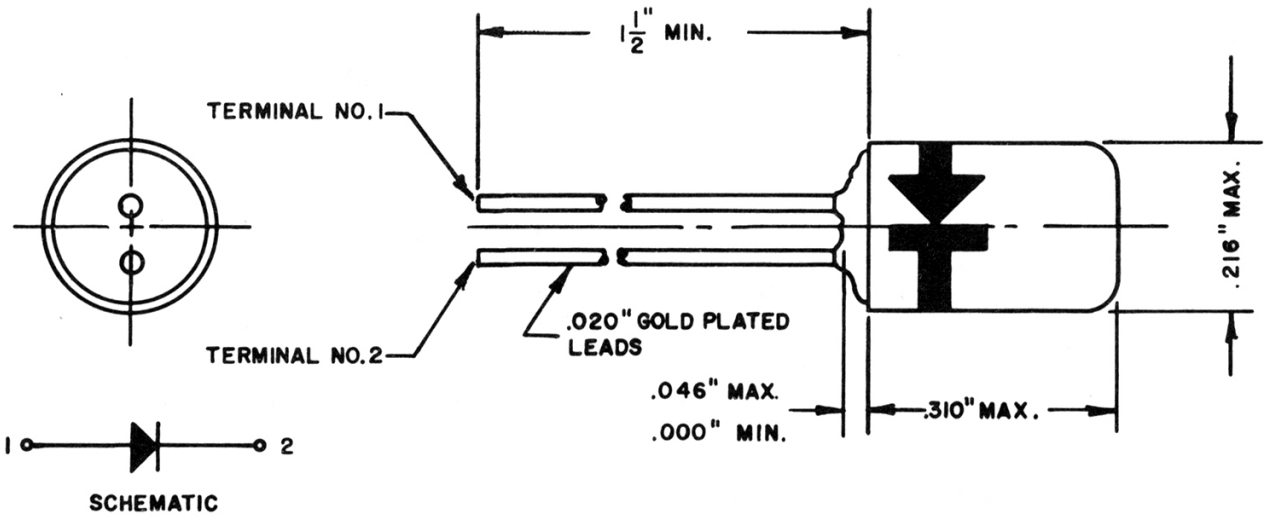
Issue 1
May 20, 1955

VARISTOR DATA SHEET
WESTERN ELECTRIC 1N331 VARISTOR



DESCRIPTION

The 1N331 is a silicon alloy junction type varistor. Its mechanical features are such that it is suitable for military use.

For data applying to all codes of this type varistor see General Data Sheet for Silicon Alloy Junction Varistors, type A.

GENERAL CHARACTERISTICS

MAXIMUM RATINGS, Absolute Values (See Note 1)

Reverse Voltage	16 volts
Forward Current	
Steady State (D-C)	50 milliamperes
Instantaneous Peak (See Note 2)	250 milliamperes
Breakdown Current	
Steady State (D-C)	3 milliamperes
Instantaneous Peak (See Note 2)	10 milliamperes

ELECTRICAL CHARACTERISTICS (See Note 1)

Breakdown Voltage	(20 min. volts (43 max. volts
Forward Voltage at +5 mAdc	1.0 max. volt
Reverse Current at -10 Vdc	10^{-8} max. ampere
Reverse Slope at 0.5 to 1.0 mAdc	1.0 max. volt

Note 1: Ratings and limits given are for an ambient temperature of 25°C. On this varistor ambient and storage temperature range is -55°C to +100°C.

Note 2: The peak Breakdown current and peak forward current values may be applied for periods not to exceed five milliseconds.

Note 3: The use of these diodes as voltage regulators at reverse current below 0.5 ma is not recommended. The impedance of the device for currents greater than 200 microamperes in the Breakdown region is in the order of 500 ohms.

SPECIAL MECHANICAL AND ELECTRICAL TESTS

The mechanical tests are non-operating destructive tests performed on a sampling basis except the temperature cycling test, paragraph 6, which is not considered destructive.

The electrical test is an operating destructive test also performed on a sampling basis.

Mechanical Tests

The varistor shall meet the requirements specified in paragraph 9 after being subjected to the mechanical tests per paragraphs 2 to 8 inclusive.

1. Lead Fatigue Test

Each lead must withstand three 90° arcs while the ends are weighted with 15-17 ounces without breaking.

2. Vibration Test, High Acceleration

The varistor shall be subjected to a vibration test in each of three orientations at frequencies from 100 to 1000 cps with a constant peak acceleration of 10G's.

SPECIAL MECHANICAL AND ELECTRICAL TESTS (Cont'd.)

3. Vibration Fatigue Test

The varistor shall be vibrated at any single frequency between 45 and 100 cps, with a constant peak acceleration of 10G's, 32 hours in each of three orientations.

4. Shock Test

The varistor shall be subjected to three 500G's shocks of approximately 1 millisecond duration in each of three orientations.

5. Centrifuge Test

The varistor shall be subjected to a centrifugal acceleration of 20,000G's in each of three orientations.

6. Temperature Cycling Test

The varistor shall be subject to five temperature cycles between -55°C and +85°C, remaining at the end temperatures until thermal equilibrium is reached. The transition from one temperature to the other shall be gradual but shall not exceed one hour.

7. Moisture Resistance Test

The varistor shall be subjected to the moisture resistance test outlined in Method 106, Mil-Std-202 dated January 29, 1953.

8. Salt Spray Corrosion

The varistor shall be subjected for 96 hours to a salt spray test performed in accordance with Method 101, Mil-Std-202 dated January 29, 1953.

9. Mechanical Test End Point Requirements

	Max.
Forward Voltage at +5 mAdc - -	1.05 volt
Reverse Current at -10 Vdc - -	10^{-8} μa

SPECIAL MECHANICAL AND ELECTRICAL TESTS (Cont'd.)

Electrical Tests

The varistor shall meet the requirements specified in paragraph 11 after the life test per paragraph 1.

1. Life Test

The varistor shall be subjected to a life test of 1000 hours operating as a half-wave unbypassed rectifier into a load resistance of 100 ohms and 10 volts AC, 60 cycle input voltage.

2. Life Test End Point Requirements

	Max.
Forward Voltage at +5 mAdc - -	1.05 volt
Reverse Current at -10 Vdc - -	10^{-8} μa

A development of Bell Telephone Laboratories, the research laboratories of the American Telephone and Telegraph Company and the Western Electric Company

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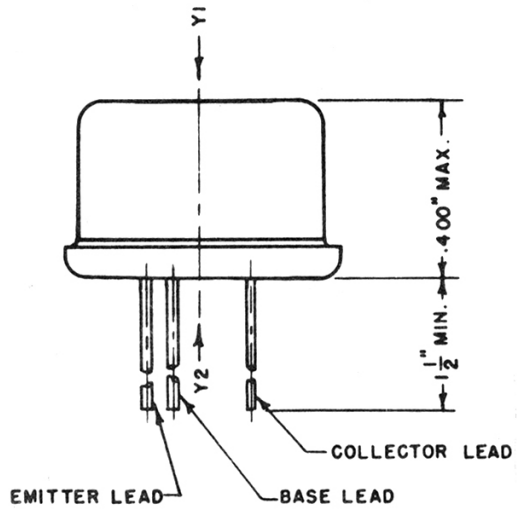
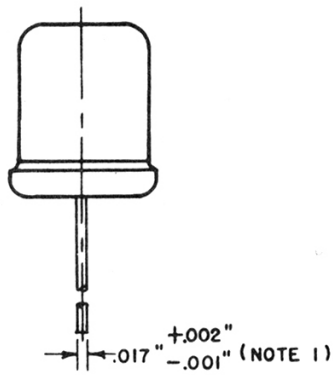
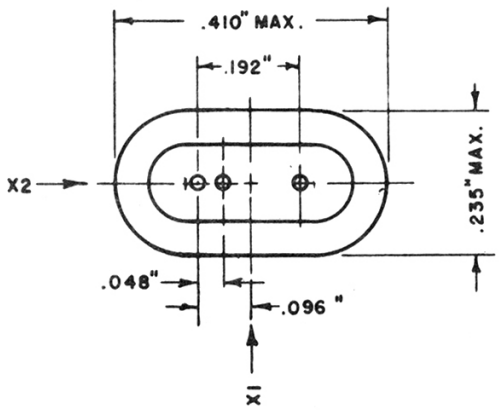
TRANSISTOR DATA SHEET
WESTERN ELECTRIC 2N21 TRANSISTOR
(DEVELOPMENT MODEL 1893)







NOTES 1- THE SPECIFIED LEAD DIAMETER APPLIES IN THE ZONE BETWEEN .050" AND .250" FROM THE BASE SEAT. BETWEEN .250" AND 1.500" A MAXIMUM OF .021" DIAMETER IS HELD. OUTSIDE OF THESE ZONES THE LEAD DIAMETER IS NOT CONTROLLED.

2- FOR LEAD SPACING TOLERANCES, USE JETEC GAUGE NO. GE 7-3.

Description

The 2N21 is a point contact transistor triode in an hermetically sealed enclosure. It is designed for use in switching circuits where the large-signal parameters of the active device are of primary interest. Electrically, it is similar to the 2N22 and 2N23 transistors. Its mechanical features are such that it is considered suitable for severe military use.

For linear operations, where output characteristic anomalies may be of importance (see page 8), the 2N21A transistor is recommended.

GENERAL CHARACTERISTICS

Mechanical Data

Mounting position - any

Socket - See Note 1

Dimensions and pin connections - - - - - - - - - - - - - See Outline Page 1

Absolute Maximum Ratings (Note 2)

Collector voltage -	V_c	-100 volts
Collector dissipation - - - - - - - - - - - - - - - - - -	P_c	120 milliwatts
Emitter voltage -	V_e	-100 volts
Emitter dissipation - - - - - - - - - - - - - - - - - - -	P_e	90 milliwatts
Ambient storage temperature - - - - - - - - - - - - - -		(+85°C (-55°C
Shock -		500g

Suggested Design Maximums (Note 2)

Collector current -	I_c	(+40 ma (-40 ma
Emitter current -		(+40 ma (- 2 ma

ELECTRICAL CHARACTERISTICS (Note 3)

Large Signal Parameters		Min.*	5%†	Mode**	95%†	Max.*	
Collector Current (I_e=0 mAdc; V_c=-20 Vdc)	I_c	- 0.4	-0.5	-1.1	-1.9	- 2.2	mAdc
Collector Current (I_e=6.0 mAdc; V_c=-5 Vdc)	I_c	-11.5	-12	-14	-16	-17.5	mAdc
Collector Voltage (I_e=3.0 mAdc; I_c=-5.5 mAdc)	V_c	-	-0.75	-1.0	-1.7	- 2.0	Vdc
Emitter Current (V_e=-10 Vdc; I_c=0 mAdc)	I_e	-	0.005	0.03	0.1	0.2	mAdc
Small Signal Parameters							
Short Circuit Current Multiplication Ratio							
(1)(I_e=-0.05mAdc; V_c=-10Vdc)	α_{ce}	-	-	0.03	-	0.3	
(2)(I_e=+0.05mAdc; V_c=-10Vdc)	α_{ce}	2.0	-	3.5	10	-	
(3)(I_e=1.0 mAdc; V_c=-10Vdc)	α_{ce}	1.8	2.0	2.5	3.0	-	
Open Circuit Input Impedance (I_e=1.0 mAdc; V_c=-10 Vdc)	Z_{11}	100	200	280	380	400	ohms

		Min.*	5%†	Mode**	95%†	Max.*	
Open Circuit Reverse Transfer Impedance (I_e=1.0 mAdc; V_c=-10 Vdc)	Z_{12}	60	100	160	230	250	ohms
Open Circuit Output Impedance (I_e=1.0 mAdc; V_c=-10 Vdc)	Z_{22}	8K	10K	13K	18K	20K	ohms
Current Multiplication Ratio Cut-off Frequency Test[4] (I_e=1.0 mAdc; V_c=-10 Vdc)	$f_{\alpha ce}$	1.0	1.3	2	6	7.0	mc
Turn-off Time[5]	tt	-	0.8	2	3	3.5	μsec

Special Electrical Tests

Noise Figure[6] (I_e=1.0 mAdc; V_c=-10 Vdc)	NF	-	40	45	-	55	db
Emitter Floating Potential[7] (I_e=0; V_c=-10 Vdc)	V_{ef}	-	-	-	-	-0.7	Vdc
Elevated Temperature Test[8]							
Collector Current (I_e=0 mAdc; V_c=-15 Vdc)	I_c	-	-0.8	-1.5	-2.7	-3.3	mAdc
Collector Voltage (I_e=3.0 mAdc; I_c=-5.5 mAdc)	V_c	-	-	-	-	-2.6	Vdc
Open Circuit Output Impedance (I_e=1.0 mAdc; V_c=-10 Vdc)	Z_{22}	4K	-	-	-	24K	ohms
Temperature Cycling Test[9]							
Collector Current (I_e=0 mAdc; V_c=-20 Vdc)	I_c	-0.2	-	-	-	-2.7	mAdc
Collector Voltage (I_e=3.0 mAdc; I_c=-5.5 mAdc)	V_c	-	-	-	-	-2.5	Vdc
Open Circuit Output Impedance (I_e=1.0 mAdc; V_c=-10 Vdc)	Z_{22}	4K	-	-	-	24K	ohms
Moisture Resistance[10]							
Collector Current (I_e=0 mAdc; V_c=-20 Vdc)	I_c	-0.2	-	-	-	-2.7	mAdc
Collector Voltage (I_e=3.0 mAdc; I_c=-5.5 mAdc)	V_c	-	-	-	-	-2.5	Vdc
Open Circuit Output Impedance (I_e=1.0 mAdc; V_c=-10 Vdc)	Z_{22}	4K	-	-	-	24K	ohms

Special Mechanical Tests		Min.	Max.	
Vibration, High Acceleration[11]	V_c		0.060	Vac
Collector Current (I_e=0 mAdc; V_c=-20 Vdc)	I_c	-0.2	-2.4	mAdc
Collector Voltage (I_e=3.0 mAdc; I_c=-5.5 mAdc)	V_c		-2.4	Vdc
Open Circuit Output Impedance (I_e=1.0 mAdc; V_c=-10 Vdc)	Z_{22}	6K	22K	ohms
Shock Test[12]	$V_{c(peak)}$		1.0	Volt
Collector Current (I_e= 0 mAdc; V_c=-20 Vdc)	I_c	-0.2	-2.4	mAdc
Collector Voltage (I_e=3.0 mAdc; I_c=-5.5 mAdc)	V_c		-2.4	Vdc
Open Circuit Output Impedance (I_e=1.0 mAdc; V_c=-10 Vdc)	Z_{22}	6K	22K	ohms
Vibration Fatigue[13]				
Collector Current (I_e=0 mAdc; V_c=-20 Vdc)	I_c	-0.2	-2.4	mAdc
Collector Voltage (I_e=3.0 mAdc; I_c=-5.5 mAdc)	V_c		-2.5	Vac
Open Circuit Output Impedance (I_e=1.0 mAdc; V_c=-10 Vdc)	Z_{22}	6K	22K	ohms
Centrifuge Test[14]				
Collector Current (I_e=0 mAdc; V_c=-20 Vdc)	I_c	-0.2	-2.4	mAdc
Collector Voltage (I_e=3.0 mAdc; I_c=-5.5 mAdc)	V_c		-2.4	Vdc
Open Circuit Output Impedance (I_e=1.0 mAdc; V_c=-10 Vdc)	Z_{22}	6K	22K	ohms
Salt Spray Corrosion Test[15]				
Hermetic Seal Test[16]				
Transistor Life Test[17]				
Collector Current (I_e=0 mAdc; V_c=-20 Vdc)	I_c	-0.2	-2.4	mAdc
Collector Voltage (I_e=3.0 mAdc; I_c=-5.5 mAdc)	V_c		-2.4	Vdc
Open Circuit Output Impedance (I_e=1.0 mAdc; V_c=-10 Vdc)	Z_{22}	6K	22K	ohms

*Manufacturer's test specification limit.

**Modal values are those which occur most frequently. (Not a manufacturer's requirement)

†Approximately 5% of transistors in a typical group have values outside that shown. (Not a manufacturer's requirement)

Note 1: The external connections meet the requirements for JETEC Base Standard E3-15 and will fit a 5 pin in-line subminiature tube socket, or its equivalent, when the lead length, as measured from the transistor base, is reduced to 0.200".

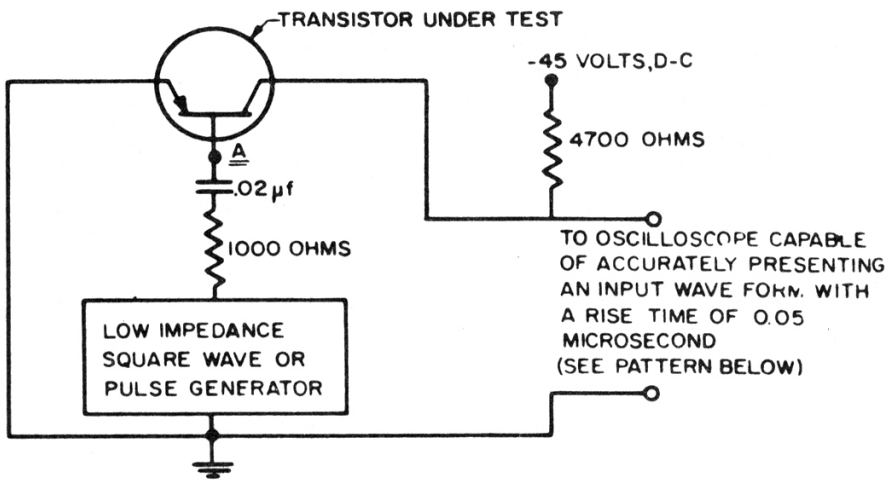
Note 2: Inward direction of current is taken as positive for both emitter and collector. Voltages are measured with respect to the base. Subscripts "c" and "e" refer to collector and emitter respectively. Voltages are referred to on an absolute basis so that a potential of V_c=-20 volts is greater than a potential of V_c=-10 volts. Electrical ratings are on the basis of any duration longer than the order of 1 millisecond at an ambient temperature of 25 ± 5°C.

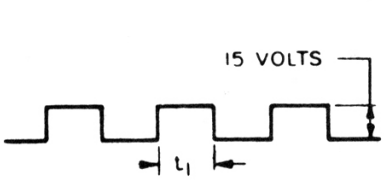
Note 3: Ambient Temperature 25°C. Modal values are those which occur most frequently.

Note 4: Cut off is defined as the frequency at which the current amplification is 3 db below its low frequency reference value. Reference frequency is approx. 100kc.

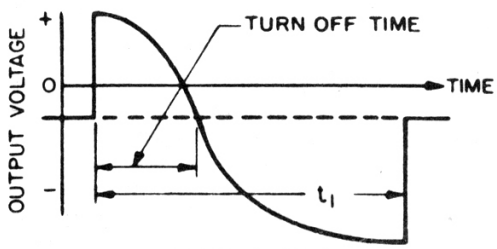
Note 5: Turn-off time is measured in the following circuit.

TURN-OFF TIME MEASURING CIRCUIT





5 KC PULSE APPLIED TO BASE OF TRANSISTOR AT POINT A



OSCILLISCOPE PATTERN OF OUTPUT VOLTAGE

Note 6: Noise Figure in decibels = 10 $\log_{10}$ (Noise Factor). Noise Factor, as used here, is the ratio of the output to input noise power per unit bandwidth (1 cycle) in a linear system at a frequency of 1000 cps ± 10%. The input noise source used is a 1,000 ohms ± 10% resistor whose noise temperature is standard (290°K) at all frequencies, and the output detector is an average responding r.m.s. calibrated indicator.

Note 7: Emitter Floating Potential may be defined as the voltage present at the emitter when the emitter is open-circuited and a specified d.c. potential is applied to the collector. A high input impedance (greater than 5 megohms) vacuum tube voltmeter is used for this measurement.

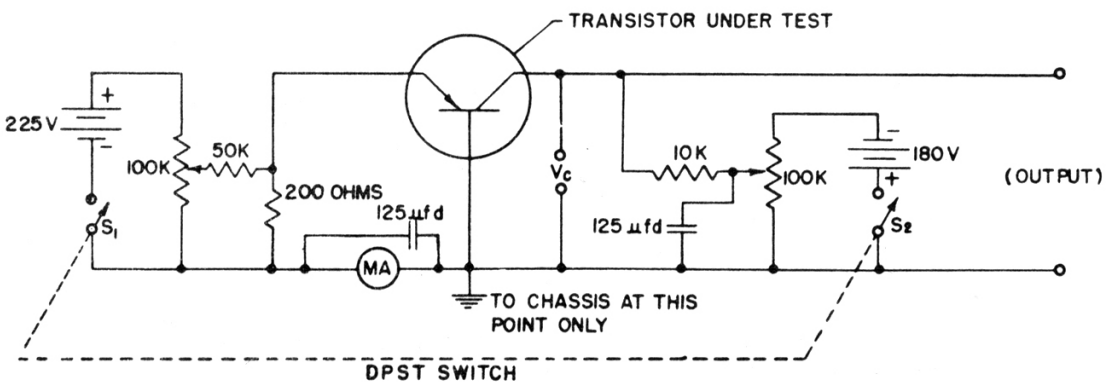
Note 8: This test is made with the transistor at an ambient temperature of +55°C (+131°F).

Note 9: These tests are made after the transistor (selected on a sampling basis) has been subjected to five temperature cycles from -55°C to +85°C and return with a 15 minute holding period at each end temperature.

Note 10: These tests are made after the transistor (selected on a sampling basis) has been subjected to the moisture resistance test outlined in Method 106, MIL-STD-202 dated January 29, 1953.

Note 11: During this test the transistor (selected on a sampling basis) is vibrated at frequencies from 100 to 1000 cycles per second with a constant peak acceleration of 10G's in the orientations X_1, X_2 and Y_1 as indicated on page 1. The transistor is biased in the circuit shown below with I_c=1.0 mAdc, and V_c=-10 Vdc and the alternating voltages produced are metered on an average responding r.m.s. calibrated a.c. vacuum tube voltmeter. After these vibrations, the three tests listed under Vibration, High Acceleration are made.

POINT CONTACT MICROPHONIC TEST CIRCUIT



Note 12: During this test the transistor (selected on a sampling basis) is subjected to three half sine wave 500 G shocks of approximately 1 millisecond duration in each of the three orientations X_1, X_2 and Y_2 shown on page 1. The method used is similar to that described in Method 202, MIL-STD-202. During the shocks the transistor is biased in the same manner and in the same circuit used in the Vibration, High Acceleration Test (see note 11). The value of the peak voltage produced across the collector load resistance as measured by a peak reading device shall not exceed the specified value. After these shocks, the three tests listed under Shock Tests are made.

Note 13: These tests are performed after the transistor (selected on a sampling basis) has been vibrated at 50 cps, with a constant peak acceleration of 10G, for a total of 96 hours, 32 hours in each of the three orientations X_1, X_2 and Y_1 as shown in the outline drawing on page 1.

Note 14: These tests are made after the transistor (selected on a sampling basis) has been subjected to a centrifuge acceleration of 5000G's in each of the three orientations X_1, X_2 and Y_2 as shown in the outline drawing on page 1.

Note 15: The transistor leads and case shall show no significant visual damage or corrosion, and all markings shall be legible after the unit (selected on a sampling basis) has been subjected to 96 hours in salt spray test as performed in accordance with Method 101, MIL-STD-202 dated January 29, 1953.

Note 16: The transistor (selected on a sampling basis) is subjected to an ambient temperature of +110°C for a 15 minute period at atmospheric pressure. Upon completion of this exposure the transistor must be free from impregnant visible to the eye, or perceptible to the touch on the exterior surface.

Note 17: These tests are made after 24, 100, 300 and 500 hours of power aging. During this period, the transistor operates at a D.C. collector power dissipation level of 80 mw at an initial operating point "A" shown on the static output characteristic. The ambient temperature during the life test may vary from +20°C to +35°C.

Operating Precaution

The transistor should not be subjected to service in which excessive transients might cause the ratings of the device to be exceeded, such as may result from inserting the transistor into or removing it from the socket with the power on. Base contact should be made first. If solder connections are made to the transistor leads, heat sink protection on the transistor side of the joint should be provided, as with flat nose pliers. When cutting leads for socketing, a shearing tool or a clamp between the unit and the transistor should be used.

Operation of the transistor as a linear device in the region of emitter biases between voltage cut-off and saturation is not recommended due to anomalies which appear in this range in some transistors. An anomaly can be defined as a condition in the output characteristics when, for a fixed value of emitter current, the collector voltage can be a multiple valued function of the collector current or the collector current can be a multiple valued function of the collector voltage.

FIG. 1

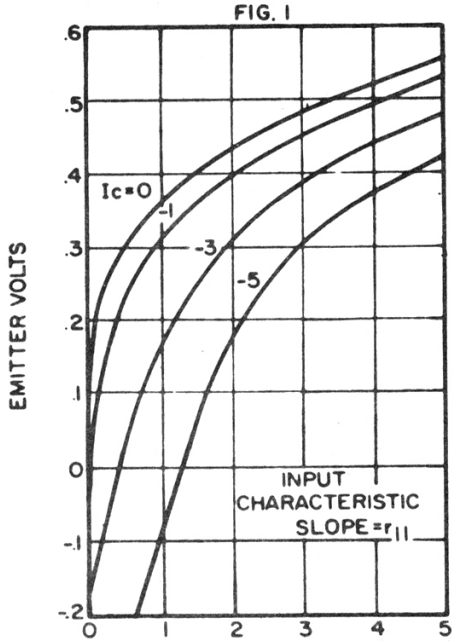


FIG. 3

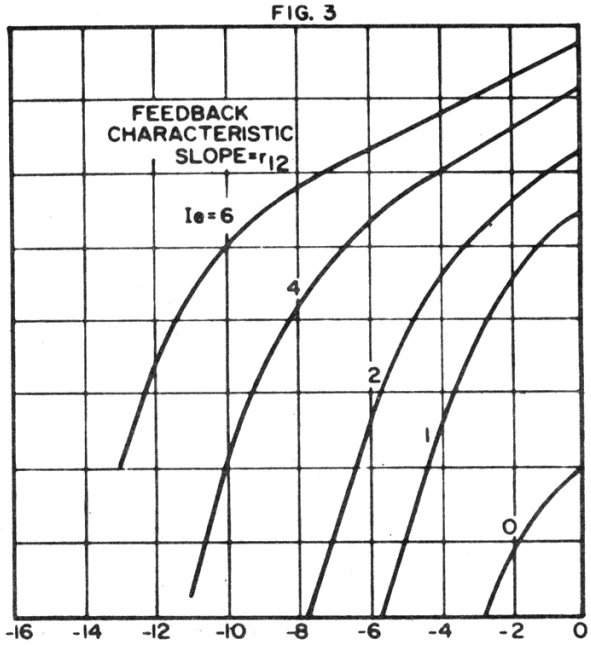


FIG. 2

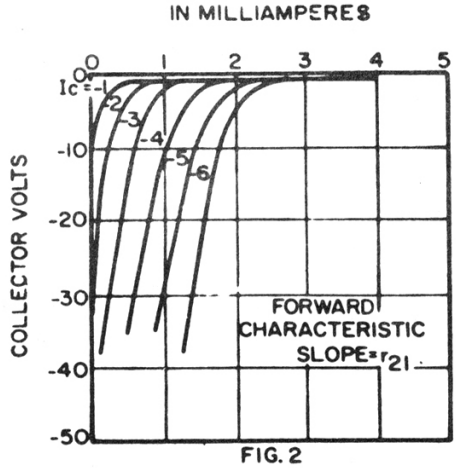
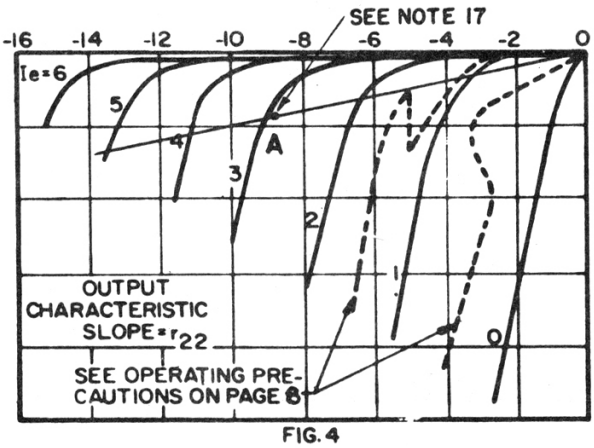


FIG. 4



A development of Bell Telephone Laboratories, the research laboratories of the American Telephone and Telegraph Company and the Western Electric Company

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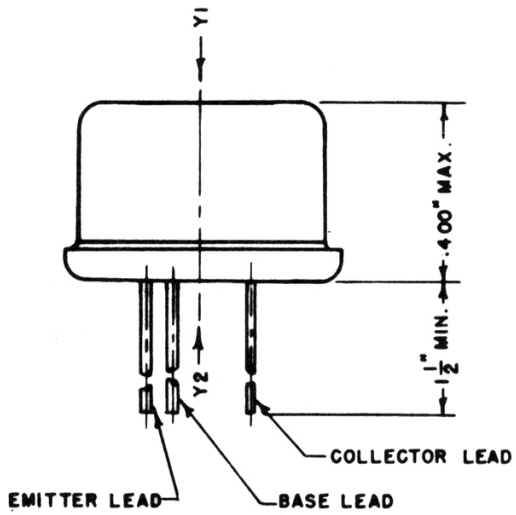
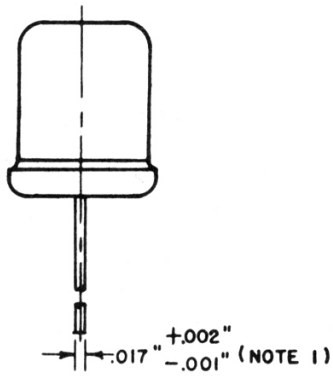
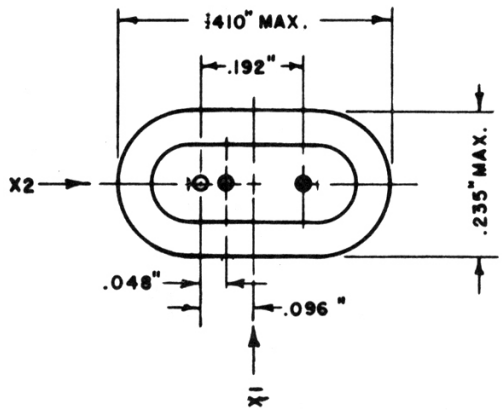
Issue 2
May 20, 1955

TRANSISTOR DATA SHEET
WESTERN ELECTRIC 2N21A TRANSISTOR
(DEVELOPMENT MODEL 1893)







NOTES 1- THE SPECIFIED LEAD DIAMETER APPLIES IN THE ZONE BETWEEN .050" AND .250" FROM THE BASE SEAT. BETWEEN .250" AND 1.500" A MAXIMUM OF .021" DIAMETER IS HELD. OUTSIDE OF THESE ZONES THE LEAD DIAMETER IS NOT CONTROLLED.

2- FOR LEAD SPACING TOLERANCES, USE JETEC GAUGE NO. GE 7-3.

DESCRIPTION

The 2N21A is a point contact transistor triode in an hermetically sealed enclosure. It is designed for use in switching circuits where both the large-signal parameters and the small-signal parameters of the active device are of interest. Electrically, it is similar to the 2N22 and 2N23 transistors. Its mechanical features are such that it is considered suitable for severe military use. For switching circuits where output characteristic anomalies in the active region are of no concern (see note 7), the 2N21 transistor is recommended.

GENERAL CHARACTERISTICS

Mechanical Data

Mounting position	Any
Socket	See Note 1
Dimensions and pin connections	See Outline Page 1

Absolute Maximum Ratings (Note 2)

Collector voltage	V_c	-100 volts
Collector dissipation	P_c	120 milliwatts
Emitter voltage	V_e	-100 volts
Emitter dissipation	P_e	90 milliwatts
Ambient storage temperature		(+85°C (-55°C
Shock		500g

Suggested Design Maximums (Note 2)

Collector current	I_c	(+40 ma (-40 ma
Emitter current		(+40 ma (- 2 ma

ELECTRICAL CHARACTERISTICS (Note 3)

Large Signal Parameters		Min.*	5%†	Mode**	95%†	Max.*	
Collector Current (I_e=0 mAdc; V_c=-20 Vdc)	I_c	- 0.4	-0.5	-1.1	-1.9	- 2.2	mAdc
Collector Current (I_e=6.0 mAdc; V_c=-5 Vdc)	I_c	-11.5	-12	-14	-16	-17.5	mAdc
Collector Voltage (I_e=3.0 mAdc; I_c=-5.5 mAdc)	V_c	-	-0.75	-1.0	-1.7	- 2.0	Vdc
Emitter Current (V_e=-10 Vdc; I_c=0 mAdc)	I_e	-	-0.005	-0.03	-0.08	- 0.1	mAdc

Small Signal Parameters

Short Circuit Current Multiplication Ratio vs Emitter Current[4]							
Open Circuit Input Impedance (I_e=1.0 mAdc; V_c=-10 Vdc)	Z_{11}	100	200	280	380	400	ohms

		Min.*	5%†	Mode**	95%†	Max.*	
Open Circuit Reverse Transfer Impedance (I_e=1.0 mAdc; V_c=-10 Vdc)	Z_{12}	60	100	160	230	250	ohms
Open Circuit Output Impedance (I_e=1.0 mAdc; V_c=-10 Vdc)	Z_{22}	8K	10K	13K	18K	20K	ohms
Current Multiplication Ratio Cut-off Frequency Test[5] (I_e=1.0 mAdc; V_c=-10 Vdc)	$f_{\alpha ce}$	1.0	1.3	2	6	7.0	mc
Turn-off Time[6]	tt	-	0.8	2	3	3.5	µsec

Special Electrical Tests

Characteristic Curve Anomalies[7]							
Noise Figure[8] (I_e=1.0 mAdc; V_c=-10 Vdc)	NF	-	40	45	-	55	db
Emitter Floating Potential[9] (I_e=0; V_c=-10 Vdc)	V_{ef}	-	-	-	-	-0.7	Vdc
Elevated Temperature Test[10] Collector Current (I_e=0 mAdc; V_c=-15 Vdc)	I_c	-	-0.8	-1.5	-2.7	-3.3	mAdc
Collector Voltage (I_e=3.0 mAdc; I_c=-5.5 mAdc)	V_c	-	-	-	-	-2.6	Vdc
Open Circuit Output Impedance (I_e=1.0 mAdc; V_c=-10 Vdc)	Z_{22}	4K	-	-	-	24K	ohms
Temperature Cycling Test[11] Collector Current (I_e=0 mAdc; V_c=-20 Vdc)	I_c	-0.2	-	-	-	-2.7	mAdc
Collector Voltage (I_e=3.0 mAdc; I_c=-5.5 mAdc)	V_c	-	-	-	-	-2.5	Vdc
Open Circuit Output Impedance (I_e=1.0 mAdc; V_c=-10 Vdc)	Z_{22}	4K	-	-	-	24K	ohms
Moisture Resistance[12] Collector Current (I_e=0 mAdc; V_c=-20 Vdc)	I_c	-0.2	-	-	-	-2.7	mAdc

		Min.*	Max.*	
Collector Voltage (I_e=3.0 mAdc; I_c=5.5 mAdc	V_c		-2.5	Vdc
Open Circuit Output Impedance (I_e=1.0 mAdc; V_c=-10 Vdc)	Z_{22}	4K	24K	ohms
Special Mechanical Tests				
Vibration, High Acceleration[13]	V_c		0.060	Vac
Collector Current (I_e=0 mAdc; V_c=-20 Vdc)	I_c	-0.2	-2.4	mAdc
Collector Voltage (I_e=3.0 mAdc; I_c=-5.5 mAdc)	V_c		-2.4	Vdc
Open Circuit Output Impedance (I_e=1.0 mAdc; V_c=-10 Vdc)	Z_{22}	6K	22K	ohms
Shock Test[14]	$V_{c(peak)}$		1.0	Volt
Collector Current (I_e= 0 mAdc; V_c=-20 Vdc)	I_c	-0.2	-2.4	mAdc
Collector Voltage (I_e=3.0 mAdc; I_c=-5.5 mAdc)	V_c		-2.4	Vdc
Open Circuit Output Impedance (I_e=1.0 mAdc; V_c=-10 Vdc)	Z_{22}	6K	22K	ohms
Vibration Fatigue[15]				
Collector Current (I_e=0 mAdc; V_c=-20 Vdc)	I_c	-0.2	-2.4	mAdc
Collector Voltage (I_e=3.0 mAdc; I_c=-5.5 mAdc)	V_c		-2.5	Vac
Open Circuit Output Impedance (I_e=1.0 mAdc; V_c=-10 Vdc)	Z_{22}	6K	22K	ohms
Centrifuge Test[16]				
Collector Current (I_e=0 mAdc; V_c=-20 Vdc)	I_c	-0.2	-2.4	mAdc
Collector Voltage (I_e=3.0 mAdc; I_c=-5.5 mAdc)	V_c		-2.4	Vdc
Open Circuit Output Impedance (I_e=1.0 mAdc; V_c=-10 Vdc)	Z_{22}	6K	22K	ohms

		Min.*	Max.*	
Salt Spray Corrosion Test[17]				
Hermetic Seal Test[18]				
Transistor Life Test[19]				
Collector Current (I_e=0 mAdc; V_c=-20 Vdc)	I_c	-0.2	-2.4	mAdc
Collector Voltage (I_e=3.0 mAdc; I_c=-5.5 mAdc)	V_c		-2.4	Vdc
Open Circuit Output Impedance (I_e=1.0 mAdc; V_c=-10 Vdc)	Z_{22}	6K	22K	ohms

*Manufacturer's test specification limit.

**Modal values are those which occur most frequently. (Not a manufacturer's requirement)

†Approximately 5% of transistors in a typical group have values outside that shown. (Not a manufacturer's requirement)

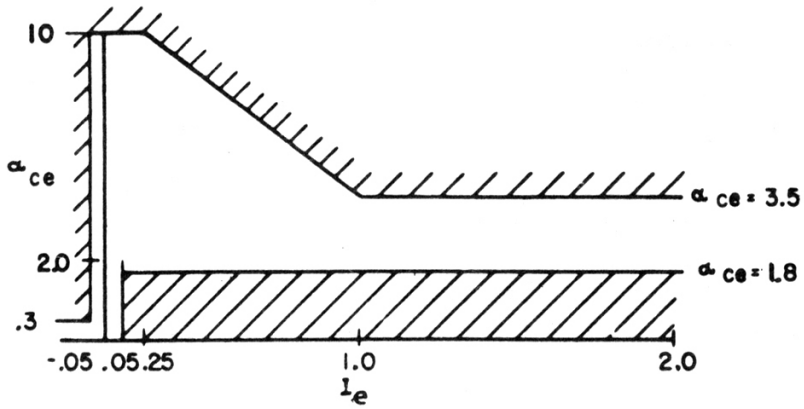
Note 1: The external connections meet the requirements for JETEC Base Standard E3-15 and will fit a 5 pin in-line subminiature tube socket, or its equivalent, when the lead length, as measured from the transistor base, is reduced to 0.200".

Note 2: Inward direction of current is taken as positive for both emitter and collector. Voltages are measured with respect to the base. Subscripts "c" and "e" refer to collector and emitter respectively. Voltages are referred to on an absolute basis so that a potential of V_c=-20 volts is greater than a potential of V_c=-10 volts. Electrical ratings are on the basis of any duration longer than the order of 1 millisecond at an ambient temperature of 25 ± 5°C.

Note 3: Ambient Temperature 25°C.

Note 4: When operating with V_c=-10 volts dc and with the emitter bias varying between -.05 ma and +2.0 ma at approximately 30 cps, the scope display curve of α_{ce} vs I_e shall fall

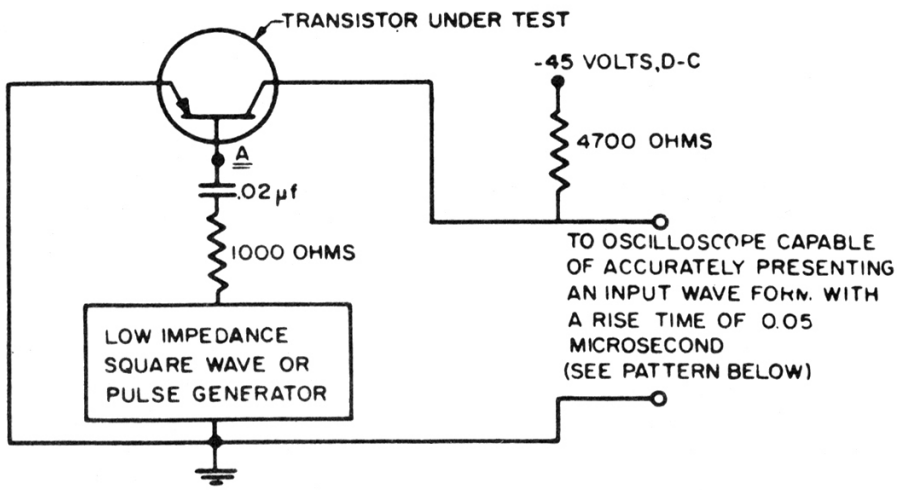
within the unshaded regions of the figure shown below. The scope trace, at I_e greater than that at which the first peak of α_{ce} above 2 occurs, must exhibit a monotonically decreasing value of α_{ce}.

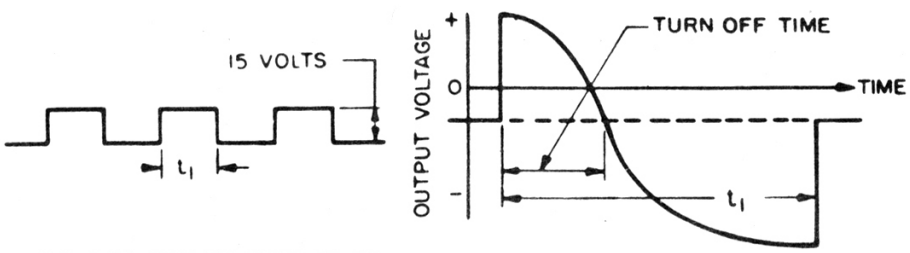


Note 5: Cut-off is defined as the frequency at which the current amplification is 3 db below its low frequency reference value. Reference frequency is approximately 100KC.

Note 6: Turn-off time is measured in the following circuit.

TURN-OFF TIME MEASURING CIRCUIT

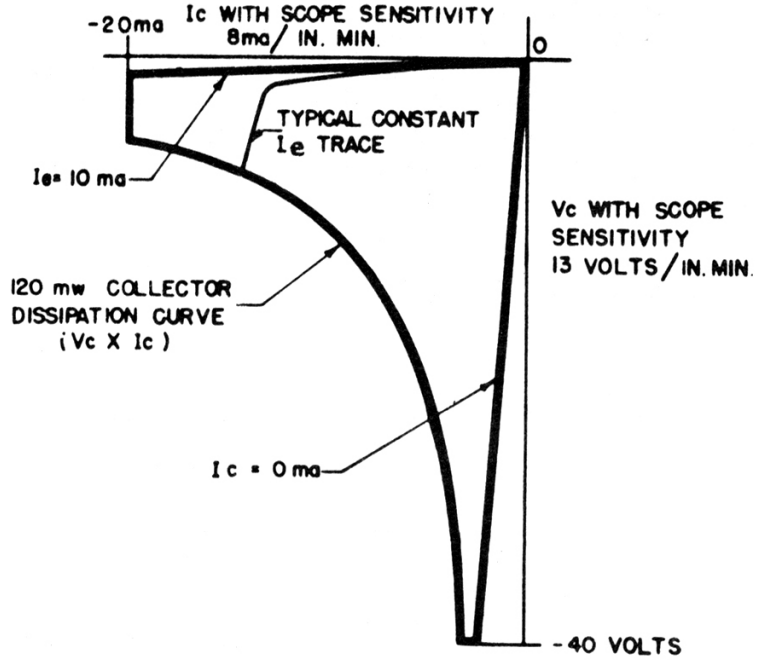




.5 KC PULSE APPLIED TO BASE OF TRANSISTOR AT POINT A

OSCILLISCOPE PATTERN OF OUTPUT VOLTAGE

Note 7: With emitter and collector load resistances of 1000 ohms the static output characteristic curves (with emitter current as the parameter) shall, when examined within the operating region outlined below, show no anomalies greater than those permitted by figures 5 and 6.



Note 8: Noise Figure in decibels = 10 $\log_{10}$ (Noise Factor). Noise Factor, as used here, is the ratio of the output to input noise power per unit bandwidth (1 cycle) in a linear system at a frequency of 1000 cps ± 10%. The input noise source used is a 1000 ohms ± 10% resistor whose noise temperature is standard (290°K) at all frequencies, and the output detector is an average responding r.m.s. calibrated indicator.

Note 9: Emitter Floating Potential may be defined as the voltage present at the emitter when the emitter is open-circuited and a specified d.c. potential is applied to the collector. A high input impedance (greater than 5 megohms) vacuum tube voltmeter is used for this measurement.

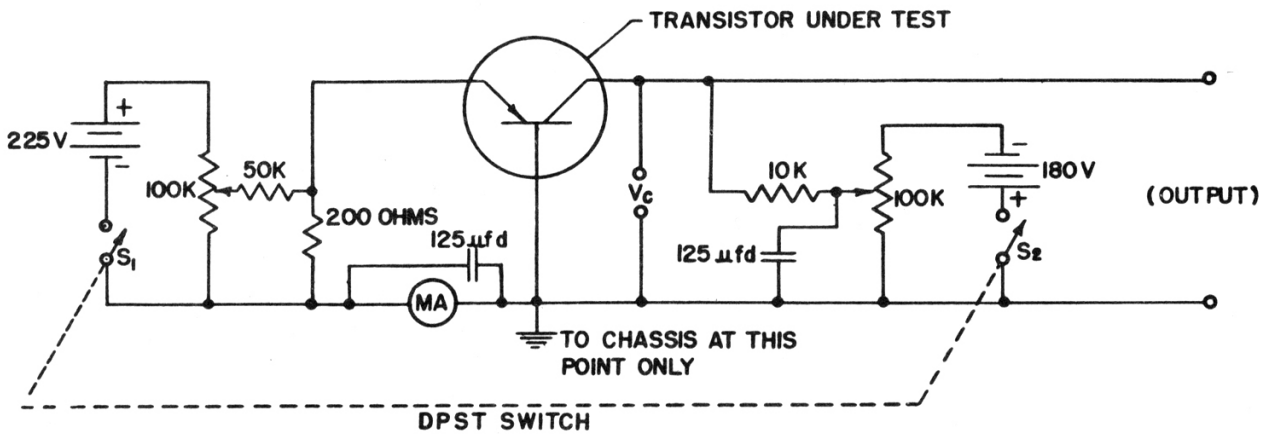
Note 10: This test is made with the transistor at an ambient temperature of +55°C (+131°F).

Note 11: These tests are made after the transistor (selected on a sampling basis) has been subjected to five temperature cycles from -55°C to +85°C and return with a 15 minute holding period at each end temperature.

Note 12: These tests are made after the transistor (selected on a sampling basis) has been subjected to the moisture resistance test outlined in Method 106, MIL-STL-202 dated January 29, 1953.

Note 13: During this test the transistor (selected on a sampling basis) is vibrated at frequencies from 100 to 1000 cycles per second with a constant peak acceleration of 10G's in the orientations X_1, X_2, and Y_1 as indicated on page 1. The transistor is biased in the circuit shown below with I_C=1.0 mAdc, and V_C=-10 Vdc and the alternating voltages produced are metered on an average responding r.m.s. calibrated a.c. vacuum tube voltmeter. After these vibrations the three tests listed under Vibration, High Acceleration are made.

POINT CONTACT MICROPHONIC TEST CIRCUIT



Note 14: During this test the transistor (selected on a sampling basis) is subjected to three half sine wave 500 G shocks of approximately 1 millisecond duration in each of the three orientations X_1, X_2 and Y_2 shown on page 1. The method used is similar to that described in Method 202, MIL-STD-202. During the shocks the transistor is biased in the same manner and in the same circuit used in the Vibration, High Acceleration Test (See note 13). The value of the peak voltage produced across the collector load resistance as measured by a peak reading device shall not exceed the specified value. After these shocks the three tests listed under Shock Test are made.

Note 15: These tests are performed after the transistor (selected on a sampling basis) has been vibrated at 50 cps, with a constant peak acceleration of 10G, for a total of 96 hours, 32 hours in each of the three orientations X_1, X_2 and Y_1 as shown in the outline drawing on page 1.

Note 16: These tests are made after the transistor (selected on a sampling basis) has been subjected to a centrifuge acceleration of 5000G's in each of the three orientations X_1, X_2 and Y_2 as shown in the outline drawing on page 1.

Note 17: The transistor leads and case shall show no significant visual damage or corrosion, and all markings shall be legible after the unit (selected on a sampling basis) has been subjected to 96 hours in salt spray test as performed in accordance with Method 101 MIL-STD-202 dated January 29, 1953.

Note 18: The transistor (selected on a sampling basis) is subjected to an ambient temperature of +110°C for a 15 minute period at atmospheric pressure. Upon completion of this exposure the transistor must be free from impregnant visible to the eye, or perceptible to the touch on the exterior surface.

Note 19: These tests are made after 24, 100, 300 and 500 hours of power aging. During this period, the transistor operates at a D.C. collector power dissipation level of 80 mw at an initial operating point "A" shown on the static output characteristic. The ambient temperature during the life test may vary from +20°C to +35°C.

Operating Precaution

The transistor should not be subjected to service in which excessive transients might cause the ratings of the device to be exceeded, such as may result from inserting the transistor into or removing it from the socket with the power on. Base contact should be made first. If solder connections are made to the transistor leads, heat sink protection on the transistor side of the joint should be provided, as with flat nose pliers. When cutting leads for socketing, a shearing tool or a clamp between the unit and the transistor should be used.

FIG. 1

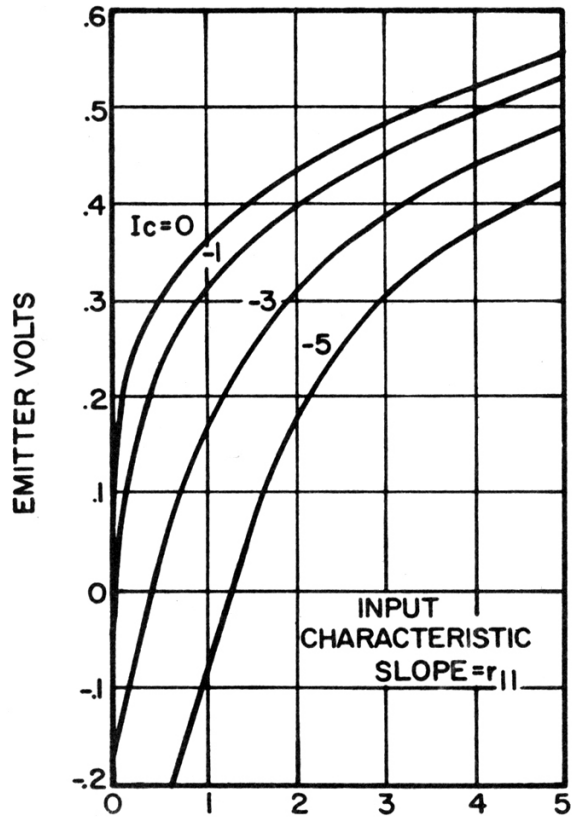
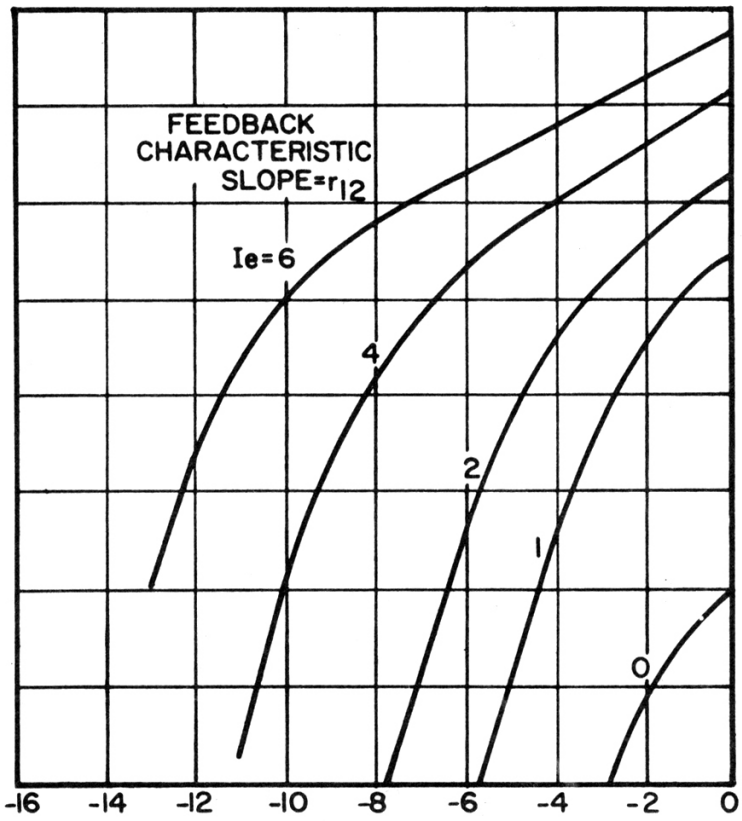


FIG. 3



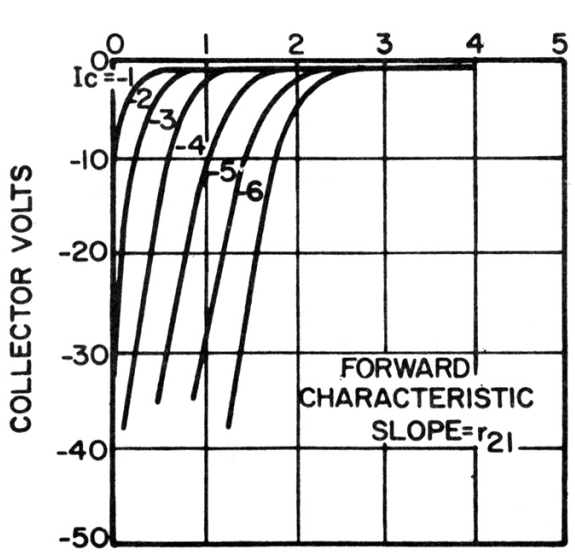


FIG. 2

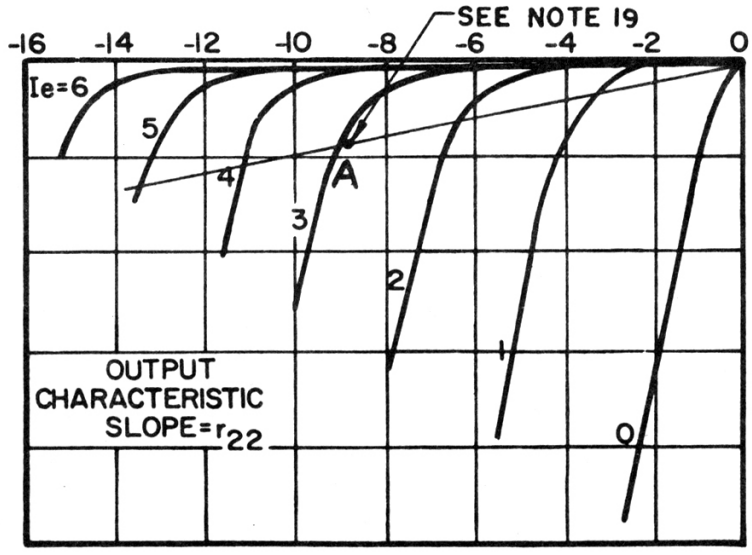


FIG. 4

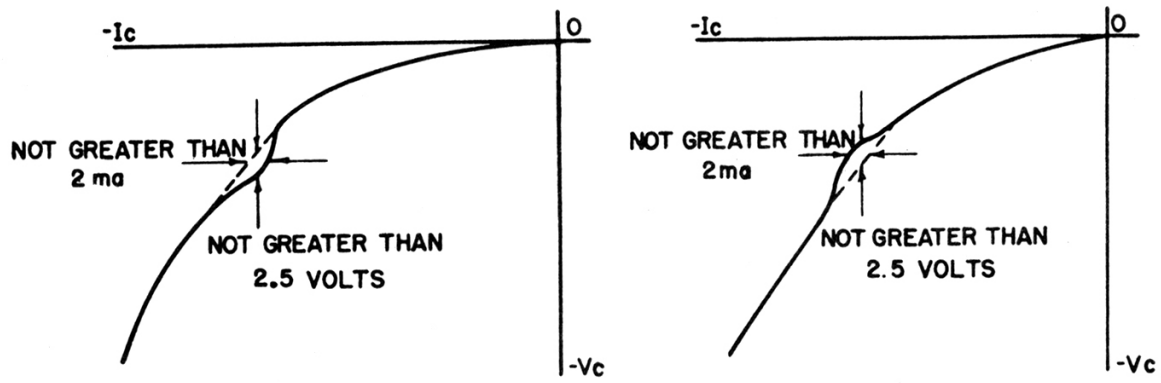


FIG. 5

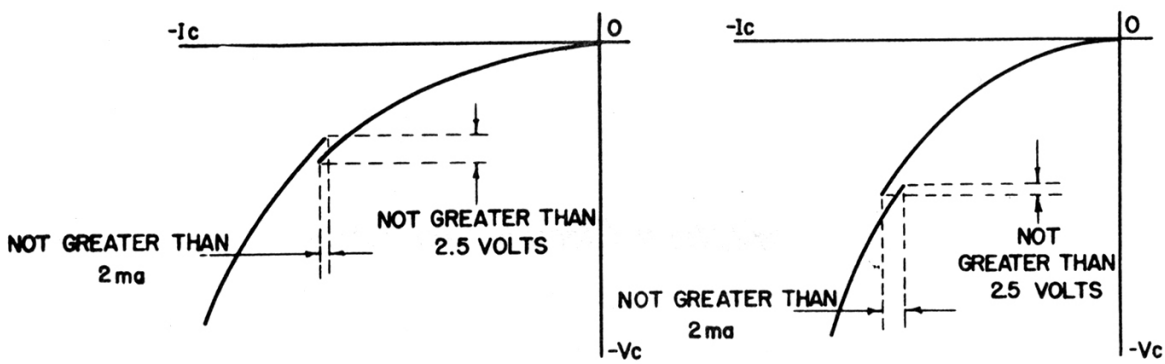


FIG. 6

A development of Bell Telephone Laboratories, the research laboratories of the American Telephone and Telegraph Company and the Western Electric Company

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Western Electric Company

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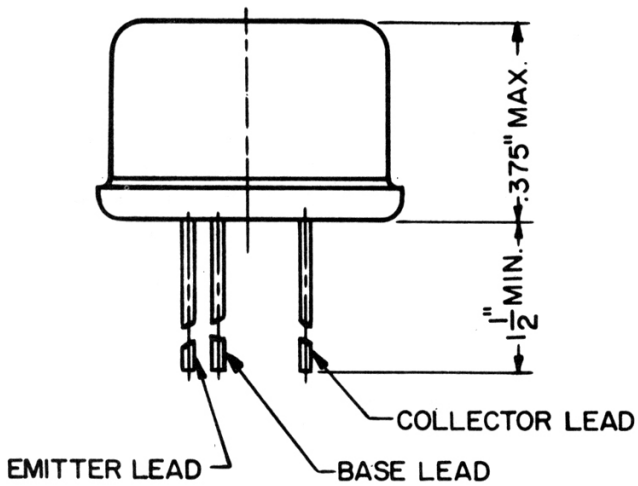
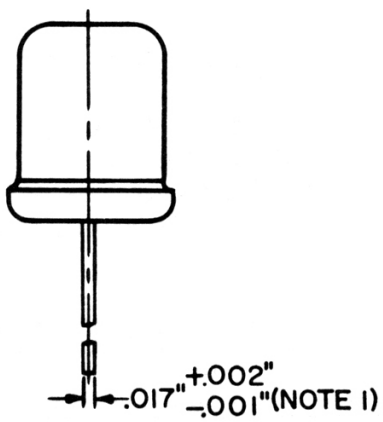
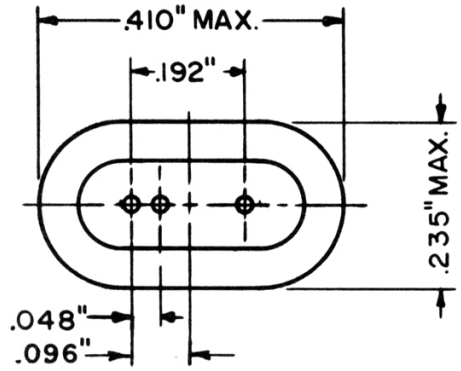
TRANSISTOR DATA SHEET
WESTERN ELECTRIC 2N27 TRANSISTOR
(DEVELOPMENT MODEL A1858)







NOTES 1:- THE SPECIFIED LEAD DIAMETER APPLIES IN THE ZONE BETWEEN .050" AND .250" FROM THE BASE SEAT. BETWEEN .250" AND 1.500" A MAXIMUM OF .021" DIAMETER IS HELD. OUTSIDE OF THESE ZONES THE LEAD DIAMETER IS NOT CONTROLLED.

2:- FOR LEAD ARRANGEMENT USE RTMA GAUGE NO. GE7-3.

DESCRIPTION

The 2N27 is an n-p-n grown junction transistor in a hermetically sealed enclosure. It is designed for small signal transmission applications.

GENERAL CHARACTERISTICS

Mechanical Data

Mounting Position - any
Dimensions and Connections - - - - - - - - - - - See outline page 1

Maximum Ratings (Note 1)

Collector Voltage - - - - - - - - - - - - - - - -	V_c	+35 volts
Emitter Voltage - - - - - - - - - - - - - - - - -	V_c	+20 volts
Base Current - - - - - - - - - - - - - - - - - -	I_b	± 5 milliamperes
Junction Temperature[2] - - - - - - - - - - - - -		85° Centrigrade

ELECTRICAL CHARACTERISTICS (at 25°C)

Small Signal Parameters (I_e=-1 mAdc; V_c=4.5 Vdc)		Min.	Median	Max.	
Short Circuit Current Multiplication Ratio	α_N or H_{21}	-0.95*	-.980	-0.995*	
Short Circuit Input Impedance	H_{11}	-	35	75*	ohms
Open Circuit Feedback Voltage Ratio	H_{12}	-	1.3×10^{-4}	2.5×10^{-4}*	
Open Circuit Output Admittance	H_{22}	-	0.14	0.5*	micromho
Short Circuit Current Multiplication Ratio at 60°C	α_N or H_{21}	-	-	1.0*	

Other Parameters

Collector Current with Open Emitter					
(I_e=0; V_c=4.5 Vdc)	I_c	-	1	10*	µAdc
(I_e=0; V_c=10.5 Vdc)	I_c	-	1.5	12*	µAdc
(I_e=0; V_c=30 Vdc)	I_c	-	4	30*	µAdc
Collector Capacitance (I_e=0; V_c=4.5 Vdc)	C_c	-	8.5	17*	µµf
Cut off Frequency of Alpha (I_e=-1mAdc; V_c=4.5 Vdc)	$f_{\alpha c}$	1*	2	-	mc
Noise Figure at 1000 cps (I_e=-1mAdc; V_c=4.5 Vdc R_g=1000 ohms)	NF	-	17.5	30*	db

*Indicates manufacturer's specification limit.

Note 1: Emitter and collector currents are limited only by local dissipation in the emitter and collector junctions. The suggested maximum rating for both I_e and I_c is 100 ma. All maximum ratings are on the basis of any duration longer than the order of 100 milliseconds.

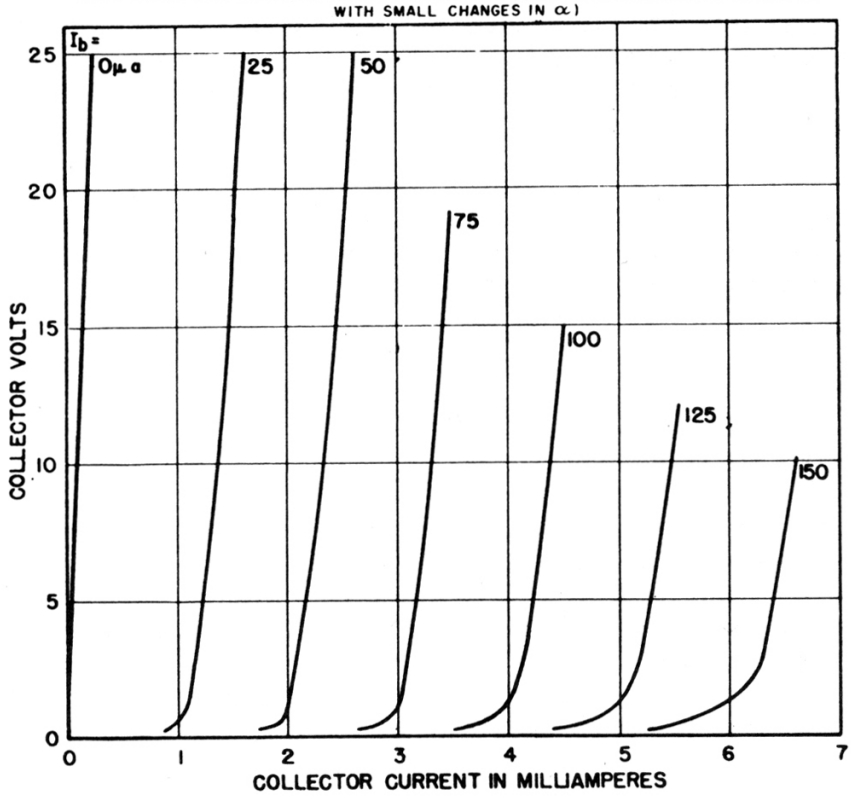
Note 2: The junction temperature increases approximately 0.5°C per milliwatt of dissipation in free air. This results in a maximum power dissipation of about 50 mw at an ambient temperature of 60°C.

CONNECTING PRECAUTIONS

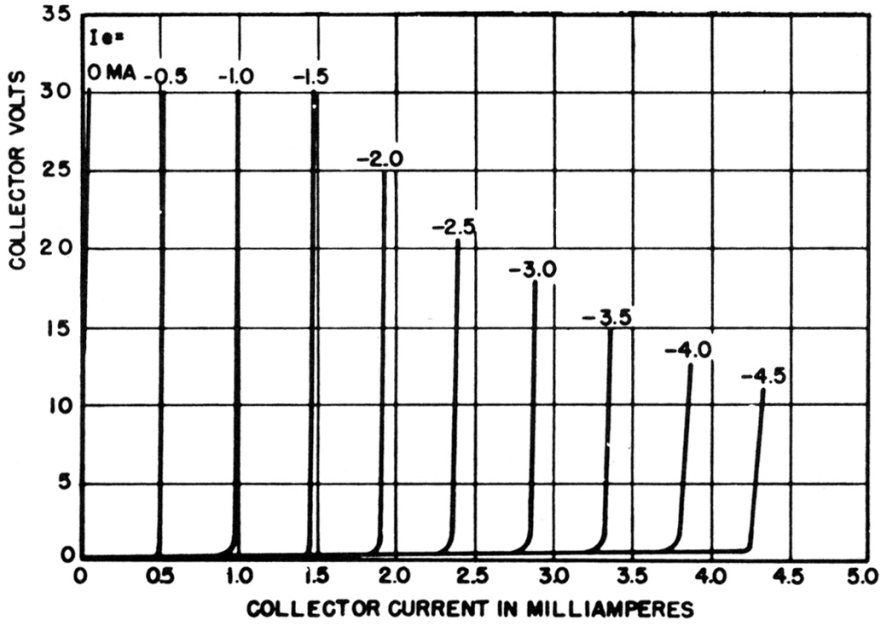
During soldering care must be taken to avoid damage to the unit. However, the specified maximum ambient temperature may be exceeded provided the temperature of the base lead measured approximately .050" from the glass seal as measured with a .010" iron constantin thermocouple does not exceed 245°C for more than 10 seconds. Before and after this 10 second period, the unit must be exposed to a room ambient not exceeding 45°C.

No bend should be made in the leads closer than 1/16" to the body of the transistor.

TYPICAL OUTPUT CHARACTERISTIC GROUNDED EMITTER
AMBIENT TEMPERATURE 25°C.
(THIS SET OF CHARACTERISTICS IS A FUNCTION OF 1-α AND THUS CHANGES APPRECIABLY WITH SMALL CHANGES IN α)



TYPICAL OUTPUT CHARACTERISTIC GROUNDED BASE



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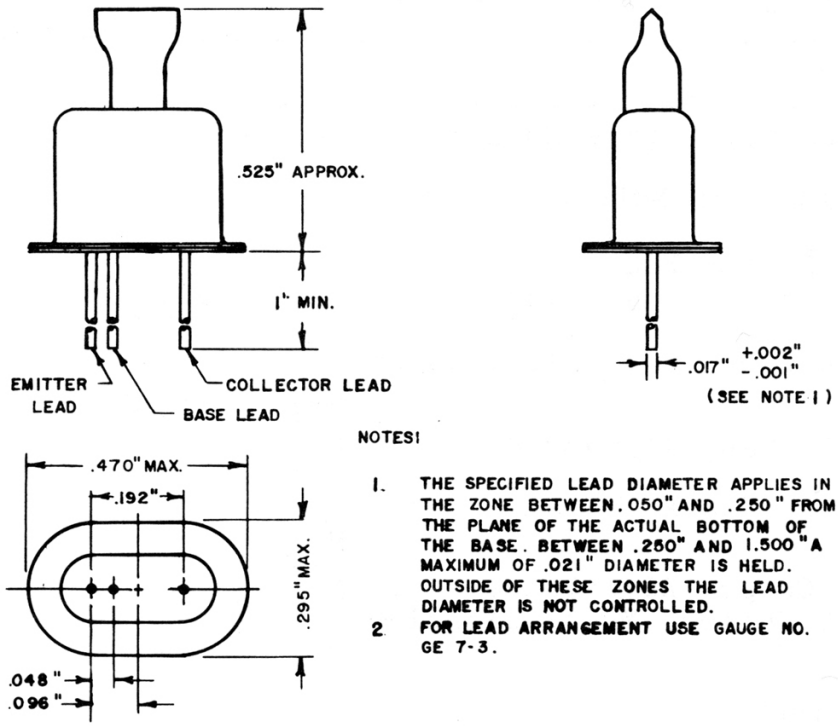
DEVELOPMENTAL

This unit is subject to change in mechanical and or electrical characteristics. Please consult Western Electric Company, Incorporated, Radio Division, 120 Broadway, New York, for current applicable design and availability.

Issue 2
December 30, 1955

INTERMEDIATE TRANSISTOR DATA SHEET
WESTERN ELECTRIC 2N28 TRANSISTOR
(DEVELOPMENT MODEL 1859)



NOTES:

1. THE SPECIFIED LEAD DIAMETER APPLIES IN THE ZONE BETWEEN .050" AND .250" FROM THE PLANE OF THE ACTUAL BOTTOM OF THE BASE. BETWEEN .250" AND 1.500" A MAXIMUM OF .021" DIAMETER IS HELD. OUTSIDE OF THESE ZONES THE LEAD DIAMETER IS NOT CONTROLLED.
2. FOR LEAD ARRANGEMENT USE GAUGE NO. GE 7-3.

DESCRIPTION

The 2N28 is an n-p-n grown junction transistor in a hermetically sealed enclosure. It is designed for small signal transmission applications.

GENERAL CHARACTERISTICS

MECHANICAL DATA

Mounting Position - any
Dimensions and Connections - - - - - - - - - - - See outline Page 1

MAXIMUM RATINGS

Collector Voltage - - - - - - - - - - - - - - - - +30 volts
Emitter Voltage - - - - - - - - - - - - - - - - - (+20 volts

Base Current - - - - - - - - - - - - - - - - - - - ±5 ma
Junction Temperature (See Note 1) - - - - - - 85° Centigrade

CHARACTERISTICS (See Note 2)

SMALL SIGNAL PARAMETERS (I_e = -1 mAdc; V_c = 4.5 Vdc)		Min.		Max.	
Short Circuit Current Multiplication Ratio	H_{21}	-0.94*	-	-0.995*	
Short Circuit Input Impedance	H_{11}	-	-	75*	ohms
Open Circuit Feedback Voltage Ratio	H_{12}	-	-	10^{-3}*	
Open Circuit Output Admittance	H_{22}	-		0.5*	μmho
Short Circuit Current Multiplication Ratio at 60°C	H_{21}	-	-	-1.0*	

OTHER PARAMETERS

Collector Current with Open Emitter (I_e = 0; V_c = 30 Vdc)	I_c	-	-	15*	μa
Collector Capacitance (I_e = 0; V_c = 4.5 Vdc)	C_c	-	-	17*	μμf
Cut-off Frequency (I_e = -1 mAdc V_c = 4.5 Vdc)	F_c	0.5*	-	-	mc
Noise Figure	NF	-	-	30*	db

*Indicates manufacturers specification limit

Note 1 : The junction temperature increases approximately 0.5°C/mw in free air and results in a max. power dissipation of about 50 mw at 60°C ambient.

Note 2: Ambient temperature 25°C.

CONNECTING PRECAUTIONS

During soldering care must be taken to avoid damage to the unit. However, the specified maximum ambient temperature may be exceeded provided the temperature of the base lead measured approximately .050" from the glass seal as measured with a .010" iron constantin thermocouple does not exceed 245°C for more than 10 seconds. Before and after this 10 second period, the unit must be exposed to a room ambient not exceeding 45°C.

No bend should be made in the leads closer than 1/16" to the body of the transistor.

A development of Bell Telephone Laboratories, the research laboratories of the American Telephone and Telegraph Company and the Western Electric Company

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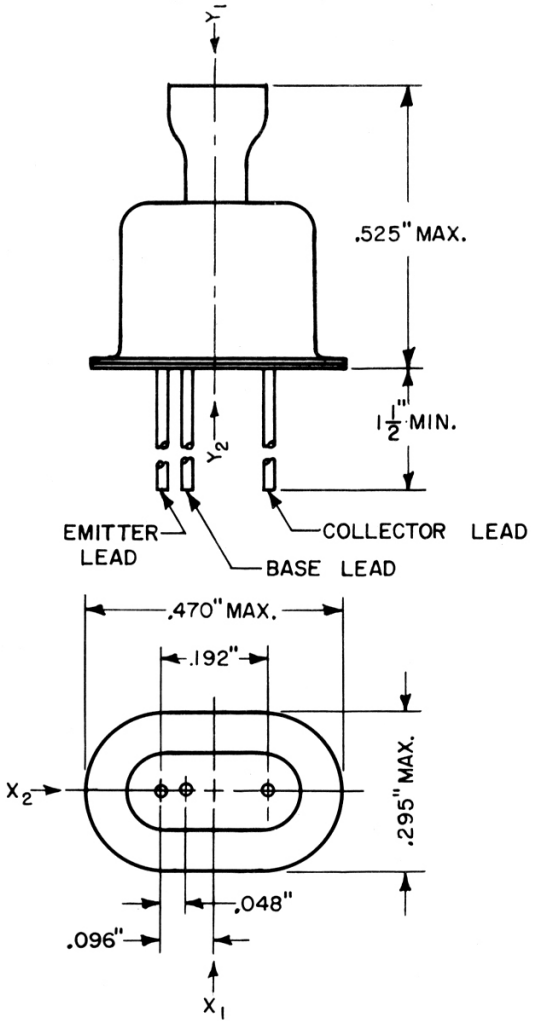
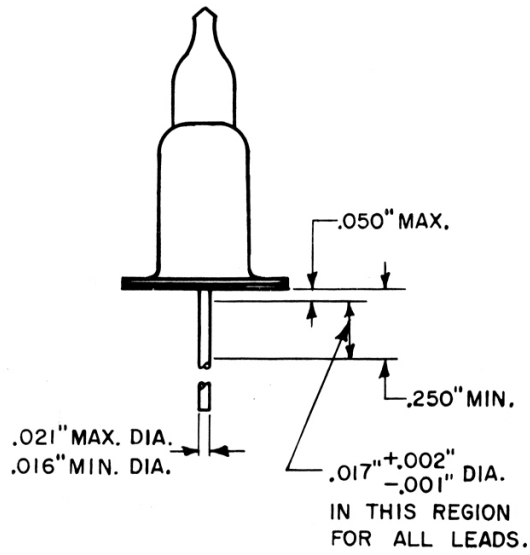
Western Electric Company

Issue 1
May 28, 1956

TRANSISTOR DATA SHEET
WESTERN ELECTRIC 2N29 TRANSISTOR
(DEVELOPMENT MODEL A 1752)





NOTES–

1.–ALL SURFACES EXCEPT LEADS COATED WITH GRAY LACQUER.

2.–LEAD DIMENSIONS AND SPACINGS SAME AS ON E3–15 STANDARD BASE.

DESCRIPTION

The 2N29 is an n-p-n grown junction transistor in a hermetically sealed enclosure. It is designed for small signal transmission applications. Its mechanical features are such that it is considered suitable for military use.

GENERAL CHARACTERISTICS

Mechanical Data

Mounting Position - any
Dimensions and Connections - - - - - - - - - - - - - See outline page 1

Maximum Ratings (Note 1)

Collector Voltage	V_{CB}	+35 volts
Emitter Voltage	V_{EB}	+20 volts
Base Current	I_B	± 5 milliamperes
Junction Temperature (Note 2)		85° Centigrade

ELECTRICAL CHARACTERISTICS, (at 25°C unless otherwise specified)

Small Signal Parameters (I_E = -1 mAdc; V_{CB} = 4.5 Vdc)		Min.	Median	Max.	
Short Circuit Current Multiplication Ratio	h_{fb}	-0.96*	-.980	-0.995*	
Short Circuit Input Impedance	h_{ib}	-	35	50*	ohms
Open Circuit Feedback Voltage Ratio	h_{rb}	-	1.3×10^{-4}	2.5×10^{-4}*	
Open Circuit Output Admittance	h_{ob}	-	0.14	0.5*	micromho
Short Circuit Current Multiplication Ratio at 55°C	h_{fb}	-	-.989	1.0*	

Other Parameters					
Collector Current with Open Emitter (I_E = 0; V_{CB} = 30 Vdc)	I_C	-	4	15*	µAdc
(I_E = 0; V_{CB} = 30 Vdc; T=55°C)	I_C	-	15	65*	µAdc
Collector Capacitance (I_E = 0; V_{CB} = 4.5 Vdc)	C_{ob}	-	8.5	17*	µµf
Cut off Frequency of Alpha (I_E = -1 mAdc; V_{CB} = 4.5 Vdc)	$f_{\alpha b}$	1*	2	-	mc
Noise Figure at 1000 cps (I_E = -1 mAdc; V_{CB} = 4.5 Vdc R_g = 1000 ohms)	NF	-	17.5	30*	db

* Indicates manufacturer's specification limit.

Note 1: Emitter and collector currents are limited only by local dissipation in the emitter and collector junctions. The suggested maximum rating for both I_E and I_C is 100 ma. All maximum ratings are on the basis of any duration longer than the order of 100 milliseconds.

Note 2: The junction temperature increases approximately 0.5°C per milliwatt of dissipation in free air. This results in a maximum power dissipation in free air of about 50 mw at an ambient temperature of 60°C.

Special Tests

The following tests are performed on a sampling basis in accordance with the methods and conditions specified in Military Specification MIL-T-12679A (Sig. C.). Deviations from this specification and mechanical and electrical requirements, when not stated explicitly in the specification, are as noted below in the "Requirement" column.

MIL-T-12679 Test	Requirement
4.11 Lead Fatigue Test	4-90° arcs
4.18 Vibration, High Acceleration (non operation)	One cycle of specified frequency range in each of the following directions; X_1, X_2, and Y_1 orientations (See Note 3)
4.19 Vibration Fatigue	See Note 3
4.20 Shock Test	See Note 3
4.21 Centrifuge Test	5000 G (See Note 3)
4.25 Temperature Test (non operation)	5 temperature cycles, -55 to + 85°C (See Note 3)
4.26 High Temperature Operation Test	55° Centigrade (See Note 4)
4.28 Moisture Resistance Test	See Note 5
4.30 Salt Spray Corrosion	---

4.32 Transistor Life Test

		Min.	Max.	
Short Circuit Current Multiplication Ratio (I_E = -1 mAdc; V_{CB}= 4.5 Vdc)	h_{fb}	-0.950	-0.995	
Open Circuit Output Admittance (I_E = -1 mAdc; V_{CB} = 4.5 Vdc)	h_{ob}	---	0.5	μmho
Collector Current with Open Emitter (I_E = 0; V_{CB} = 30 Vdc)	I_{CO}		15	μA

These tests are made after 24, 100, 300 and 500 hours of power aging. During this period, the transistor operates at a d.c. collector power dissipation level of 50 mw and bias conditions of I_C = 2.5 mA, and V_{CB} = 20 Volts. The ambient temperature during the life test may vary from + 20°C to + 35°C.

(Notes 3, 4, 5 and "Connecting Precautions" on page 4)

Note 3: Post Test Electrical Requirement

		Min.	Max.	
Short Circuit Current Multiplication Ratio (I_E = -1 mAdc; V_{CB} = 4.5 Vdc)	h_{fb}	-.960	-.995	
Collector Current With Open Emitter (I_E = 0; V_{CB} = 30 Vdc)	I_C	---	15	μA

Note 4: Electrical Requirement at 55°C

Short Circuit Current Multiplication Ratio (I_E = -1 mAdc; V_{CB} = 4.5 Vdc)	h_{fb}	---	1.0	
Collector Current With Open Emitter (I_E = 0; V_{CB} = 30 Vdc)	I_C	---	65	μA

Note 5: Post Test Electrical Requirement

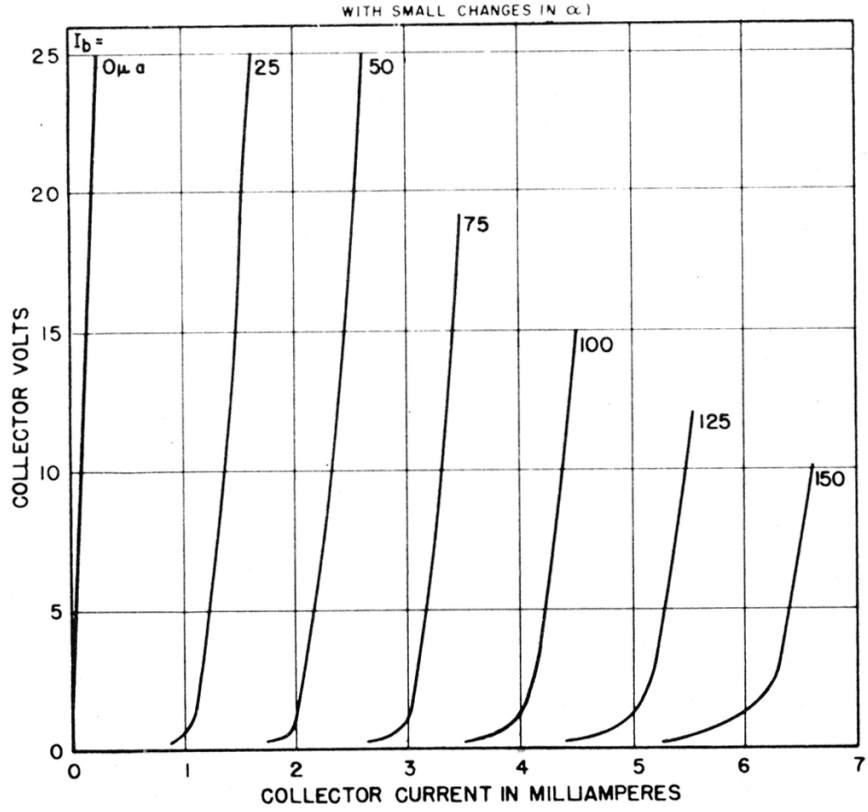
Short Circuit Current Multiplication Ratio (I_E = -1 mAdc; V_{CB} = 4.5 Vdc)	h_{fb}	-.950	-.955	
Collector Current With Open Emitter (I_E = 0; V_{CB} = 30 Vdc)	I_C	---	30	μA

CONNECTING PRECAUTIONS

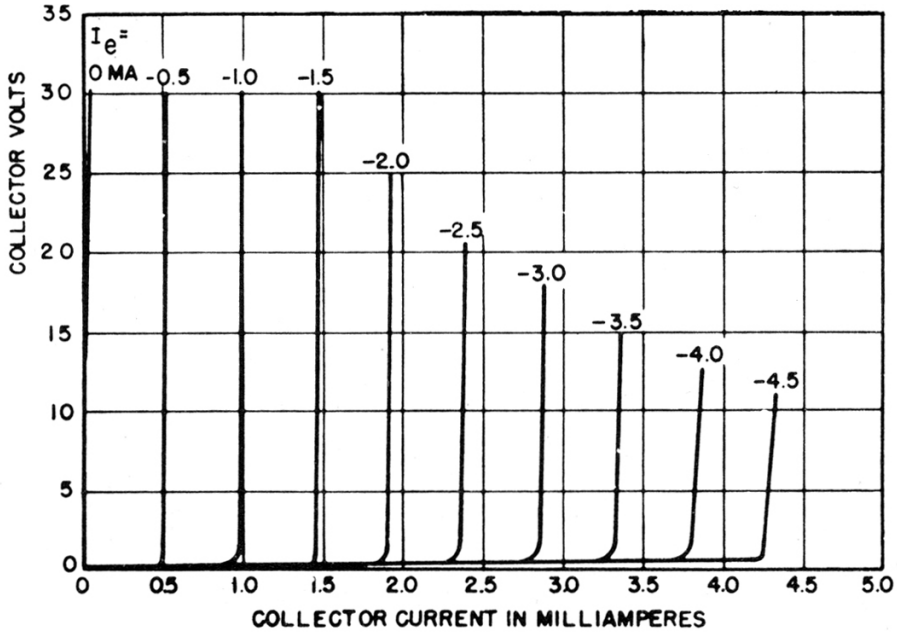
During soldering care must be taken to avoid damage to the unit. However, the specified maximum ambient temperature may be exceeded provided the temperature of the base lead measured approximately .050" from the glass seal as measured with a .010" iron constantin thermocouple does not exceed 245°C for more than 10 seconds. Before and after this 10 second period, the unit must be exposed to a room ambient not exceeding 45°C.

No bend should be made in the leads closer than 1/16" to the body of the transistor.

TYPICAL OUTPUT CHARACTERISTIC GROUNDED EMITTER
AMBIENT TEMPERATURE 25°C.
(THIS SET OF CHARACTERISTICS IS A FUNCTION OF $1-\alpha$ AND THUS CHANGES APPRECIABLY WITH SMALL CHANGES IN α)



TYPICAL OUTPUT CHARACTERISTIC GROUNDED BASE



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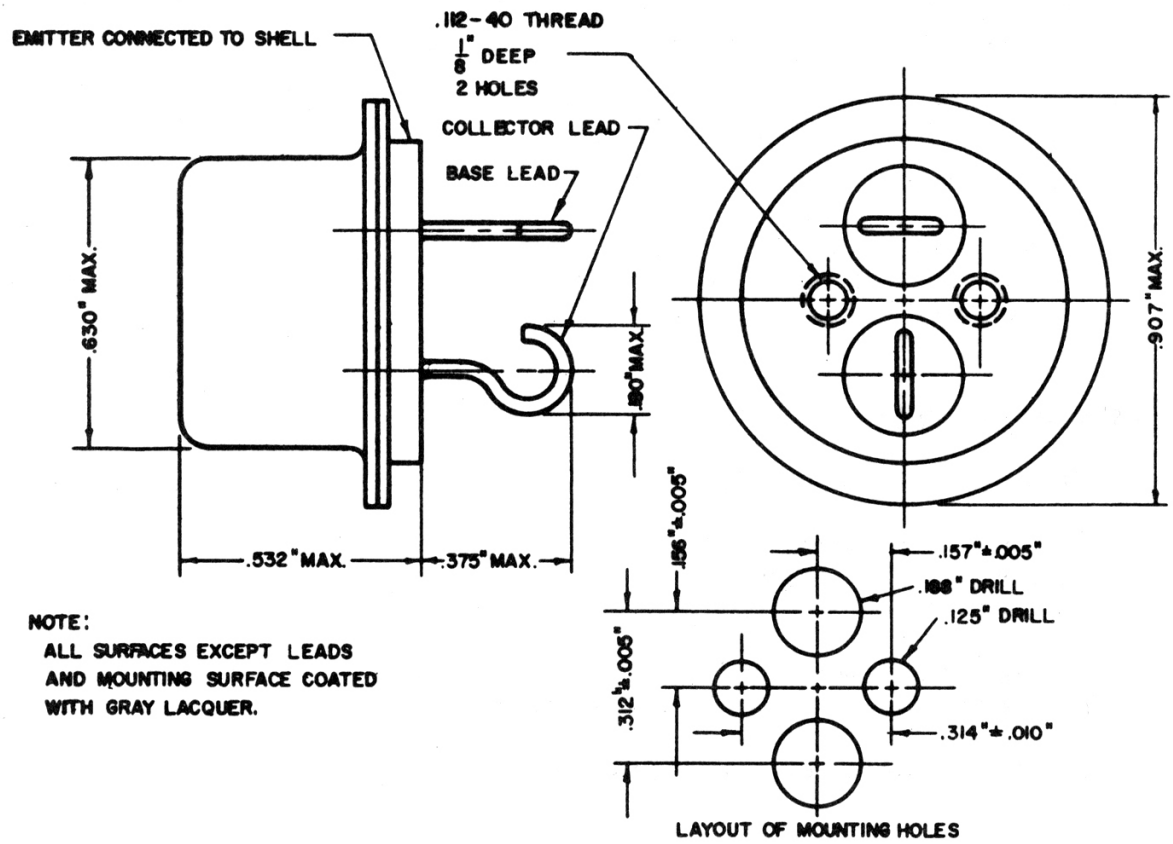
Issue 3
May 20, 1955

TRANSISTOR DATA SHEET
WESTERN ELECTRIC 2N66 TRANSISTOR



DESCRIPTION

The 2N66 is a p-n-p alloy transistor hermetically sealed in a welded can. It is intended for power conversion, transmission, switching and electronic control applications.

GENERAL CHARACTERISTICS

Mechanical Data

Mounting (See Note 1)	Any position
Dimensions and Connections	See outline

GENERAL CHARACTERISTICS (Cont'd.)

Power Dissipation Characteristics

Internal temperature drop, collector junction to mounting surface	2°C/watt
Temperature drop from collector junction to ambient for typical mountings (See Note 2)	
Insulating socket in free air	66°C/watt
Aluminum sheets 3-1/2" x 3-1/2"	
Unpainted, 1/16" thick	13°C/watt
Painted black, 1/16" thick	11°C/watt
Unpainted, 1/8" thick	11°C/watt

Maximum Ratings

Current; continuous to any electrode		0.8 ampere
Collector voltage; 25°C		
Collector to base		-60 volts
Collector to emitter		-40 volts
Emitter voltage; 25°C		
Emitter to base, collector open		-60 volts
Collector junction temperature	T_J	80°C

ELECTRICAL CHARACTERISTICS (at 25°C ambient)

Static Characteristics

Reverse currents at -4.5 volts		
Collector to base	I_{co}	< 75 μa
Emitter to base	I_{eo}	< 75 μa
Reverse currents at -40 volts		
Collector to base	I_{co}	< 300 μa
Emitter to base	I_{eo}	< 300 μa
Reverse currents at -60 volts		
Collector to base	I_{co}	< 1 ma
Emitter to base	I_{eo}	< 1 ma
Common emitter current gain; (Vc=-4.5v)		
Base current for 100 ma collector current	I_b	< 4 ma
Base current for 400 ma collector current	I_b	< 25 ma

Static Characteristics (Cont'd.)

Common emitter transconductance; (V_c=-4.5v)		
Base voltage for 100 ma collector current	V_b	<-1.0 volts
Base voltage for 400 ma collector current	V_b	<-2.0 volts
Minimum collector voltage for 200 ma collector current and 25 ma base current in common emitter connection		<-0.4 volts

Dynamic Characteristics

Collector capacitance (I_c=0, V_c=-4.5v)	C_c	≈400 μμfd
Common base (alpha) cut-off frequency	$f_{\alpha c}$	>0.2 mc/sec.

NOTE 1: Two 4-40 tapped holes are provided in bottom of transistor for mounting. Adequate heat sink must be attached. Care should be taken to get good thermal contact between transistor and heat sink.

NOTE 2: The collector junction temperature rise above ambient temperature (T_J-T_A) under operating conditions on any heat sink can be determined from Figure 1 which indicates how the collector saturation current varies with collector junction temperature.

The collector saturation current $[I_c(0,-1)|_{T_A}]$ at the ambient temperature (T_A) is measured with the unit attached to the heat sink. The operating power is then applied, and the unit is allowed to come to thermal equilibrium in the same temperature ambient. Power is then removed, and the collector saturation current $[I_c(0,-1)|_{T_J}]$ is measured within 25 milliseconds after the power is removed.

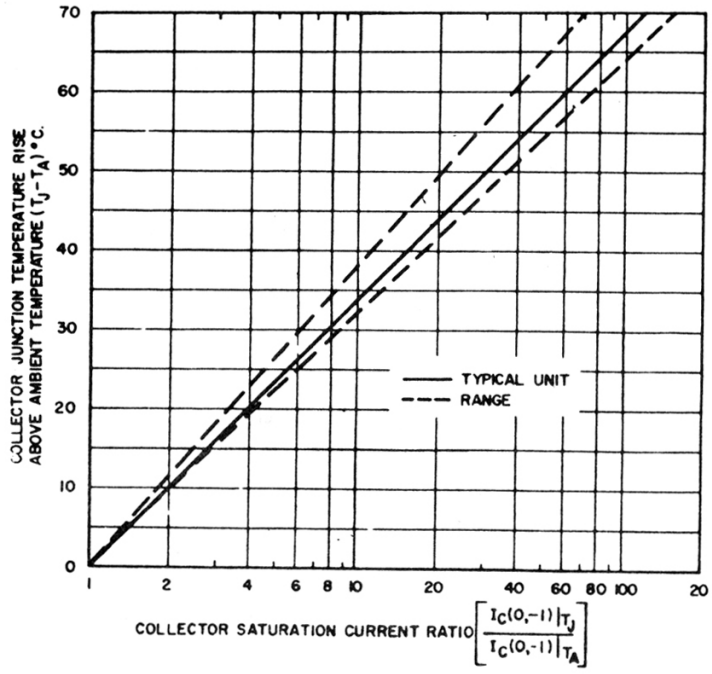


FIG. 1

The ratio $\frac{I_c(0,-1)|_{T_J}}{I_c(0,-1)|_{T_A}}$ is used with Figure 1 to determine the collector junction temperature rise above ambient temperature.

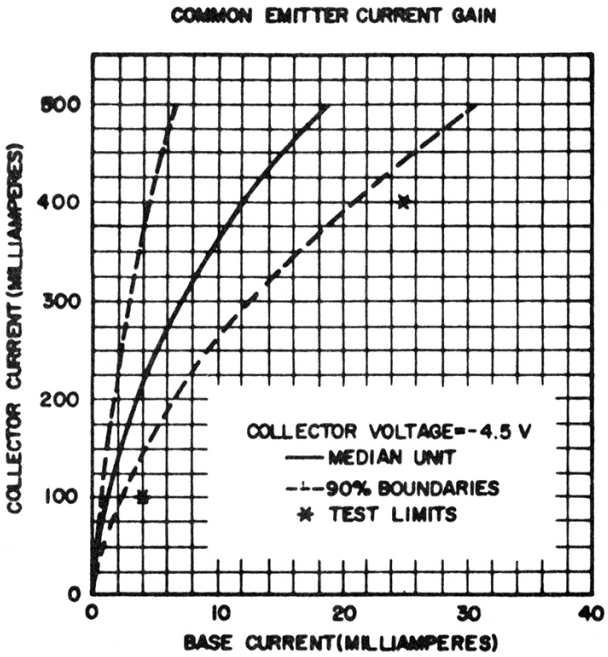


FIG. 2

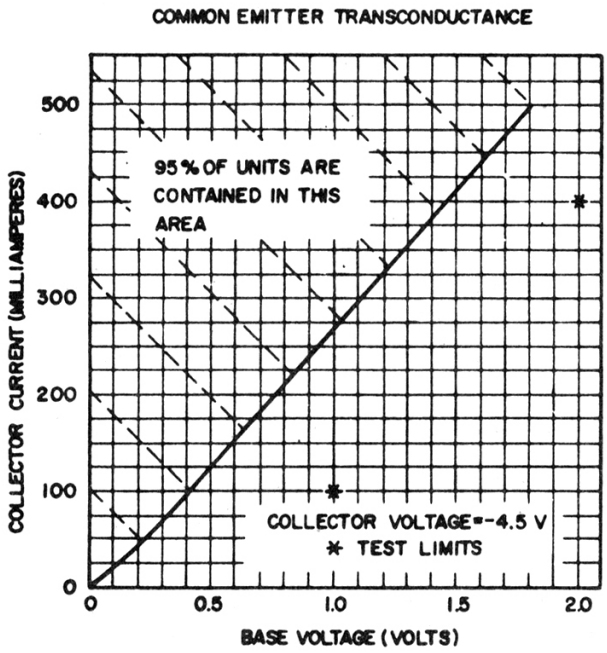


FIG. 3

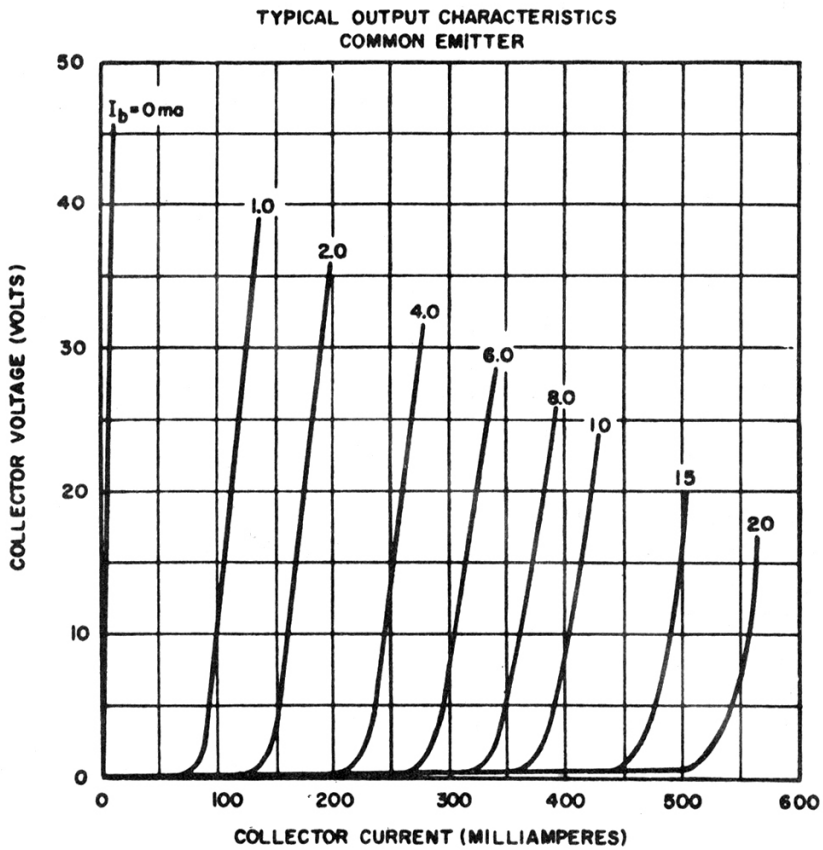


FIG. 4

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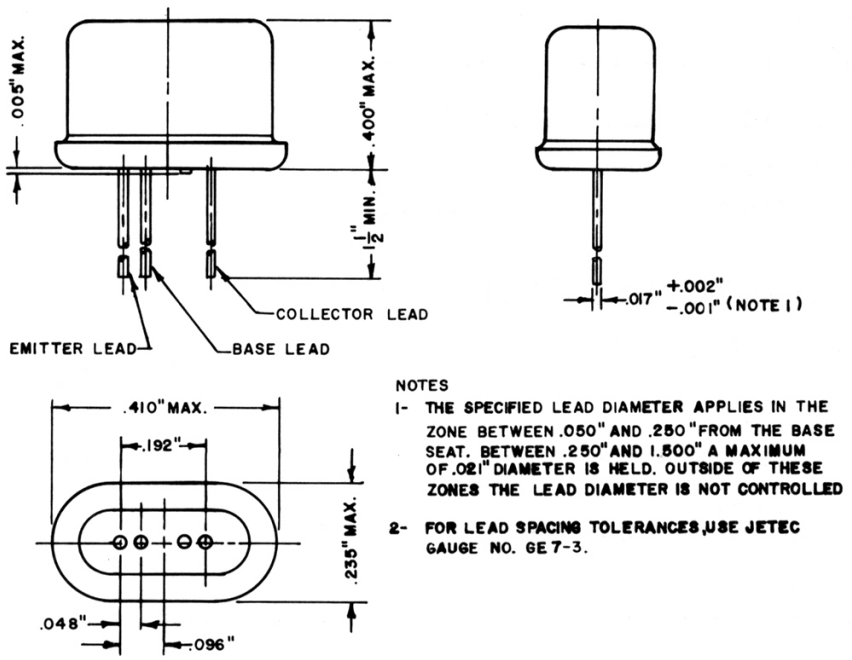
TRANSISTOR DATA SHEET
WESTERN ELECTRIC 2N67 TRANSISTOR
(DEVELOPMENT MODEL 1894)



NOTES

1- THE SPECIFIED LEAD DIAMETER APPLIES IN THE ZONE BETWEEN .050" AND .250" FROM THE BASE SEAT. BETWEEN .250" AND 1.500" A MAXIMUM OF .021" DIAMETER IS HELD. OUTSIDE OF THESE ZONES THE LEAD DIAMETER IS NOT CONTROLLED

2- FOR LEAD SPACING TOLERANCES, USE JETEC GAUGE NO. GE 7-3.

DESCRIPTION

The 2N67 is a point-contact transistor triode in an hermetically sealed enclosure. It is designed for use in high speed switching circuits where the large-signal parameters of the active device are of primary interest. Electrically, it is similar to the 2N26 transistor. Its mechanical features are such that it is considered suitable for severe military use.

GENERAL CHARACTERISTICS

Mechanical Data

Mounting position ..... any

Socket ..... See Note 1

Dimensions and pin connections ..... See Outline

GENERAL CHARACTERISTICS (Cont'd.)

Absolute Maximum Ratings (Note 2)

Collector voltage	V_c	-100 volts
Collector dissipation	P_c	100 milliwatts
Emitter voltage	V_e	-100 volts
Emitter dissipation	P_e	80 milliwatts
Ambient storage temperature		+85, -55°C
Shock		500G

Suggested Design Maximums (Note 2)

Collector current	I_c	+40, -40 ma
Emitter current	I_e	+40, -2 ma

ELECTRICAL CHARACTERISTICS (Notes 2 & 3)

Large Signal Parameters

		Min.*	5%†	Mode**	5%†	Max.*	
Collector current (I_e=0 mAdc, V_c=-8 Vdc)	I_c		-.20	-.45	-.65		mAdc
Collector voltage (I_e=4.0 mAdc; I_c=-9.5 mAdc)	V_c		-1.5	-2.5	-3.7	-4.0	Vdc
Emitter current (V_e=-10 Vdc; I_c=0 mAdc)	I_e		-.003	-.005	-.04	-.1	mAdc

Special Electrical Tests (Switching Characteristics) (notes 2 & 3)

Circuit Figure 1, values of Table 1 and Figures 2 and 3 apply to the following tests:

Test	Min.*	5%†	Mode**	5%†	Max.*	
1. Peak to peak voltage amplitude of the oscillations at the emitter with emitter current at one or more values that are less than or equal to 0.1 mAdc; Condition A	2.0	2.5	3.3	3.9		volts
2. Peak voltage; Condition B		-.05	-.29	-.48	-.5	volt
3. Valley voltage; Condition C	-2.0	-2.4	-2.6	-3.1		volts
4. Deep valley voltage; Condition D		-6.3	-7.1	-8.5	-8.6	volts

* Indicates manufacturer's test specification limit.

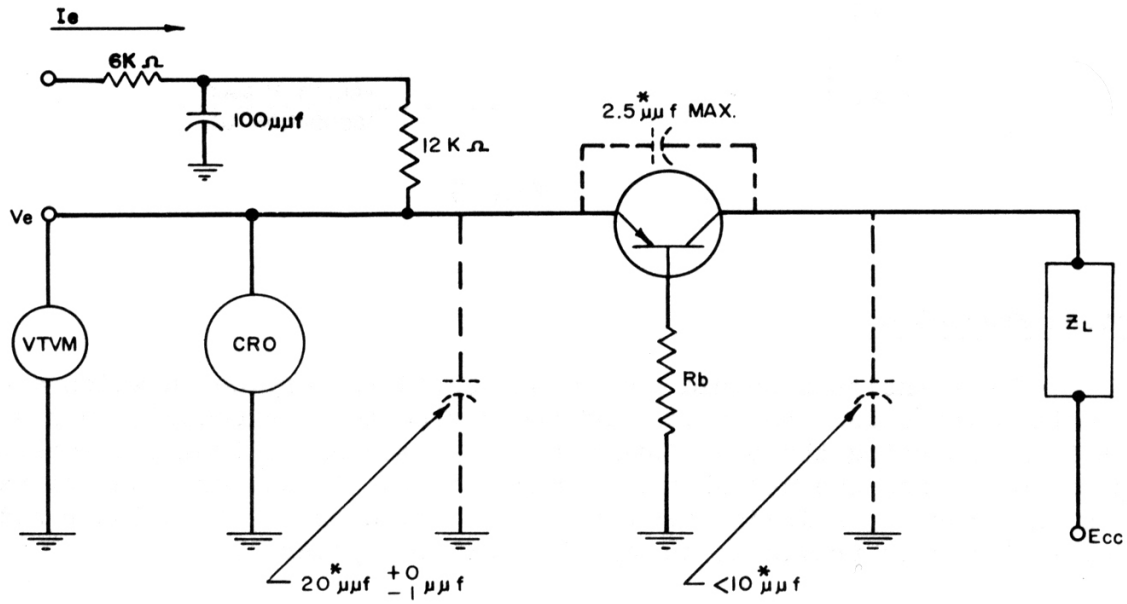
† Approximately 5% of transistors in a typical group have values outside that shown. (Not a manufacturing limit).

**Based on a typical group. (Not a manufacturer's requirement).

Note 1: The external connections meet the requirements for JETEC Base Standard E3-15 and will fit a 5 pin in-line subminiature tube socket, or its equivalent, when the lead length, as measured from the transistor base is reduced to 0.200".

Note 2: Inward direction of current is taken as positive for both emitter and collector. Voltages are measured with respect to the base. Subscripts "c" and "e" refer to collector and emitter respectively. Voltages are referred to on an absolute basis so that a potential of Vc=-20 volts is greater than a potential of Vc=-10 volts. Electrical ratings are on the basis of any duration longer than the order of 1 millisecond at an ambient temperature of 25 ± 10°C.

Note 3: Ambient temperature 25°C. Modal values are those which occur most frequently.

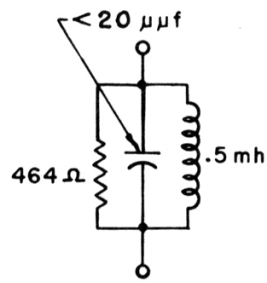


* TOTAL DIRECT CAPACITY INCLUDING APPARATUS & STRAYS (NOT INCLUDING TRANSISTOR)

FIG. 1

TABLE I

CONDITION	Rb OHMS	Z_L OHMS	Ecc VOLTS
A	511	Z_1 (SEE FIG.2)	-8
B	511	0	-8
C	511	1100 (RES.)	-10
D	0	169.5 (RES.)	-14.5



EQUIVALENT CIRCUIT FOR Z_1 AT Imc.

FIG. 2

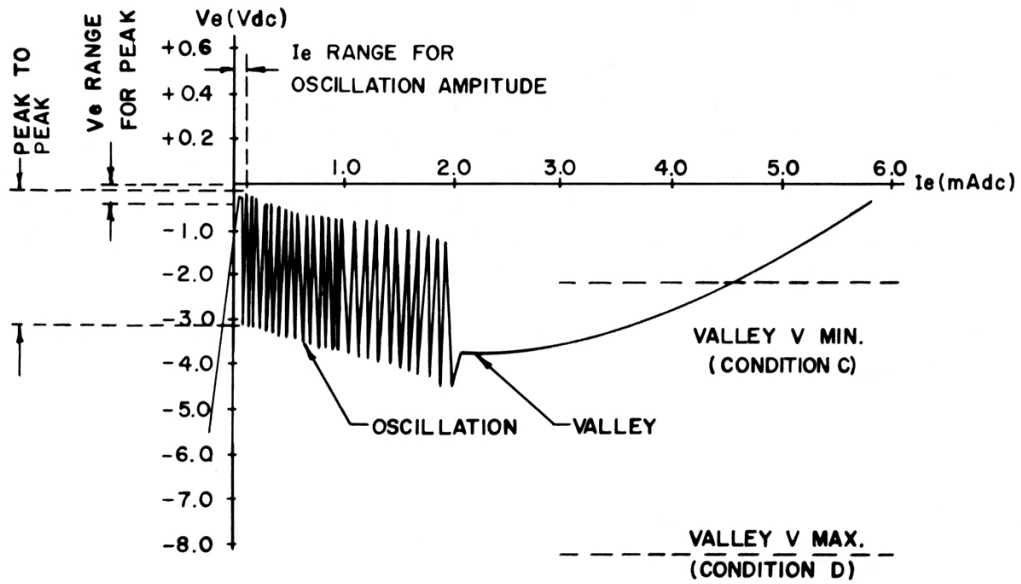


FIG. 3

Operating Precaution

The transistor should not be subjected to service in which excessive transients might cause the ratings of the device to be exceeded, such as may result from inserting the transistor into or removing it from the socket with the power on. Base contact should be made first. If solder connections are made to the transistor leads, heat sink protection on the transistor side of the joint should be provided, as with a flat nose pliers.

A development of Bell Telephone Laboratories, the research laboratories of the American Telephone and Telegraph Company and the Western Electric Company

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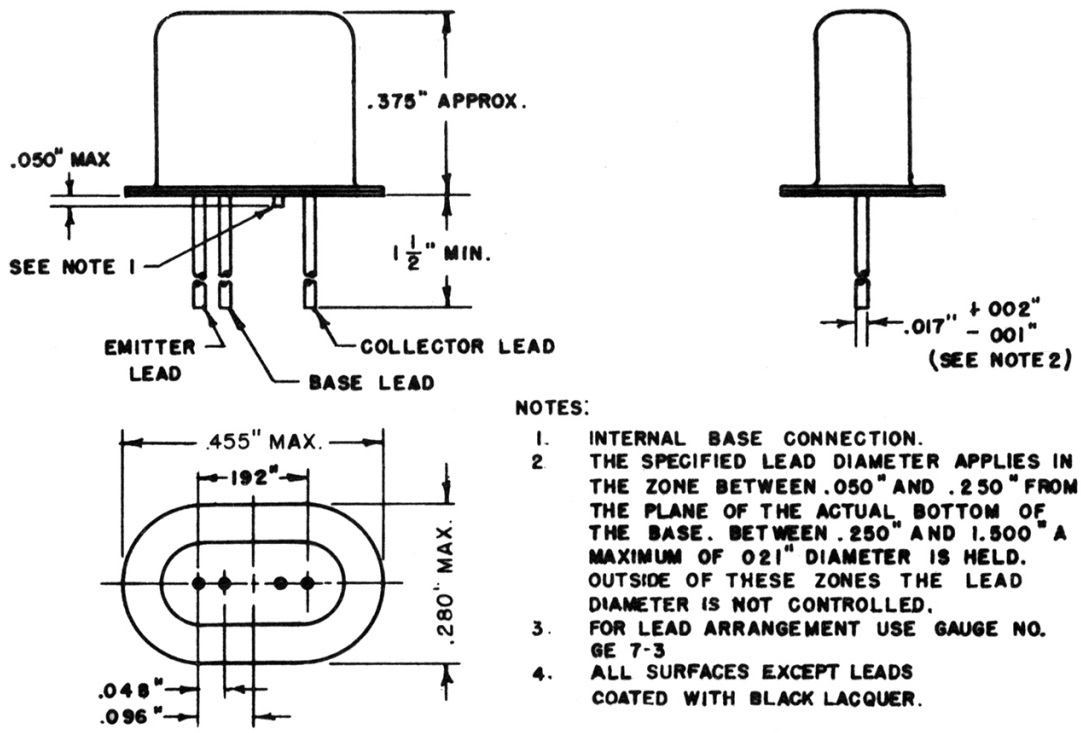
Issue 1
December 30, 1955

TRANSISTOR DATA SHEET
WESTERN ELECTRIC 2N110 TRANSISTOR
(DEVELOPMENT MODEL 2031)



NOTES:

1. INTERNAL BASE CONNECTION.
2. THE SPECIFIED LEAD DIAMETER APPLIES IN THE ZONE BETWEEN .050" AND .250" FROM THE PLANE OF THE ACTUAL BOTTOM OF THE BASE. BETWEEN .250" AND 1.500" A MAXIMUM OF .021" DIAMETER IS HELD. OUTSIDE OF THESE ZONES THE LEAD DIAMETER IS NOT CONTROLLED.
3. FOR LEAD ARRANGEMENT USE GAUGE NO. GE 7-3
4. ALL SURFACES EXCEPT LEADS COATED WITH BLACK LACQUER.

DESCRIPTION

The 2N110 is a point contact transistor triode in an hermetically sealed enclosure. It is designed for use over a wide temperature range in switching circuits where the large-signal parameters of the active device are of primary interest. Electrically, it is similar to the 2N21 transistor. Its mechanical features are such that it is considered suitable for severe military use.

GENERAL CHARACTERISTICS

Mechanical Data

Mounting position - any

Socket - See Note 1

Dimensions and pin connections - - - - - - - - - - - - - - - See Outline Page 1

Absolute Maximum Ratings (Note 2)

Collector voltage - - - - - - - - - - - - - - - - - -	V_c	-100 volts
Collector dissipation - - - - - - - - - - - - - - - -	P_c	200 milliwatts
Emitter voltage - - - - - - - - - - - - - - - - - - -	V_e	-100 volts
Emitter dissipation - - - - - - - - - - - - - - - - -	P_e	140 milliwatts
Ambient storage temperature - - - - - - - - - - - -		(+85°C (-55°C
Shock -		500 g

Suggested Design Maximums (Note 2)

Collector current - - - - - - - - - - - - - - - - - -	I_c	-50 ma
Emitter current - - - - - - - - - - - - - - - - - - -	I_e	+50 ma

ELECTRICAL CHARACTERISTICS (Ambient 25°C)

		Min.	Max.	
Emitter to Collector Voltage (I_e = 10.0 mAdc, I_c = -18.0 mAdc)	V_{ec}	0	-2.5	volts
Rise Time (See Note 3 and Figure 1)	tr	0	0.5	μ sec.
High Temperature Tests at $65\pm^{0}_{2}$°C (See Note 5)				
Collector Current, See Note 6 (V_c = -20 Vdc, V_e = -0.5 Vdc)	I_c	0	-3.3	mAdc
Emitter Current (V_e = -10 Vdc, I_c = 0)	I_e	0	-2.0	mAdc
Turn-off Time (See Note 4 and Figure 2)	tt	0	15.0	μ sec.

NOTE 1: The external connections will fit a 5 pin in-line subminiature tube socket, or its equivalent, when the lead length, as measured from the transistor base, is reduced to 0.200". A shearing tool should be used for this purpose.

NOTE 2: Electrical ratings are on the basis of any duration longer than the order of 50 microseconds at an ambient temperature of 25 ± 5°C. An individual maximum rating may not be achievable because of other parameter limitations.

NOTE 3: Rise time (tr) is the time required for the collector current to rise from its -10 Vdc saturation value to -18 mAdc, with an emitter to collector voltage of -8 Vdc, after a +1 mAdc emitter current step is applied. The circuit of figure 1 may be used to make this test.

NOTE 4: Turn off time (tt) is the time required for the emitter to collector voltage to change from its saturation, $V_c(14,-18)$, value to -16 Vdc, with a collector supply voltage of -20 Vdc, a collector load resistance of 1000 ohms and an initial base bias of +4 mAdc, after a +14.0 mAdc base current step is applied with base voltage limited to +1.5 Vdc. The circuit of figure 2 may be used to make this measurement.

NOTE 5: All tests are made after the device has reached thermal equilibrium with biases applied. No external heat sink or forced air cooling is used.

NOTE 6: A current limited collector supply can be used to prevent excessive power dissipation.

OPERATING PRECAUTION

The transistor should not be subjected to service in which excessive transients might cause the ratings of the device to be exceeded, such as may result from inserting the transistor into or removing it from the socket with the power on. Base contact should be made first. If solder connections are made to the transistor leads, heat sink protection on the transistor side of the joint should be provided, as with flat nose pliers. When cutting leads for socketing, a shearing tool should be used.

Operation of the transistor as a linear device in the region of emitter biases between voltage cut-off and saturation is not recommended due to anomalies which appear in this range in some transistors. An anomaly can be defined as a condition in the output characteristics when, for a fixed value of emitter current, the collector voltage can be a multiple valued function of the collector current or the collector current can be a multiple valued function of the collector voltage.

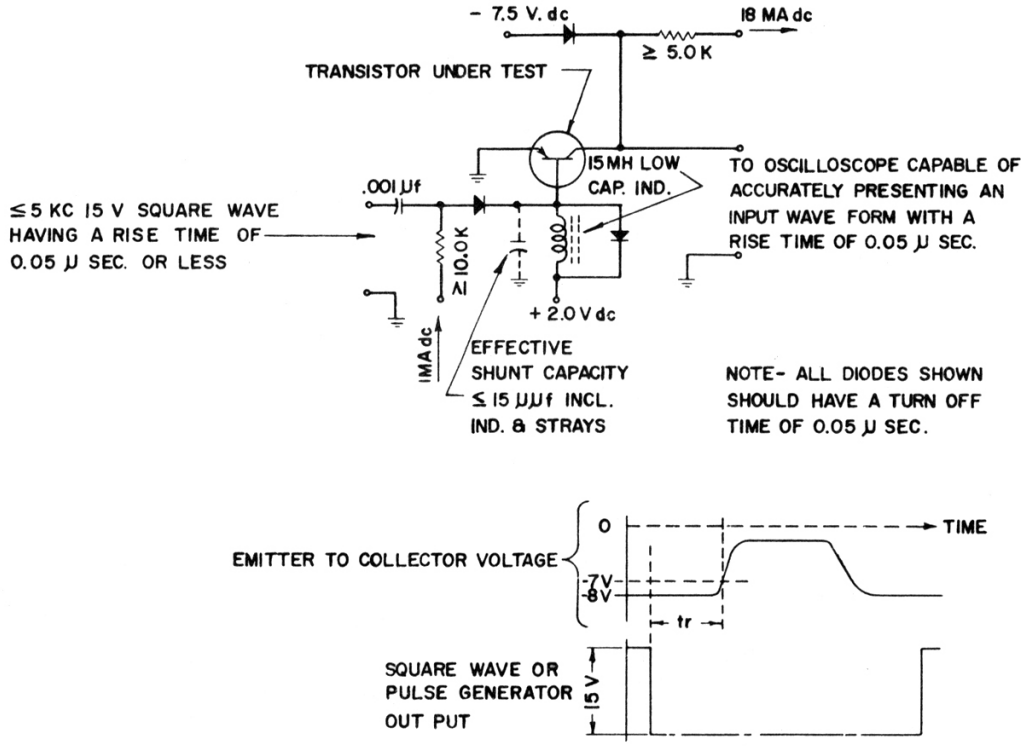


FIG. 1

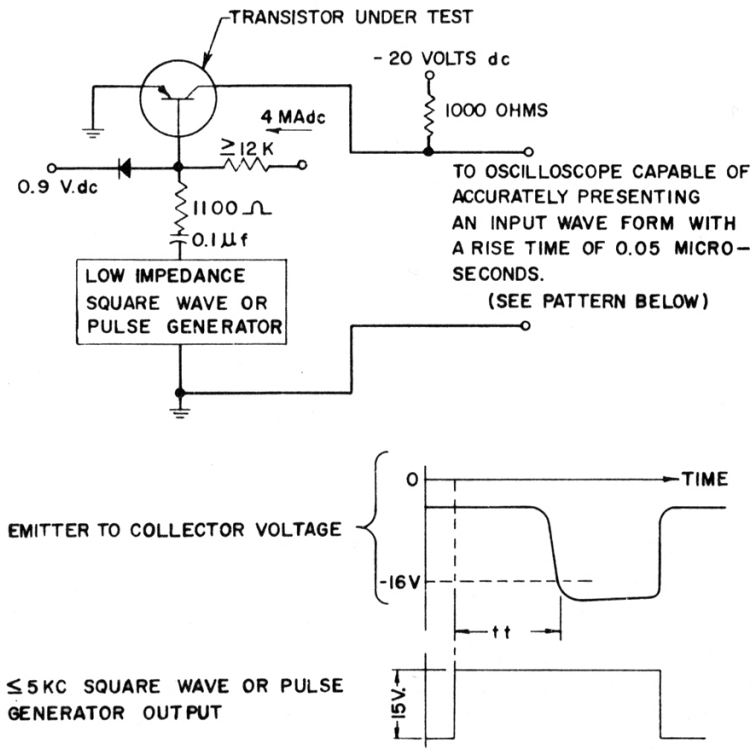
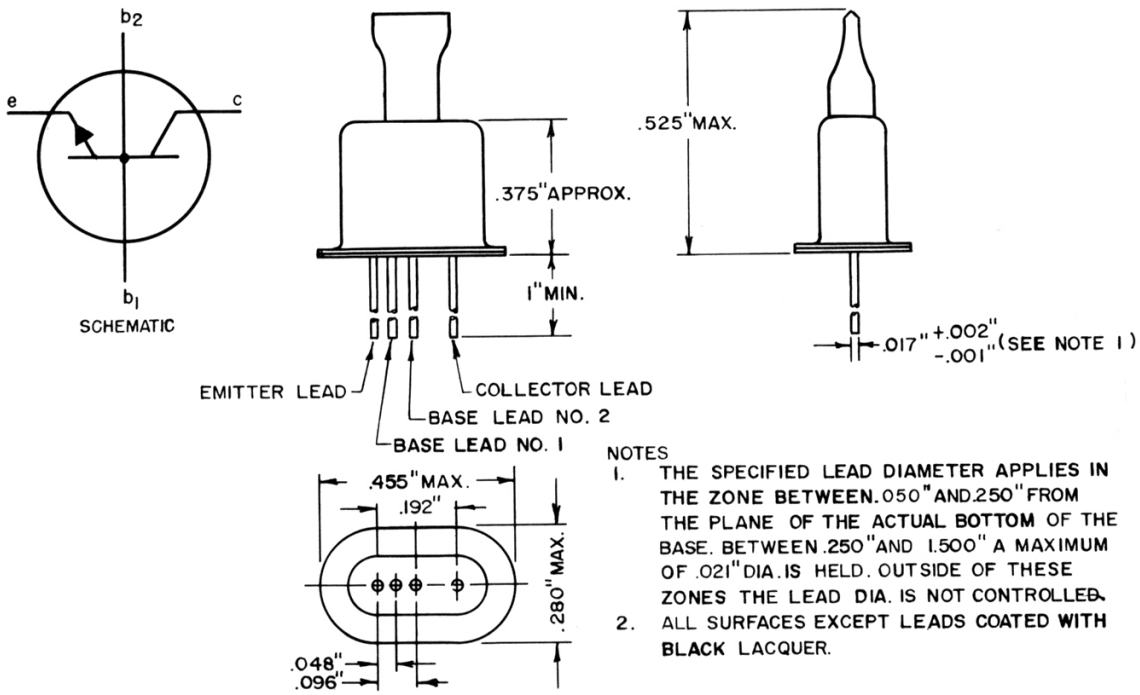


FIG. 2

PRINTED IN U.S.A.

Issue 1
September 23, 1955

TRANSISTOR DATA SHEET
WESTERN ELECTRIC 3N22 TRANSISTOR



NOTES
1. THE SPECIFIED LEAD DIAMETER APPLIES IN THE ZONE BETWEEN .050" AND .250" FROM THE PLANE OF THE ACTUAL BOTTOM OF THE BASE. BETWEEN .250" AND 1.500" A MAXIMUM OF .021" DIA. IS HELD. OUTSIDE OF THESE ZONES THE LEAD DIA. IS NOT CONTROLLED.
2. ALL SURFACES EXCEPT LEADS COATED WITH BLACK LACQUER.

DESCRIPTION

The 3N22 is an n-p-n grown junction tetrode transistor in a hermetically sealed can. It is intended for video amplifier and moderate radio frequency applications.

GENERAL CHARACTERISTICS

Mechanical Data

Mounting position - any

Dimensions and Connections - - - - - - - - - - - - - - - - see outline page 1

Maximum Ratings (See Note 1)

Voltage-collector to Base 1 - - - - - - - - - - - - - - - - - - 10 volts

Total dissipation - 30 milliwatts

Ambient temperature - 60°C

ELECTRICAL CHARACTERISTICS (At 25°C Ambient)

Small Signal Parameters
(I_e = -2 mAdc, V_c = 10 Vdc, I_{b_2} = 0.1 mAdc)

		Min.	Typical	Max.	
Low frequency short circuit current transfer ratio	α_o	.92*	.96	---	
Cut off frequency of α	$f_{\alpha c}$	15*	---	---	Mc/sec.
Short circuit input impedance at 10 Mc/sec.,	h_{11}	---	70+j30	(130+j80)*	ohms
Open circuit voltage feedback ratio at 10 Mc/sec.,	h_{12}	---	.010	.035*	
Open circuit output admittance at 10 Mc/sec.,	h_{22}	---	50+j150	(100+j250)*	μmho

Other Parameters

Collector current with open emitter (V_c = 5 Vdc)	I_{co}	---	1.0	10*	μa
Collector Capacitance (V_c = 10 Vdc)	C_c	---	2.0	4*	μμf

* Test limits

NOTE 1: Inward direction of current is taken as positive for both emitter and collector. Voltages are measured with respect to base 1. Subscripts c and e refer to collector and emitter respectively.

OPERATING AND CONNECTING PRECAUTIONS

Leads may be cut off for socket mounting or soldered by taking precaution to protect transistor by providing a heat sink between solder joint and can.

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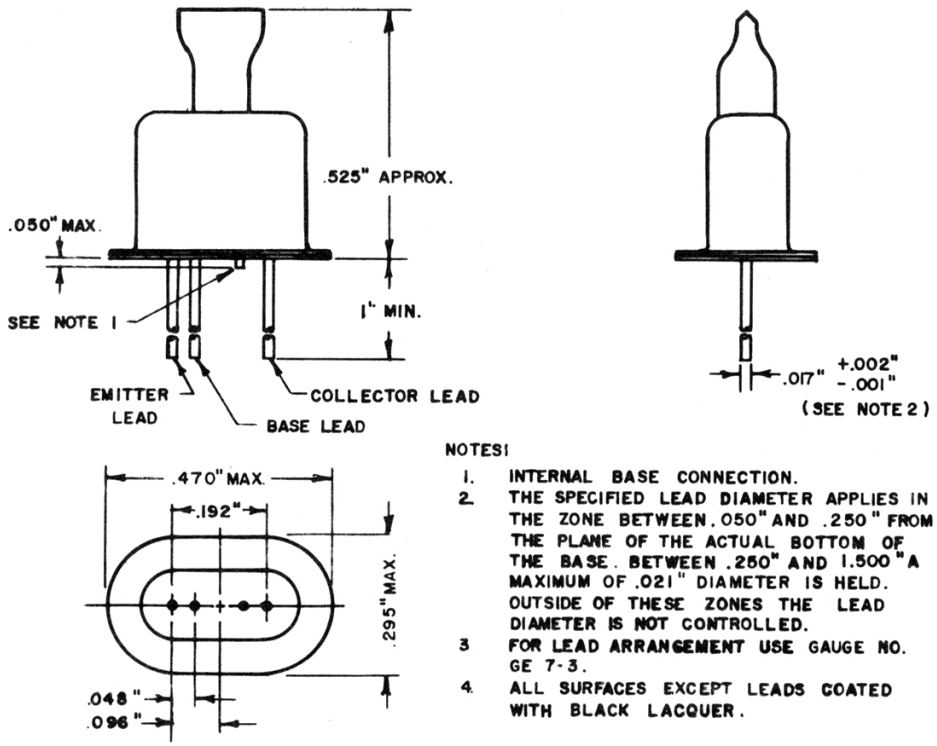
PRINTED IN U.S.A.

Issue 2
July 8, 1955

TRANSISTOR DATA SHEET
WESTERN ELECTRIC GA-52609 TRANSISTOR



DESCRIPTION

The GA-52609 is an n-p-n alloy junction transistor in a hermetically sealed can. It is designed for audio and carrier frequency transmission applications, but is also suitable for some switching applications.

GENERAL CHARACTERISTICS

Mechanical Data

Mounting position - - - - - - - - - - - - - - - - - Any

Socket - See Note 1 on page 2

Power Dissipation Characteristic

Internal temperature drop, collector junction to can - - - - - - - - - - - - - - - - - 0.4°C per mw

ABSOLUTE MAXIMUM RATINGS[2]

Current	
Intermittent to any electrode	300 ma
Continuous to any electrode	50 ma
Voltage	
Collector to base	+30 v
Emitter to base	+20 v
Total Dissipation[3]	50 mw
Ambient Temperature	85 °C

ELECTRICAL CHARACTERISTICS (at 25°C)

Small Signal Parameters (I_e=-1 ma; V_c=4.5V)

		Min.	Mode	Max.	
Short Circuit Current Multiplication Ratio	α_N or $-H_{21}$	.96*	--	.998*	
Short Circuit Current Multiplication Ratio of Inverted Transistor	α_1	--	.8	--	
Short Circuit Input Impedance	H_{11}	--	31	--	ohms
Open Circuit Feedback Voltage Ratio	H_{12}	--	17×10^{-5}	--	
Open Circuit Output Admittance	H_{22}	--	.38		µmho
Collector Capacitance (I_e = 0; V_c = 4.5V)	C_c	--	33	50*	µµf
(I_e = 0; V_c = 15V)	C_c	--	19	--	µµf
Cut-off Frequency of Alpha (I_e = -1 mA; V_c = 4.5V)	$f_{\alpha c}$	2*	3	--	mc
Noise Figure at 1000 cps (I_e=-1mA; V_c=4.5V; R_g=1000 ohms)	NF	--	7	--	db

Other Parameters

Collector Current with Open Emitter (I_e = 0; V_c = 15V)	I_c	--	4	8*	µA
(I_e = 0; V_c = 30V)	I_c	--	6	--	µA
(I_e = 0; V_c = 15V; 55°C)	I_c	--	42	75*	µA
(I_e = 0; I_c = 30 µA)	V_c	30*	43	--	v
Emitter Current with Open Collector (I_c = 0; V_e = 10V)	I_e	--	2.8	6*	µA
(I_c = 0; I_e = 20 µA)	V_e	20*	45	--	v

ELECTRICAL CHARACTERISTICS (Cont'd.)		Min.	Mode	Max.	
Element Cut-off Currents (V_{cb}= 15V; V_{eb}= 4.5V)					
Collector	I_{cR}	--	3.3	--	μA
Emitter	I_{eR}	--	.9	--	μA
Emitter Floating Potential (V_{cb}= 30V; I_e = 0)	V_{ef}	--	.07	.16*	v
R_b Test (I_c = 20 ma forward; I_e = 0)	V_{eb}	--	.6	4*	v

*Indicates manufacturer's test limits.

NOTES:

1. Leads may be cut off for socket mounting or soldered by taking precaution to protect transistor, by providing a heat sink between solder joint and can.
2. Not all may hold simultaneously.
3. At ambient temperature not greater than 60°C.
4. H_{21} is essentially constant with ambient temperature between 20°C to 95°C.

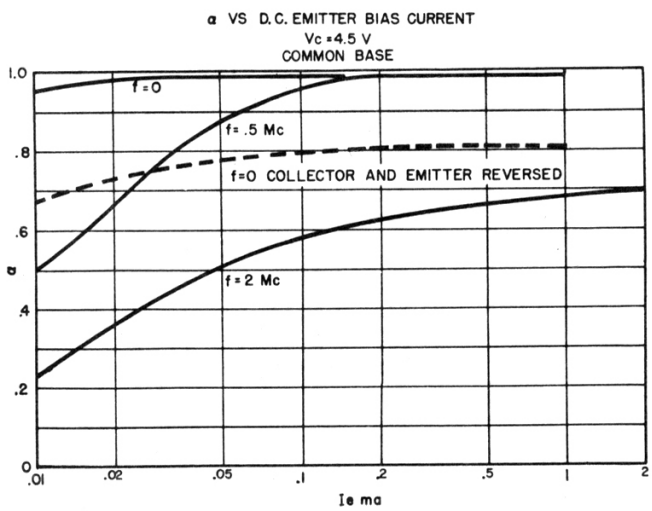


FIG. 1

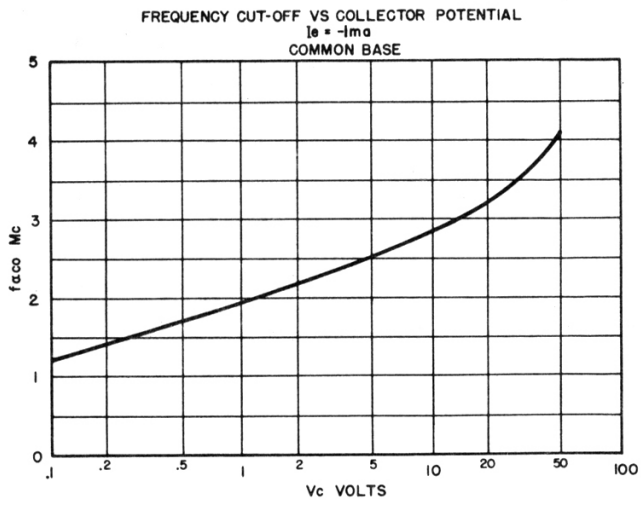


FIG. 2

Vc - Ic CHARACTERISTICS
AMBIENT TEMPERATURE OF 25° C

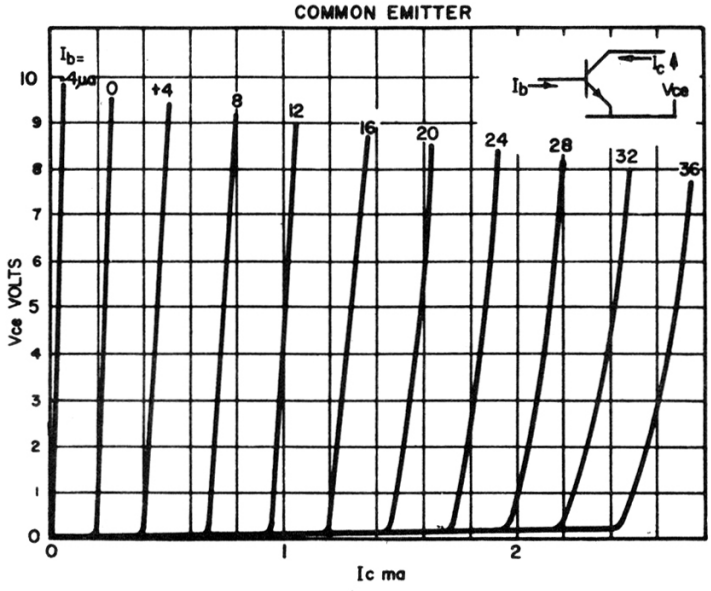


FIG. 3

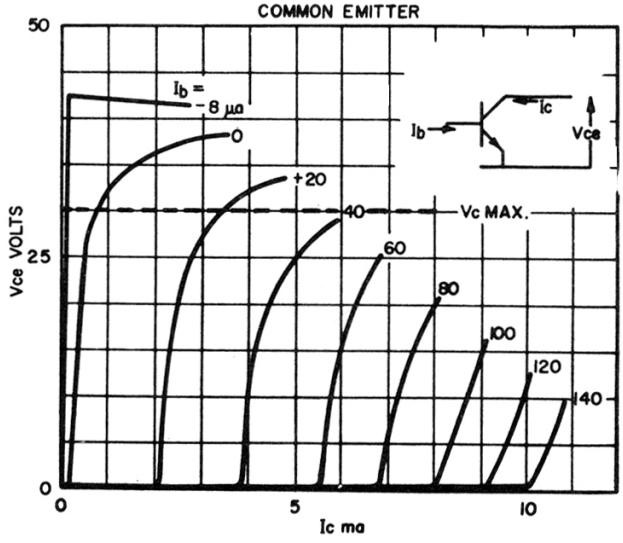


FIG. 4

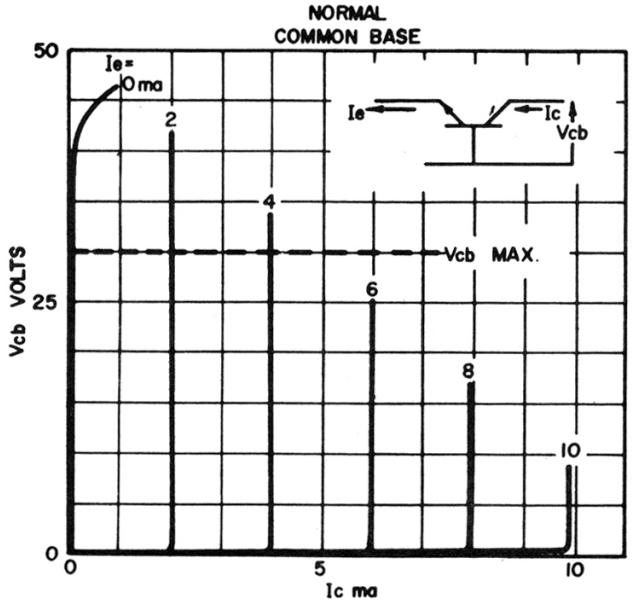


FIG. 5

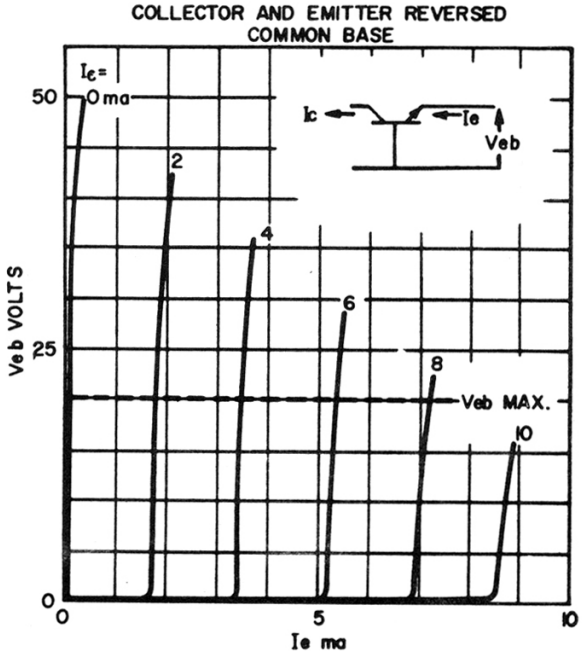


FIG. 6

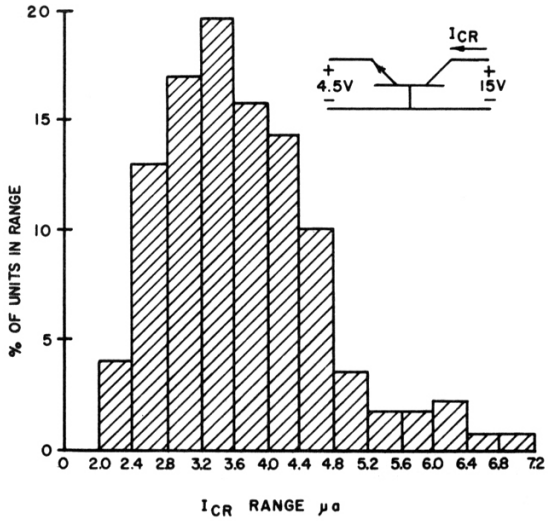


FIG. 7

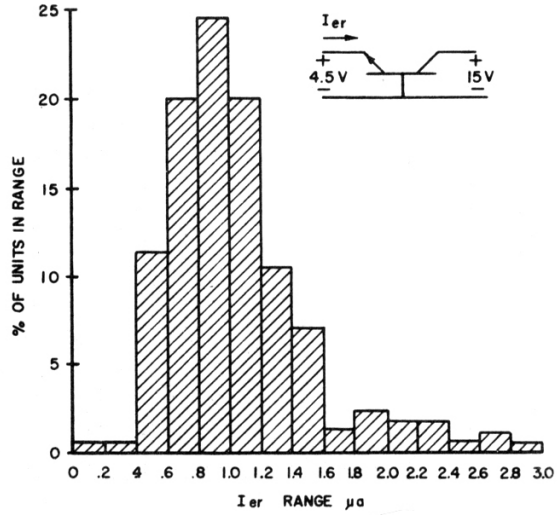


FIG. 8

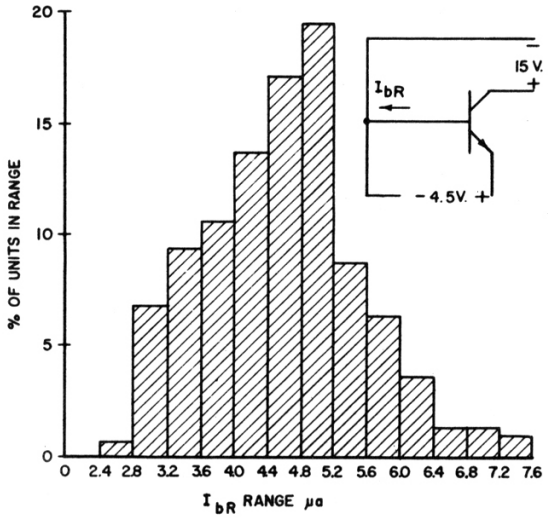


FIG. 9

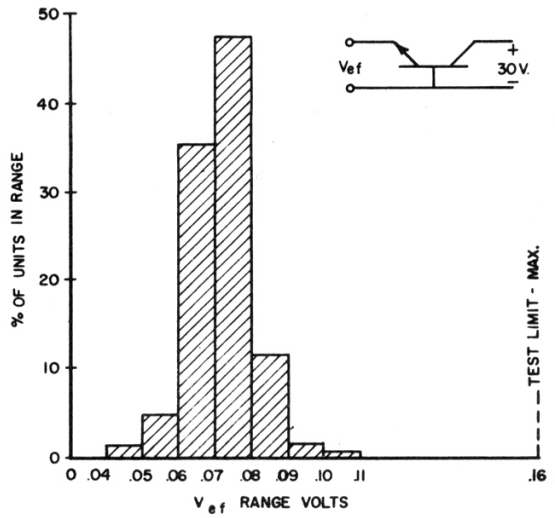


FIG. 10

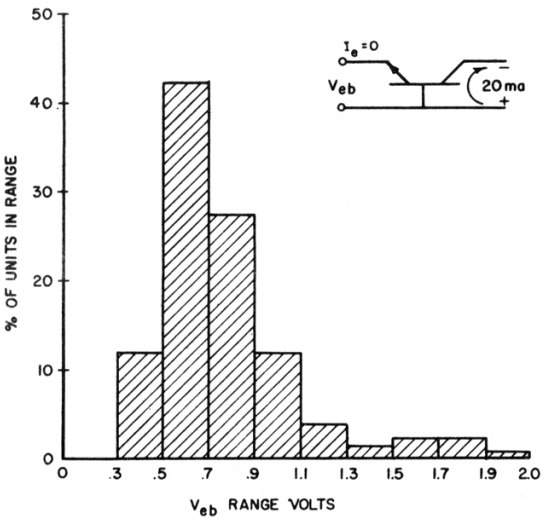


FIG. 11

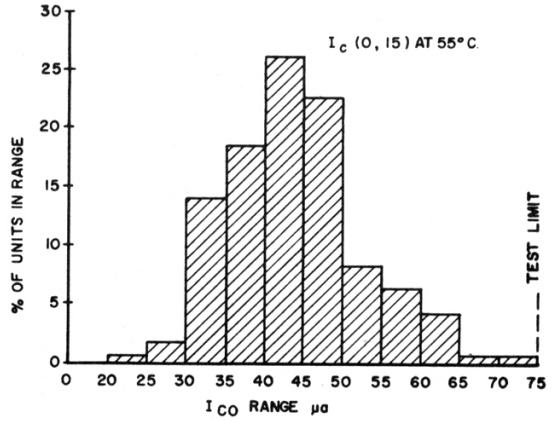


FIG. 12

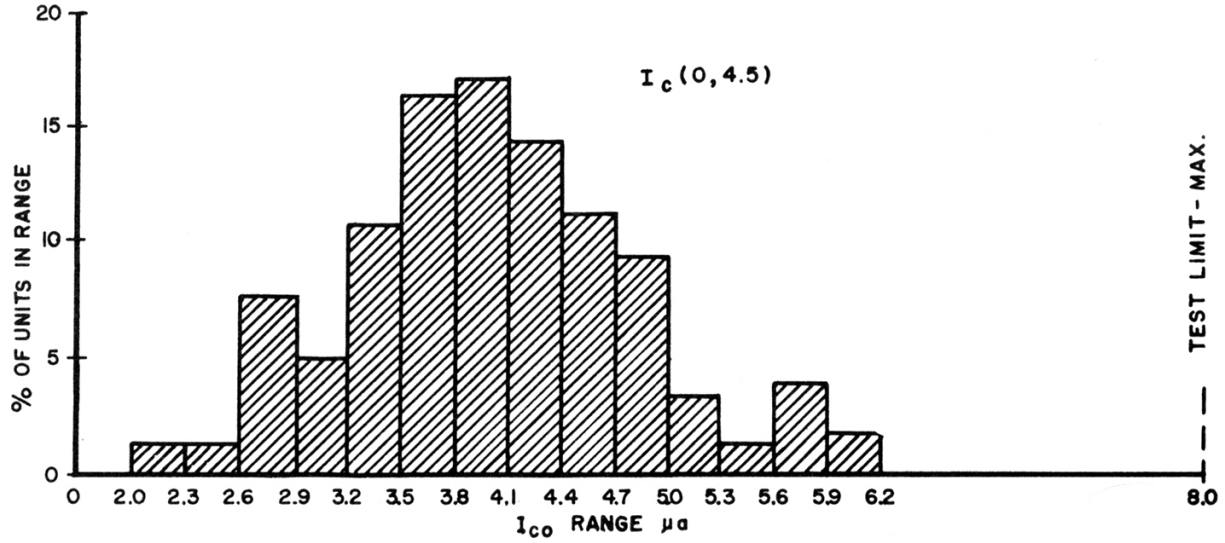


FIG. 13

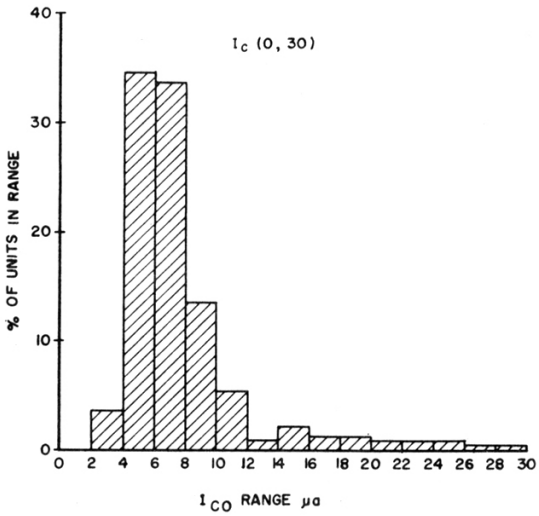


FIG. 14

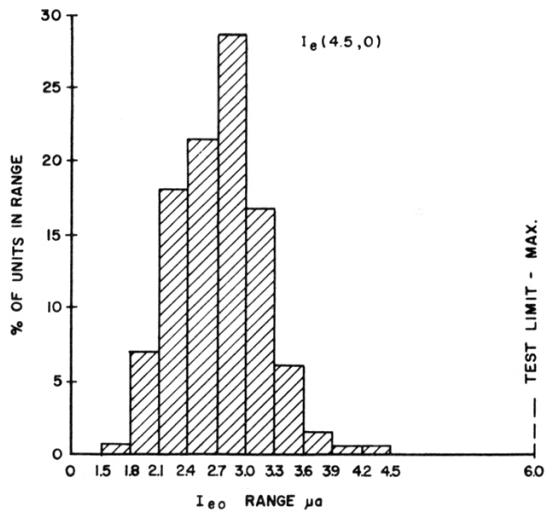


FIG. 15

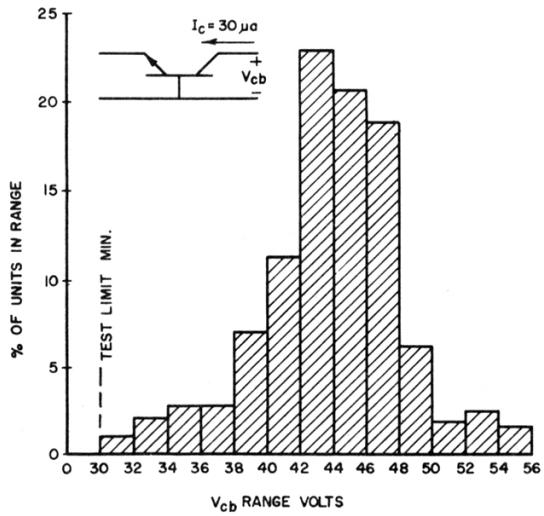


FIG. 16

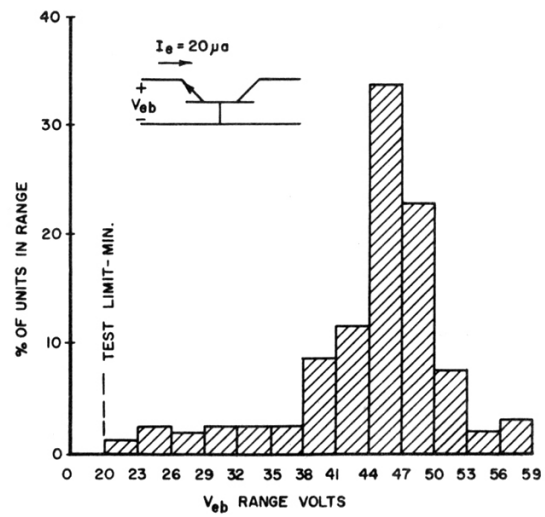


FIG. 17

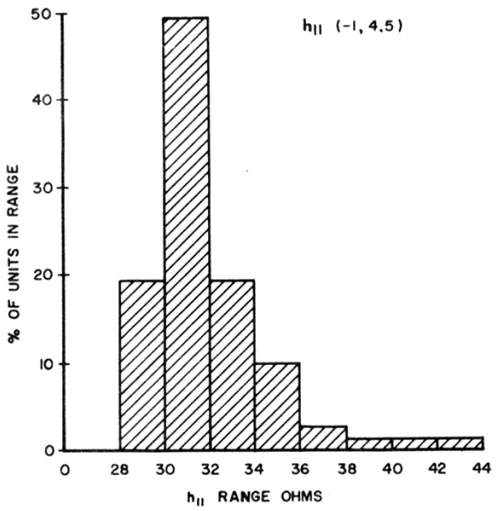


FIG. 18

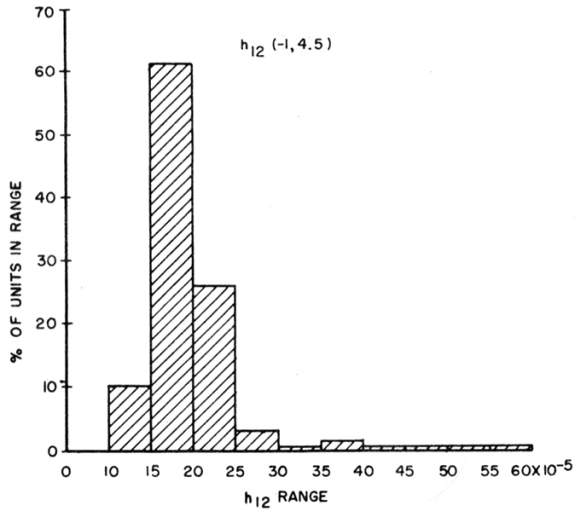


FIG. 19

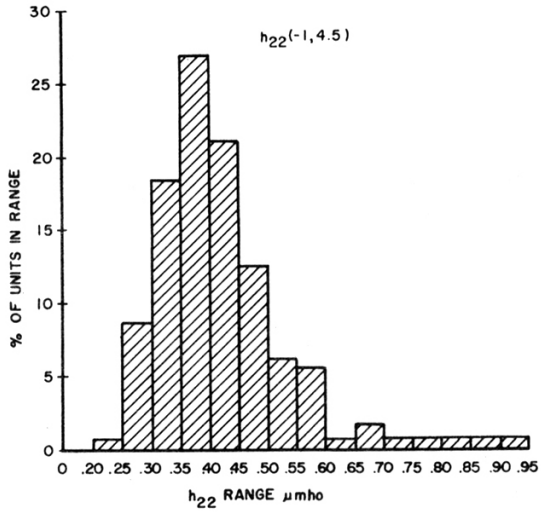


FIG. 20

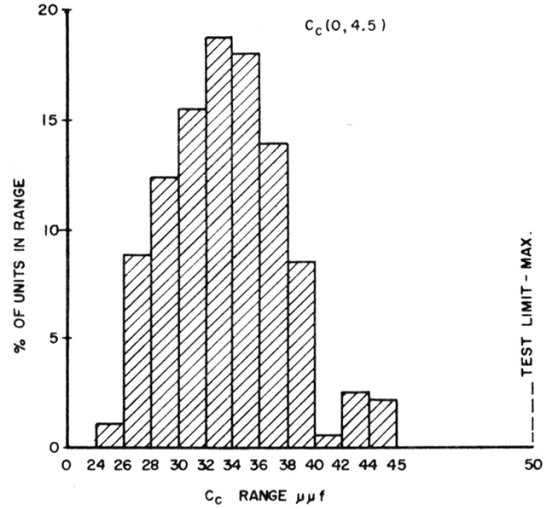


FIG. 21

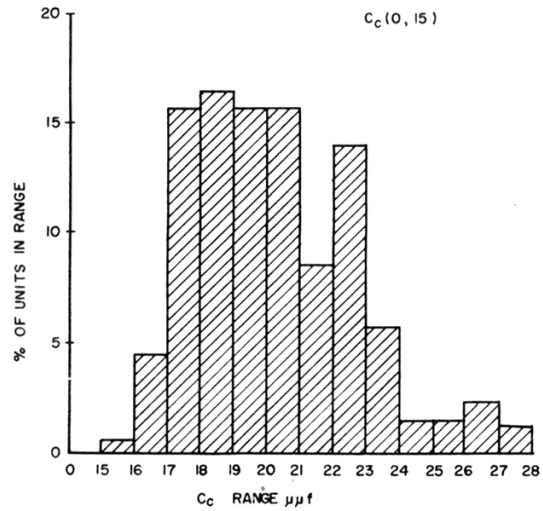


FIG. 22

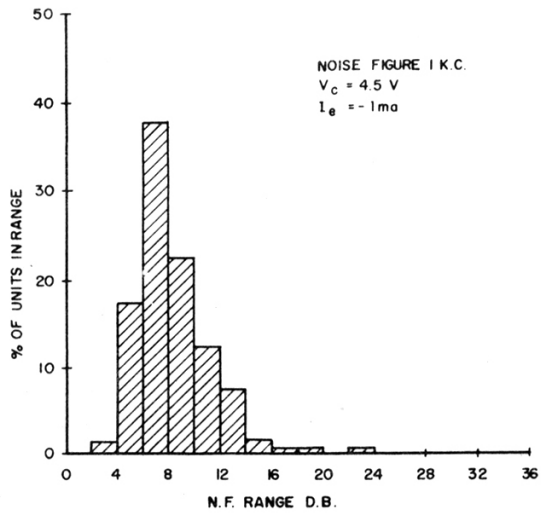


FIG. 23

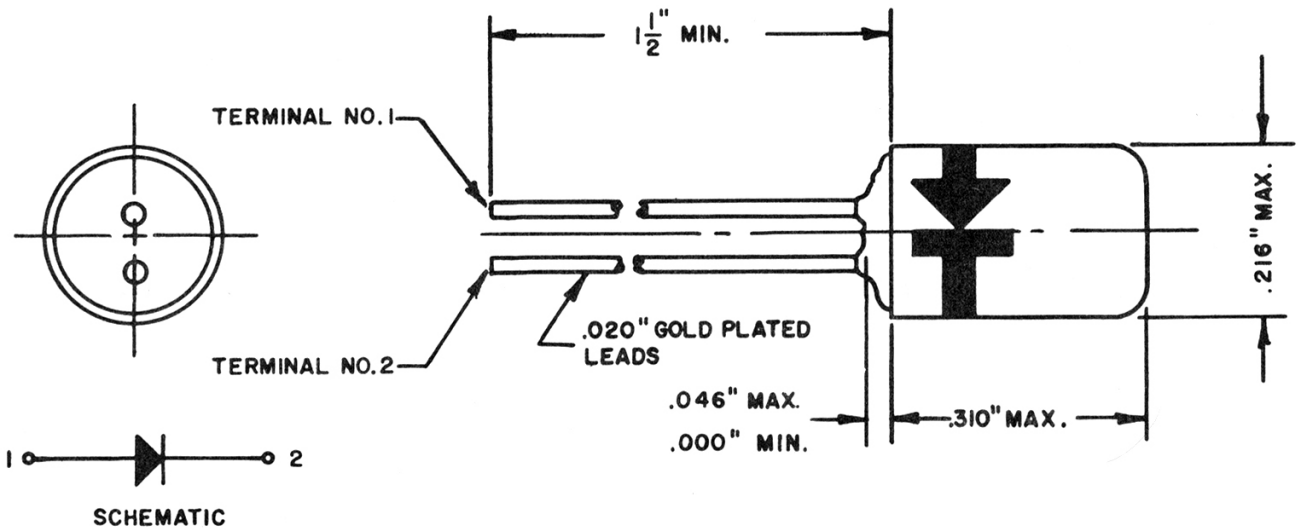
Western Electric Company

A development of Bell Telephone Laboratories, the research laboratories of the American Telephone and Telegraph Company and the Western Electric Company

PRINTED IN U.S.A.

Issue 1
June 17, 1955

VARISTOR DATA SHEET
WESTERN ELECTRIC GA-52787 VARISTOR



DESCRIPTION

The GA-52787 is a silicon alloy junction type varistor designed for use in the K-5 Radar System.

For data applying to all codes of this type varistor see General Data Sheet for Silicon Alloy Junction Varistor, type A.

MAXIMUM RATINGS (See Note 1)

Reverse Voltage	250 volts
Forward Current	
Steady State (D-C)	5 ma
Instantaneous Peak	40 ma
Breakdown Current	
Steady State (D-C)	0.5 ma
Instantaneous Peak	1.5 ma

ELECTRICAL CHARACTERISTICS (See Note 1)

	Min.	Max.	
Breakdown Voltage	120	--	volts
Forward Voltage at +5 mAdc	--	3.0	volts
Reverse Current			
at -250 Vdc, 25°C ambient	--	10^{-8}	amperes
at -250 Vdc, 85°C ambient	--	2×10^{-6}	amperes
Reverse Slope at 0.1 to 0.20 mAdc	--	3.0	volts

Note 1: Ratings and limits given are for an ambient temperature of 25°C, unless otherwise specified.

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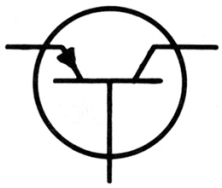
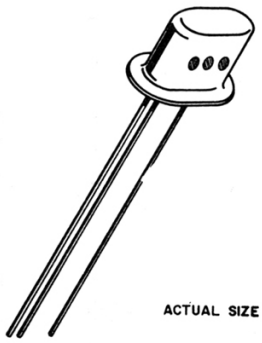
DEVELOPMENTAL

This unit is subject to change in mechanical and or electrical characteristics. Please consult Western Electric Company, Incorporated, Radio Division, 120 Broadway, New York, for current applicable design and availability.

Issue 1
December 30, 1955





ACTUAL SIZE

INTERMEDIATE TRANSISTOR DATA SHEET

WESTERN ELECTRIC GA-52829 TRANSISTOR

DESCRIPTION p-n-p ALLOY JUNCTION

Hermetically sealed transistor suitable for use in low power, high gain switching and transmission applications.

TYPICAL VALUES

α	.980
$f_{\alpha ce}$	2.8 megacycles
Vcb	-65 volts
Ico	-4.5 microamperes
Cc	22 micromicrofarads

MOUNTING AND CONNECTIONS

Unit may be mounted in any position.

When cutting leads for socketing, a shearing tool should be used.

When soldering, a heat sink should be provided between the connection and the transistor.

RECOMMENDED MAXIMA (See Note 1)

Current, continuous	50 milliamperes
Voltage	
Collector to base	-30 volts
Emitter to base	-20 volts
Collector to emitter	-30 volts
Junction Temperature	85° Centigrade

POWER DISSIPATION

Temperature drop from collector junction to:

Free air	0.5°C/mw
Heat sink on can	- °C/mw
Heat sink on leads 1/8" from can	- °C/mw

RELIABILITY

Preliminary aging studies indicate that high temperature is the primary cause of changes in characteristics. The characteristics approach an asymptote with time.

All units have been aged 48 hours at 100°C prior to final test.

NOTE 1: All of these maxima may be exceeded at the expense of transistor life.

ELECTRICAL CHARACTERISTICS (At 25°C unless otherwise specified)

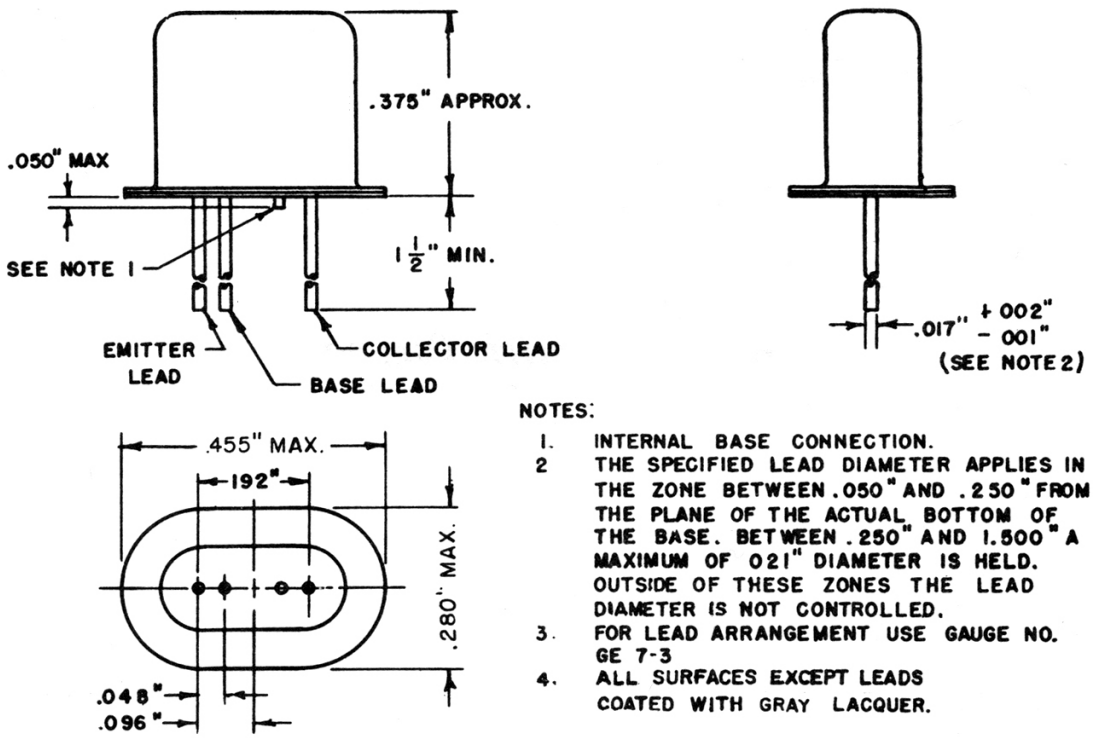
General		Min.	Median	Max.	
Current Multiplication Ratio					
(I_e = 1 mAdc, V_c = -5 Vdc)	α_N	.96	-	.996	
(V_e = -5 Vdc, I_c = 1 mAdc)	α_I	.650	-	-	
Breakdown Voltages					
(I_e = 0, I_c = -50 µAdc)	V_{cb}	-30	-	-	Vdc
(I_e = -50 µAdc, I_c = 0)	V_{eb}	-20	-	-	Vdc
(V_{be} = 0, I_c = -50 µAdc)	V_{ce}	-30	-	-	Vdc
Reverse Currents (See Note 2)					
(I_e = 0, V_c = -20 Vdc)	I_{co}	-	-4.5	-	µAdc
(I_e = 0, V_c = -15 Vdc, 45°C)	I_{co}	-	-	-50	µAdc
(V_e = -20 Vdc, I_c = 0)	I_{eo}	-	-2.5	-	µAdc
Junction Capacitance					
(I_e = 0, V_c = -5 Vdc)	C_c	-	-	50	µµfd
(V_e = -5 Vdc, I_c = 0)	C_e	-	-	-	µµfd
Frequency Cutoff					
(I_e = 1 mAdc, V_c = -10 Vdc)	$f_{\alpha ce}$	1.0	-	-	Mc
Switching					
Emitter Floating Potential					
(I_e = 0, V_c = -20 Vdc) Measured with VTVM	V_{efl}	-	-	.3	Vdc
Off Currents					
(V_e = -7.5 Vdc, V_c = -7.5 Vdc)	I_{cr}	-	-	-	µAdc
(V_e = -7.5 Vdc, V_c = -7.5 Vdc, 45°C)	I_{er}	-	-	-4.0	µAdc
On Voltages					
(I_e = 1.04 mAdc, I_c = -1.0 mAdc)	V_{ec}	-	-	-.20	Vdc
(I_e = 1.04 mAdc, I_c = -1.0 mAdc)	V_{eb}	-	-	-.30	Vdc
Transmission					
Input Impedance					
(I_e = 1 mAdc, V_c = -4.5 Vdc)	H_{11}	-	30	-	ohms
Voltage Feedback Ratio					
(I_e = 1 mAdc, V_c = -4.5 Vdc)	H_{12}	-	32	-	$x10^{-5}$

NOTE 2: Reverse currents approximately double every 12°C (21°F).

ELECTRICAL CHARACTERISTICS (Cont'd.)

		Min.	Median	Max.	
Current Multiplication Ratio (I_e = 1 mAdc, V_c = -4.5 Vdc)	$1+H_{21}$	-	.016	-	
Output Admittance (I_e = 1 mAdc, V_c = -4.5 Vdc)	H_{22}	-	.37	-	μmhos
Noise Figure (I_e = 1 mAdc, V_c = -4.5 Vdc) (f = 1 kc, R_g = 1 kΩ)	NF	-	11.5	-	db

DIMENSIONAL OUTLINE



NOTES:

1. INTERNAL BASE CONNECTION.
2. THE SPECIFIED LEAD DIAMETER APPLIES IN THE ZONE BETWEEN .050" AND .250" FROM THE PLANE OF THE ACTUAL BOTTOM OF THE BASE. BETWEEN .250" AND 1.500" A MAXIMUM OF 021" DIAMETER IS HELD. OUTSIDE OF THESE ZONES THE LEAD DIAMETER IS NOT CONTROLLED.
3. FOR LEAD ARRANGEMENT USE GAUGE NO. GE 7-3
4. ALL SURFACES EXCEPT LEADS COATED WITH GRAY LACQUER.

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Western Electric Company

DEVELOPMENTAL

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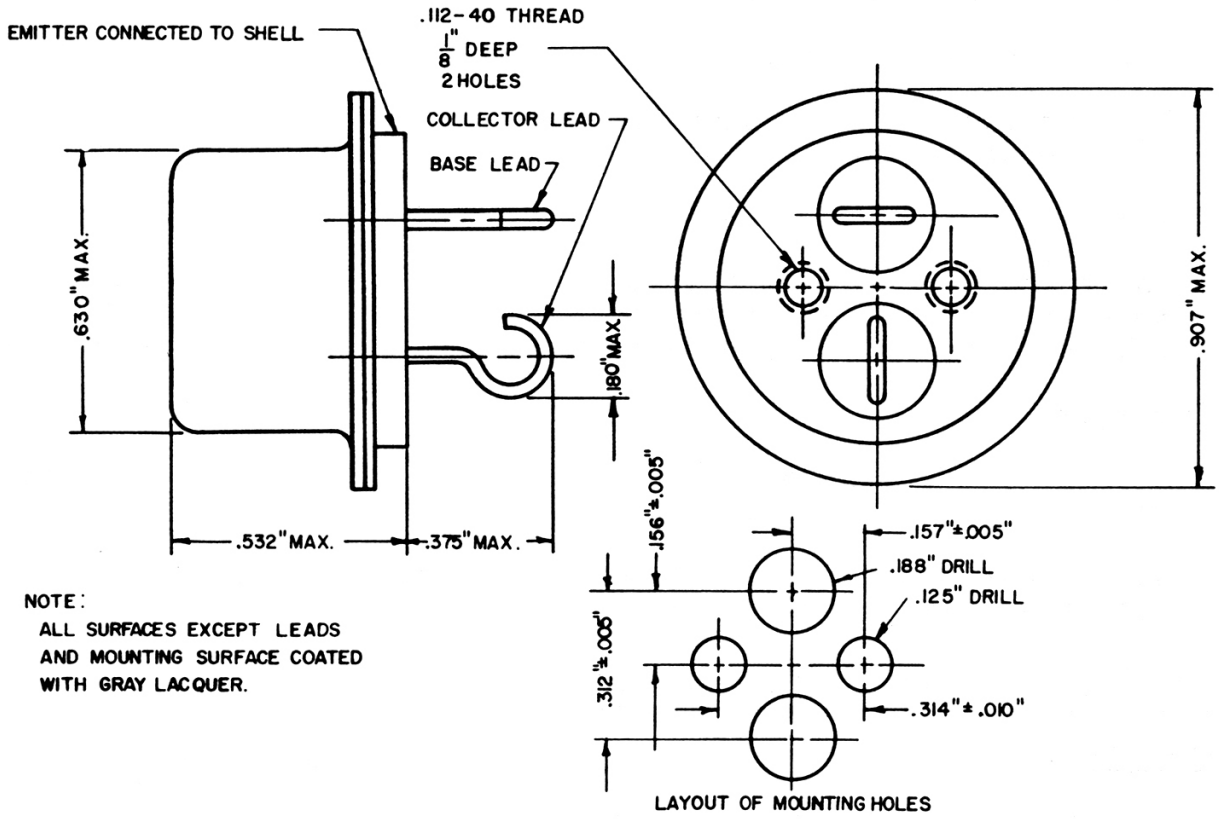
Issue 2
September 16, 1955

INTERMEDIATE TRANSISTOR DATA SHEET
WESTERN ELECTRIC GA-52830 TRANSISTOR
(DEVELOPMENT MODEL 2012)

THIS TRANSISTOR IS BEING MADE BY WESTERN ELECTRIC COMPANY IN LIMITED QUANTITIES FOR DEVELOPMENT USE ONLY.



NOTE:
ALL SURFACES EXCEPT LEADS AND MOUNTING SURFACE COATED WITH GRAY LACQUER.

DESCRIPTION

The GA-52830 transistor is of the fused junction, p-n-p type. Depending on the effectiveness of the heat sink to which it is attached, it is capable of about one-half watt dissipation. The minimum alpha cut-off frequency of four megacycles makes this a useful transistor for broad-band amplifiers and high speed switching.

MECHANICAL DATA

Mounting (See Note 1) - - - - - - - - - - - - - - - - - - Any position

Dimensions and Connections- - - - - - - - - -See outline on page 1

MAXIMUM RATINGS (Continuous Duty)

Dissipation

Internal temperature rise, mounting surface to collector junction	24°C/watt
Temperature rise on typical mountings, 3"x3"x1/16" Aluminum or Copper plate	40°C/watt
Maximum collector junction temperature	80°C
I_{co} approximately doubles for each temperature increase of	9°C

Voltage*

Collector to base, emitter open	40 volts
Emitter to base, collector open	40 volts
Collector to emitter, base open	20 volts

Current*

Emitter and collector	500 ma
Base	50 ma

*The voltage and current ratings apply only if the dissipation is not excessive.

STATIC MEASUREMENTS (25°C ambient)

Junctions		Min.	Max.	
Collector Current with Open Emitter				
(I_e = 0, V_{cb} = -4.5 volts)	I_c		10	µa
(I_e = 0, V_{cb} = -40 volts)	I_c		100	ua
Emitter Current with Open Collector				
(I_c = 0, V_{eb} = -4.5 volts)	I_e		10	µa
(I_c = 0, V_{eb} = -40 volts)	I_e		100	µa
Electrical Reach-through				
(I_e = 0, V_{cb} = -40 volts) Emitter floating potential test measured with 20,000 ohms/volt meter	V_e		1.0	volt
Voltage for Alpha = 1				
(I_c = 20 ma, I_b = 0)	V_{ce}	20		volts
Minimum Collector Voltage				
(I_b = 20 ma, I_c = 200 ma)	V_{ce}		0.25	volt

STATIC MEASUREMENTS (Cont'd.)

		Min.	Max.	
Base Input Voltage				
(I_b = 20 ma, I_c = 0)	V_{be}	---	1	volt
Base Input Current				
(I_c = 200 ma, V_c = -1 volt)	I_b	---	10	ma
(I_c = 400 ma, V_c = -1 volt)	I_b	---	30	ma

SMALL SIGNAL MEASUREMENTS (25°C ambient)

Common Emitter Short Circuit Current Gain				
(I_c = 20 ma, V_c = -4.5 volts) Test frequency 5Kc/s or lower	$\frac{\alpha}{1-\alpha}$	50	---	
Effective Alpha Cut-off Frequency (See Note 2)				
(I_c = 20 ma, V_c = -4.5 volts)	f_α	4	---	mc/s
(I_c = 200 ma, V_c = -1 volt)	f_α	2	---	mc/s
Inverted Common Emitter Current Gain				
(I_c = 200 ma, V_c = -1 volt) Emitter and Collector interchanged	$\frac{\alpha}{1-\alpha}$	2.3	---	

SMALL SIGNAL PARAMETERS (25°C ambient)

(I_e = 1 ma, V_c = -4.5V)

		Typical	
Short Circuit Input Impedance	H_{11}	28	ohms
Open Circuit Feedback Voltage Ratio	H_{12}	5×10^{-4}	
Short Circuit Current Multiplication Ratio	H_{21}	-0.99	
Open Circuit Output Admittance	H_{22}	5	µmhos
Base Resistance for 1-α Current	r_b	100	ohms
Short Circuit Current Multiplication (I_c = 20 ma, V_c = -4.5 volts)	α	0.99	
Collector Capacitance (V_c = -4.5 volts)	C_c	40	µµfd

Note 1: Two .112-40 tapped holes are provided in bottom of transistor for mounting. Adequate heat sink must be provided. Care should be taken to get good contact between transistor and heat sink.

Note 2: The effective alpha cut-off frequency is the product of the low frequency, common-emitter, short-circuit current transfer ratio and the 3db cut-off frequency of that ratio. Ideally: $(\alpha/1-\alpha) \times (1-\alpha) f\alpha \doteq f\alpha$.

Reasons for reissue: The collector voltage for certain tests at 20 ma collector current was incorrectly given as one volt and is corrected to -4.5 volts. The upper limit on base current for 400 ma collector current has been reduced from 40 ma to 30 ma. The high alpha of this transistor also required a change in the emitter floating potential test for electrical reach-through. The theoretical floating potential of 0.1 to 0.3 volts given by the formula .026 ln $(1-\alpha)$ is observed at low voltages. To avoid confusing this normal voltage with the reach-through effect, the reach-through voltage is to be measured at an emitter floating potential of one volt. No significant change in the collector reach-through voltage limit is implied.

A development of Bell Telephone Laboratories, the research laboratories of the American Telephone and Telegraph Company and the Western Electric Company

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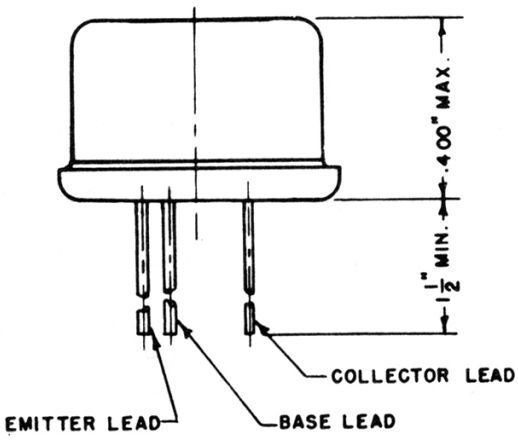
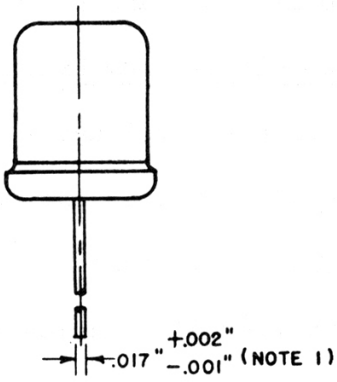
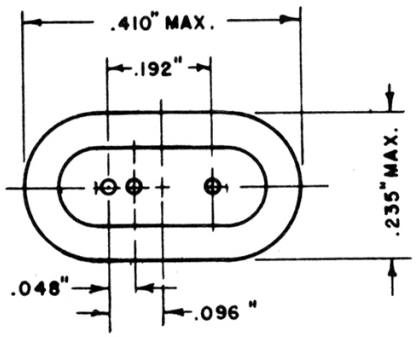
Issue 1
December 30, 1955

TRANSISTOR DATA SHEET
WESTERN ELECTRIC GA-52837 TRANSISTOR
(DEVELOPMENT MODEL 1893)







NOTES 1- THE SPECIFIED LEAD DIAMETER APPLIES IN THE ZONE BETWEEN .050" AND .250" FROM THE BASE SEAT. BETWEEN .250" AND 1.500" A MAXIMUM OF .021" DIAMETER IS HELD. OUTSIDE OF THESE ZONES THE LEAD DIAMETER IS NOT CONTROLLED.

2- FOR LEAD SPACING TOLERANCES, USE JETEC GAUGE NO. GE 7-3.

DESCRIPTION

The GA-52837 is a point contact transistor triode in an hermetically sealed enclosure. It is designed for use in switching circuits where the large-signal parameters of the active device are of primary interest. It is similar to the 2N21 transistor. Its mechanical features are such that it is considered suitable for severe military use.

GENERAL CHARACTERISTICS

Mechanical Data

Mounting position - any

Socket - See Note 1

Dimensions and pin connections - - - - - - - - - - - - - See Outline Page 1

Absolute Maximum Ratings (See Note 2)

Collector voltage - - - - - - - - - - - - - - - -	V_c	-100 volts
Collector dissipation - - - - - - - - - - - - - -	P_c	120 milliwatts
Emitter voltage - - - - - - - - - - - - - - - - -	V_e	-100 volts
Emitter dissipation - - - - - - - - - - - - - - -	P_e	90 milliwatts (+85°C
Ambient storage temperature - - - - - - - - - -		(-55°C
Shock -		500 g

Suggested Design Maximums (See Note 2)

Collector current - - - - - - - - - - - - - - - -	I_c	-40 ma
Emitter current - - - - - - - - - - - - - - - - -	I_e	+40 ma

ELECTRICAL CHARACTERISTICS (See Note 3)

Large Signal Parameters		Min.*	Max.*	
Collector Current (I_e = 0 mAdc; V_c = -20 Vdc)	I_c	-	-2.2	mAdc
Collector Current (I_e = 6.0 mAdc; V_c = -5 Vdc)	I_c	-12.5	-	mAdc
Emitter Current (V_e = -10 Vdc; I_c = 0 mAdc)	I_e	-	-0.1	mAdc
Small Signal Parameters				
Open Circuit Reverse Transfer Impedance (I_e = 1.0 mAdc; V_c = -10 Vdc)	Z_{12}	-	350	ohms
Open Circuit Output Impedance (I_e = 1.0 mAdc; V_c = -10 Vdc)	Z_{22}	8K	-	ohms
Current Multiplication Ratio Cut-off Frequency Test (See Note 4) (I_e = 1.0 mAdc; V_c = -10 Vdc)	$f_{\alpha ce}$	5.0	10.0	mc

Special Tests

Characteristic Curve Anomalies (See Note 5 and figures 1, 2 & 3)

Hermetic Seal Test (See Note 6)

* Manufacturer's test specification limit.

Note 1: The external connections meet the requirements for JETEC Base Standard E3-15 and will fit a 5 pin in-line subminiature tube socket, or its equivalent, when the lead length, as measured from the transistor base, is reduced to 0.200". A shearing tool should be used for this purpose.

Note 2: Electrical ratings are on the basis of any duration longer than the order of 50 microseconds at an ambient temperature of 25 ± 5°C. An individual maximum rating may not be achievable because of other parameter limitations.

Note 3: Ambient Temperature 25°C. Modal values are those which occur most frequently.

Note 4: Cut off is defined as the frequency at which the current amplification is 3 db below its low frequency reference value. Reference frequency is approx. 100kc.

Note 5: With emitter and collector load resistances of 1000 ohms and a sweep frequency of 60 cps the static output characteristic curves (with emitter current as the parameter) shall, when examined within the operating region outlined in figure 1, show no anomalies greater than those permitted by figures 2 and 3.

Note 6: The transistor is subjected to an ambient temperature of +110°C for a 15 minute period at atmospheric pressure. Upon completion of this exposure the transistor must be free from impregnant visible to the eye, or perceptible to the touch on the exterior surface.

Operating Precaution

The transistor should not be subjected to service in which excessive transients might cause the ratings of the device to be exceeded, such as may result from inserting the transistor into or removing it from the socket with the power on. Base contact should be made first. If solder connections are made to the transistor leads, heat sink protection on the transistor side of the joint should be provided, as with flat nose pliers. When cutting leads for socketing, a shearing tool or a clamp between the unit and the transistor should be used.

Operation of the transistor as a linear device in the region of emitter biases between voltage cut-off and saturation is not recommended due to anomalies which appear in this range in some transistors. An anomaly can be defined as a condition in the output characteristics when, for a fixed value of emitter current, the collector voltage can be a multiple valued function of the collector current or the collector current can be a multiple valued function of the collector voltage.

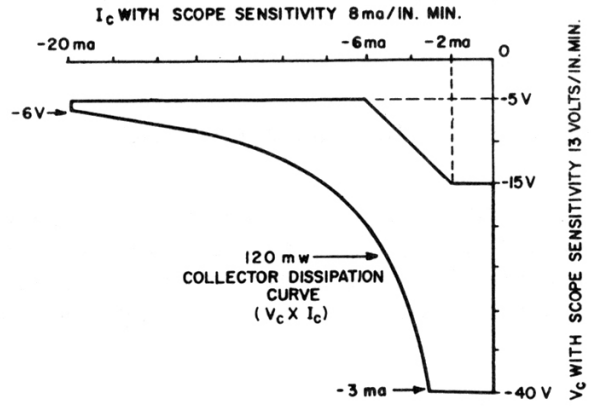


FIG. 1

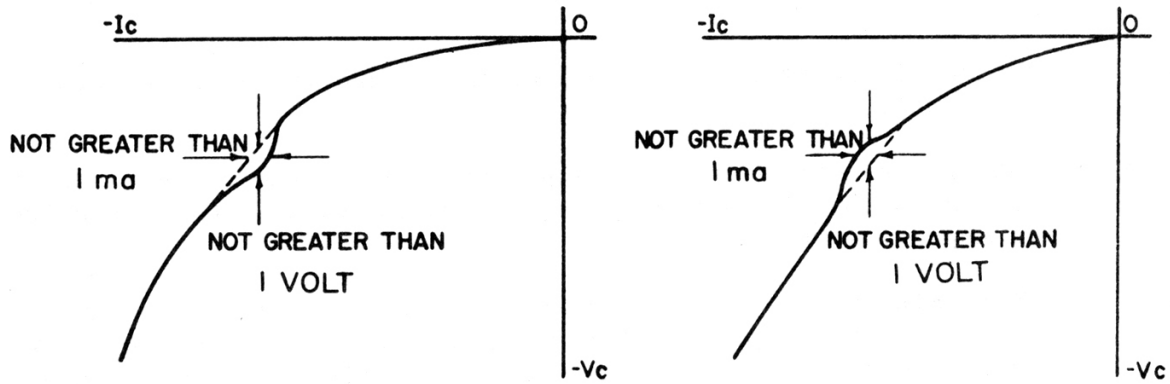


FIG. 2

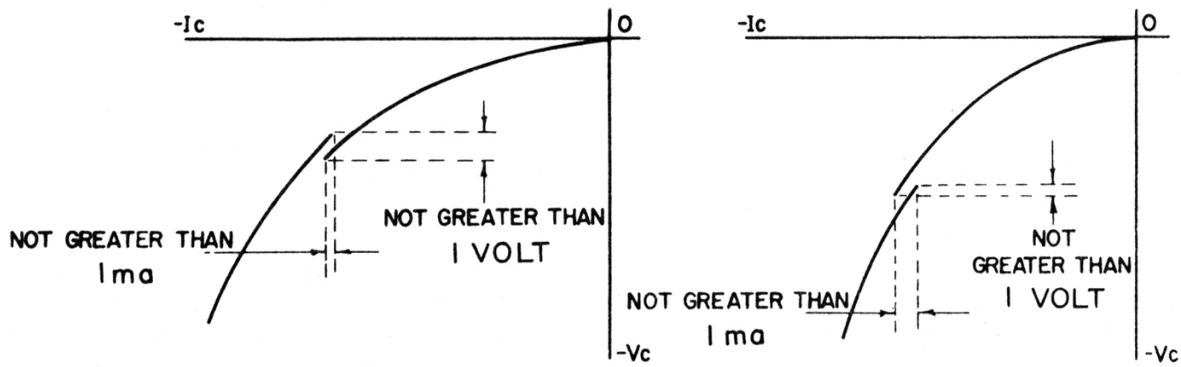


FIG. 3

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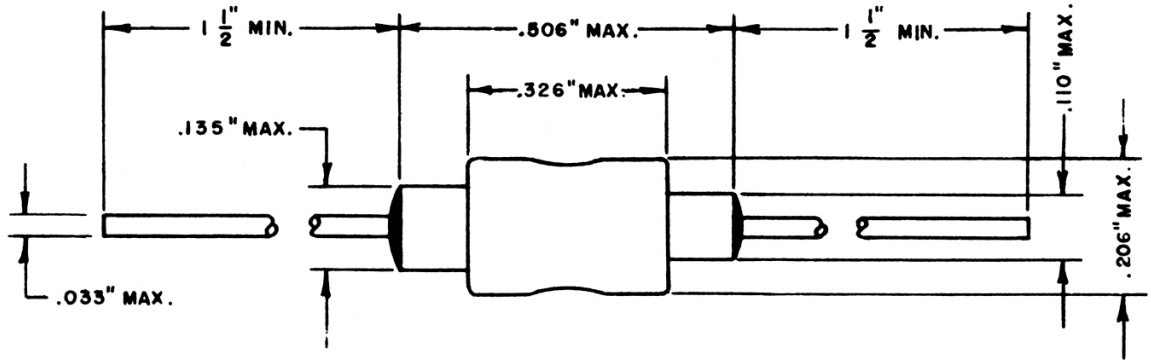
Issue 1
December 30, 1955

INTERMEDIATE VARISTOR DATA SHEET
WESTERN ELECTRIC
GA-52838, GA-52843, GA-52844 AND GA-52942 VARISTORS



SCHEMATIC

DESCRIPTION

These varistors are glass enclosed hermetically sealed silicon alloy junction diodes.

For data applying to all codes of this type varistor see General Data Sheet for Silicon Alloy Junction Varistors, type B.

MAXIMUM RATINGS

	GA-52838	GA-52843	GA-52844	GA-52942	
Power Dissipation	.5	.5	.5	.5	watt
Forward Current Instantaneous Peak (Note 1)	600	450	900	600	ma

SUGGESTED DESIGN MAXIMUM RATINGS

Reverse Voltage for Rectifier Application (Note 2)	160	200	10	120	volts
Forward Current Steady State (dc)	200	150	300	200	ma
Breakdown Current Instantaneous Peak (Note 2)	7.5	6.0	90.0	9.0	ma
Breakdown Current Steady State (dc) (Note 2)	2.5	2.0	30.0	3.0	ma

TABLE OF ELECTRICAL CHARACTERISTICS (AT 25°C ambient)

Code	Reverse Breakdown Voltage at 0.5×10^{-3} amp.	Maximum Reverse Current	Maximum Forward Voltage
	Volts	Amperes	Volts
GA-52838	200 min.	10^{-6} at 160 V	2.0 at 0.1 amp.
GA-52843	250 min.	10^{-6} at 200 V	3.0 at 0.1 amp.
GA-52844	16 min.	10^{-7} at 10 V	(1.1 at 0.1 amp.) (1.5 at 0.3 amp.)
GA-52942	150 min.	10^{-6} at 120 V	1.5 at 0.1 amp.

NOTE 1: These values are given on the basis of pulse durations of less than 25 milliseconds and allow a peak dissipation of 1.5 watts.

NOTE 2: For those codes which do not have a maximum voltage breakdown specified:

a) the maximum breakdown current depends on the characteristics of individual units and has been computed on the basis of a peak dissipation of 1.5 watts for times shorter than 25 milliseconds. For longer times the dissipation should not exceed 0.5 watts at 60°C. The current in this case has been computed on the basis of the minimum voltage breakdown found in the particular code.

b) the maximum reverse voltage for rectifier applications can be computed as 0.8 times the voltage breakdown of the individual units. The values given are computed on the basis of the minimum voltage breakdown obtainable from a given code.

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DEVELOPMENTAL

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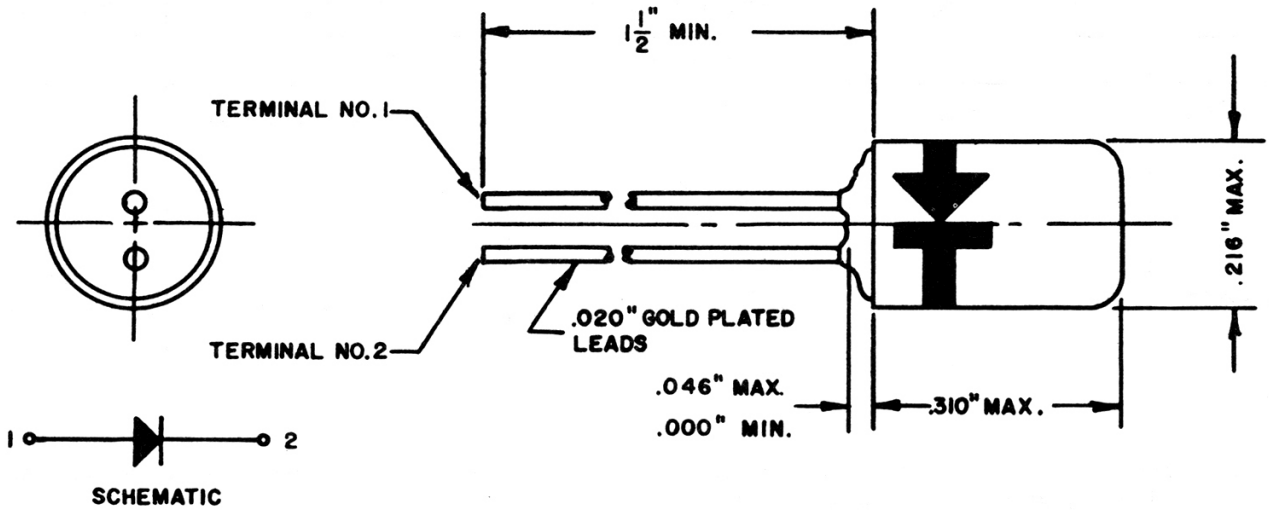
Issue 1
December 30, 1955

INTERMEDIATE VARISTOR DATA SHEET
WESTERN ELECTRIC GA-52861 AND GA-52865 VARISTORS



DESCRIPTION

These varistors are silicon alloy junction type diodes.

For data applying to all codes of this type varistor see General Data Sheet for Silicon Alloy Junction Varistors, type A.

MAXIMUM RATINGS

	GA-52861	GA-52865	
Power Dissipation (60°C)	125	125	mw
Forward Current			
Instantaneous Peak (Note 1)	75	90	ma

SUGGESTED DESIGN MAXIMUN RATINGS (AT 25°C ambient)

Reverse Voltage for Rectifier Application (Note 2)	200	80	volts
Forward Current Steady State (dc)	25	30	ma
Breakdown Current Instantaneous Peak (Note 2)	1.5	3.75	ma
Breakdown Current Steady State (dc) (Note 2)	0.5	1.25	ma

TABLE OF ELECTRICAL CHARACTERISTICS (AT 25°C ambient)

Code	Reverse Breakdown Voltage 0.2×10^{-3} amp.	Maximum Reverse Current	Maximum Forward Voltage	Maximum Reverse Slope
	Volts	Amperes	Volts	
GA-52861	250 min.	5×10^{-9} at 200 V 125×10^{-9} at 200 V at 70°C	0.75 ± 0.1 at 5×10^{-4} amp.	
GA-52865	100-165	10^{-8} at 80 V	1.5 at 0.005 amp.	3V at $(7.5 \times 10^{-4}$ amp. $(5 \times 10^{-4}$ amp.

NOTE 1: These values are given on the basis of pulse durations of less than 25 milliseconds and allow a peak dissipation of 375 mw.

NOTE 2: For those codes which do not have a maximum voltage breakdown specified:

a) the maximum breakdown current depends on the characteristics of individual units and has been computed on the basis of a peak dissipation of 375 mw for times shorter than 25 milliseconds. For longer times the dissipation should not exceed 125 mw at 60°C. The current in this case has been computed on the basis of the minimum voltage breakdown found in the particular code.

b) the maximum reverse voltage for rectifier applications can be computed as 0.8 times the voltage breakdown of the individual units. The values given are computed on the basis of the minimum voltage breakdown obtainable from a given code.

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DEVELOPMENTAL

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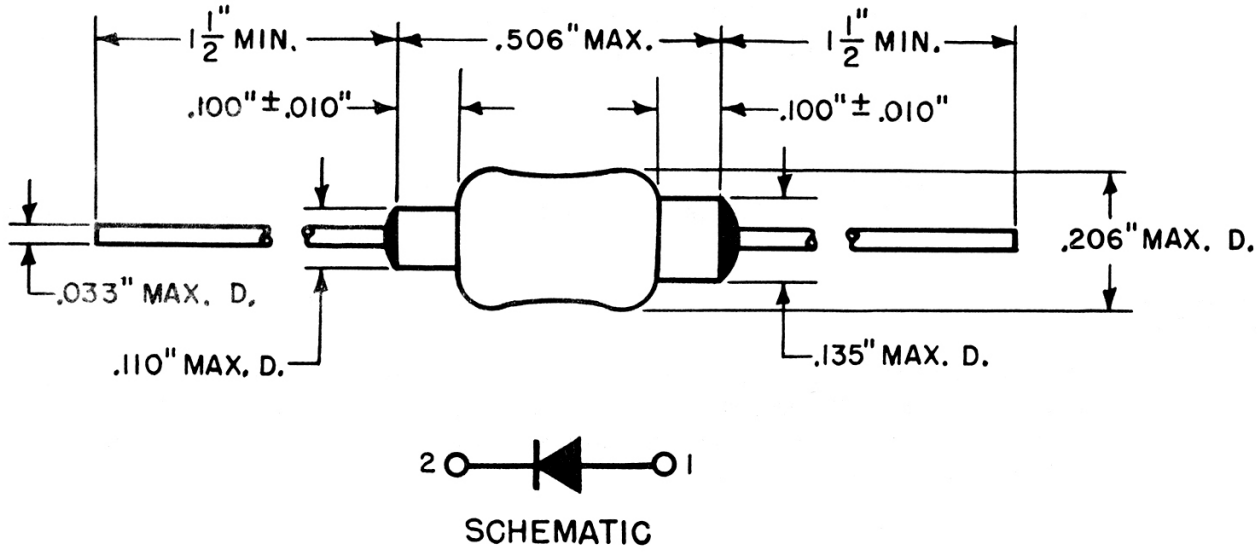
Issue 3
June 4, 1956

INTERMEDIATE VARISTOR DATA SHEET
WESTERN ELECTRIC GA-52931 VARISTOR

THIS VARISTOR IS BEING MADE BY WESTERN ELECTRIC COMPANY IN LIMITED QUANTITIES FOR DEVELOPMENT USE ONLY.



SCHEMATIC

DESCRIPTION

The GA-52931 Varistor is a voltage-limiting diffused silicon diode. It is characterized by a specified voltage breakdown, and low a-c impedance while in the voltage limiting condition.

GENERAL CHARACTERISTICS

Power Dissipation	0.5 watt
Mechanical Data	
Mounting Position	Any
Storage Temperature	-40°C to +135°C
Dimensions and Polarity	See outline drawing

ELECTRICAL CHARACTERISTICS

Breakdown Voltage	12 ± 1 v
Max. Current at 80% of Breakdown Voltage	20 μa
Max. Average Current in Breakdown Condition	40 ma
Max. Peak Current (10x900 μ sec. pulse)	3.0 a
Max. Permissible Case Temperature	135°C

Typical Values

AC Impedance at 10 ma in Breakdown Condition	6.0 ohms
Temp. Coef. of Breakdown Voltage	+0.07%/°C

CAUTION

The effective resistance of this diode is quite low above the breakdown voltage. Destructive currents will flow if the device is connected directly to a low impedance power source having an output voltage above 12 volts.

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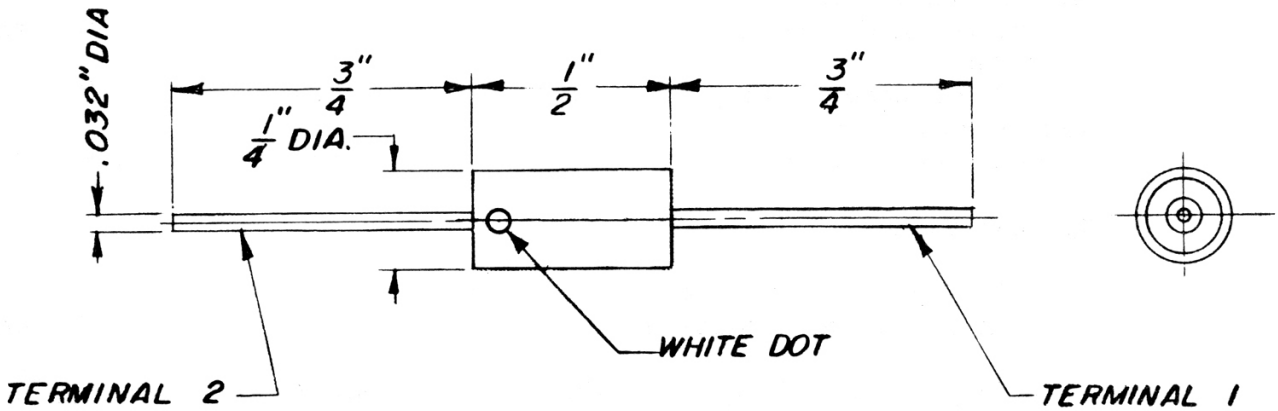
DEVELOPMENTAL

This unit is subject to change in mechanical and or electrical characteristics. Please consult Western Electric Company, Incorporated, Radio Division, 120 Broadway, New York, for current applicable design and availability.

Issue 2
April 23, 1956

INTERMEDIATE VARISTOR DATA SHEET
WESTERN ELECTRIC
GA-52932, GA-52933 AND GA-52934 VARISTORS

THIS VARISTOR IS BEING MADE BY WESTERN ELECTRIC COMPANY IN LIMITED QUANTITIES FOR DEVELOPMENT USE ONLY.



SCHEMATIC

DESCRIPTION

The GA-52932, GA-52933 and GA-52934 Varistors are voltage-limiting diffused silicon diodes. They are characterized by specified voltage breakdowns, and low ac impedances while in the voltage limiting condition.

GENERAL CHARACTERISTICS

Power Dissipation . . . . . (approx.) 1.0 watt

Mechanical Data

Mounting Position	Any
Storage Temperature	-40°C to +135°C
Dimensions and Polarity	See outline drawing

ELECTRICAL CHARACTERISTICS

	GA-52932	GA-52933	GA-52934	
Breakdown Voltage	15 ± 1	18 ± 1	20 ± 1	v
Max. Current at 80% V_B	10	10	10	μa
Max. Average Current in Breakdown Condition	60	55	50	ma
Peak Current (10x900 μsec. pulse)	2.5	2.0	1.8	a
Max. Permissible Case Temperature	135	135	135	°C
Typical Values				
AC Impedance at 10 ma in Breakdown Condition	7	7	7	ohms
Temp. Coef. of V_B	+0.07	+0.07	+0.07	%/°C

CAUTION

The effective resistance of these diodes is quite low above the breakdown voltage. Destructive currents will flow if they are connected directly to a low impedance power source having an output voltage above the specified breakdown voltage of the diode.

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DEVELOPMENTAL

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Issue 1
December 30, 1955

INTERMEDIATE VARISTOR DATA SHEET
WESTERN ELECTRIC GA-52935 VARISTOR

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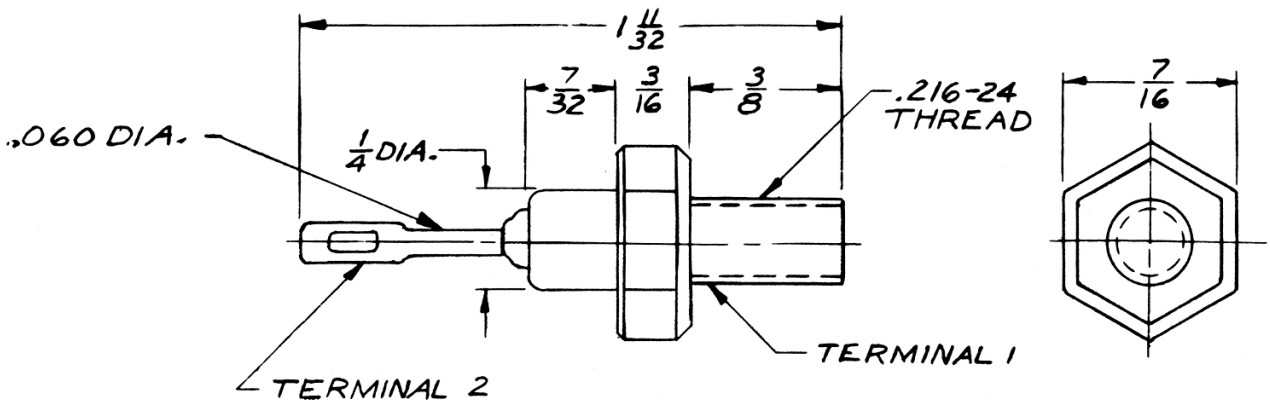

SCHEMATIC

DESCRIPTION

The GA-52935 Varistor is a voltage-limiting diffused silicon diode. It is characterized by a specified voltage breakdown, and low a-c impedance in the voltage limiting condition.

GENERAL CHARACTERISTICS

Power Dissipation

Without heat sink	1.0 watt
With adequate heat sink (See Note 1) .	3.0 watts

Mechanical Data

Mounting Position	Any
Storage Temperature	-40°C to +135°C
Dimensions and Polarity	See outline drawing
Handling	See Note 2

ELECTRICAL CHARACTERISTICS .

Breakdown Voltage	150 ± 20 v
Max. Current at 80% of Breakdown Voltage . .	300 μa
Max. Average Current in Breakdown Condition	20 ma

Typical Values

Temp. Coef. of Breakdown Voltage . . .	+0.07%/°C
AC Impedance at 10 ma in Breakdown Condition	100 ohms
Capacitance at 10v	400 μμf

Note 1. An adequate heat sink prevents rise of the temperature of the hexagon base above 135°C., in the desired application.

Note 2. When soldering or bending the negative terminal (terminal 2), it should be gripped by pliers between the point of operation and the body of the diode.

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DEVELOPMENTAL

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Issue 3
April 23, 1956

INTERMEDIATE VARISTOR DATA SHEET
WESTERN ELECTRIC GA-52936 VARISTOR

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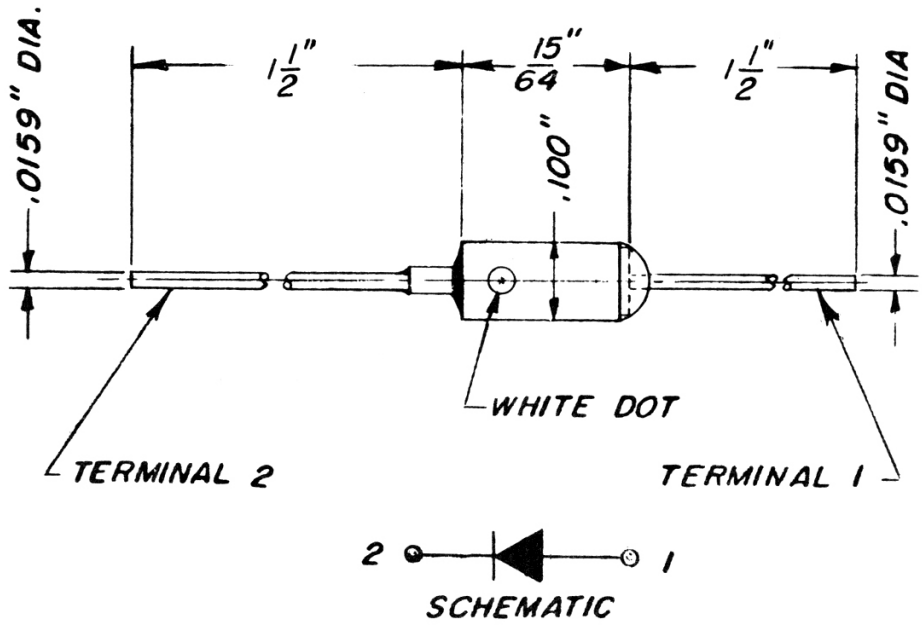

SCHEMATIC

DESCRIPTION

The GA-52936 Varistor is a miniature diffused silicon diode intended for general use as a low current rectifier. It is characterized by small size, low forward resistance, and moderately high reverse voltage breakdown.

GENERAL CHARACTERISTICS

Power Dissipation	0.25 watt
Mechanical Data	
Mounting Position	Any
Storage Temp. Range	-40°C to +135°C
Dimensions and Polarity	See outline drawing

ELECTRICAL CHARACTERISTICS

	Min.	Max.	
Maximum Peak Inverse Voltage	---	200	v
Reverse Current at 200 V	---	20	μa
Peak Forward Current (See Note 1).	---	5.0	a
Average Forward Current	---	0.25	a
Forward Voltage Drop at 0.1 amp.	---	1.0	v
Permissible Case Temperature	---	135	°C

Note 1. The rating for peak forward current is based upon a pulse duration of less than 1 millisecond.

CAUTION

Due to the inherently low forward resistance of this device, protective measures must be taken to limit forward current in the event of short circuited load.

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DEVELOPMENTAL

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Issue 2
February 10, 1956

INTERMEDIATE VARISTOR DATA SHEET
WESTERN ELECTRIC GA-52937 VARISTOR

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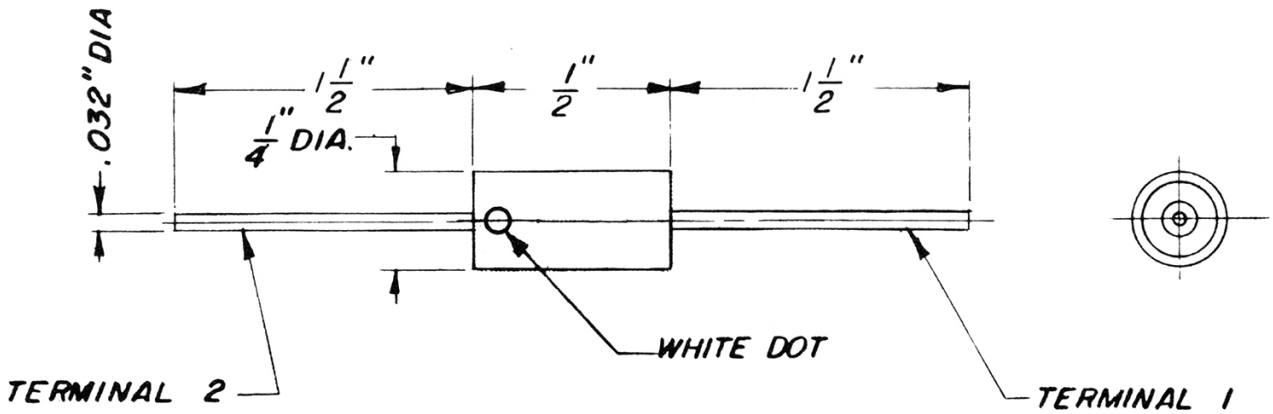

SCHEMATIC

DESCRIPTION

The GA-52937 Varistor is a diffused junction silicon diode intended for use as a low current power rectifier. It is characterized by extremely low forward resistance and moderately high reverse voltage breakdown.

GENERAL CHARACTERISTICS

Power Dissipation at 25°C ambient . . . . . 1 watt

Mechanical Data

Mounting Position	Any
Storage Temperature Range	-40°C to +135°C
Dimensions and Polarity	See outline drawing

ELECTRICAL CHARACTERISTICS	Min.	Max.	
Maximum Peak Inverse Voltage	---	200	v
Reverse Current at 200 V	---	20	μa
Peak Forward Current (See Note 1)	---	10	a
Average Forward Current	---	1.0	a
Forward Voltage Drop at 1 ampere	---	1.2	v
Permissible Case Temperature	---	135	°C

Note 1. The rating for peak forward current is based upon a pulse duration of less than 1 millisecond.

CAUTION

Due to the inherently low forward resistance of this device, protective measures must be taken to limit forward current in the event of short circuited load.

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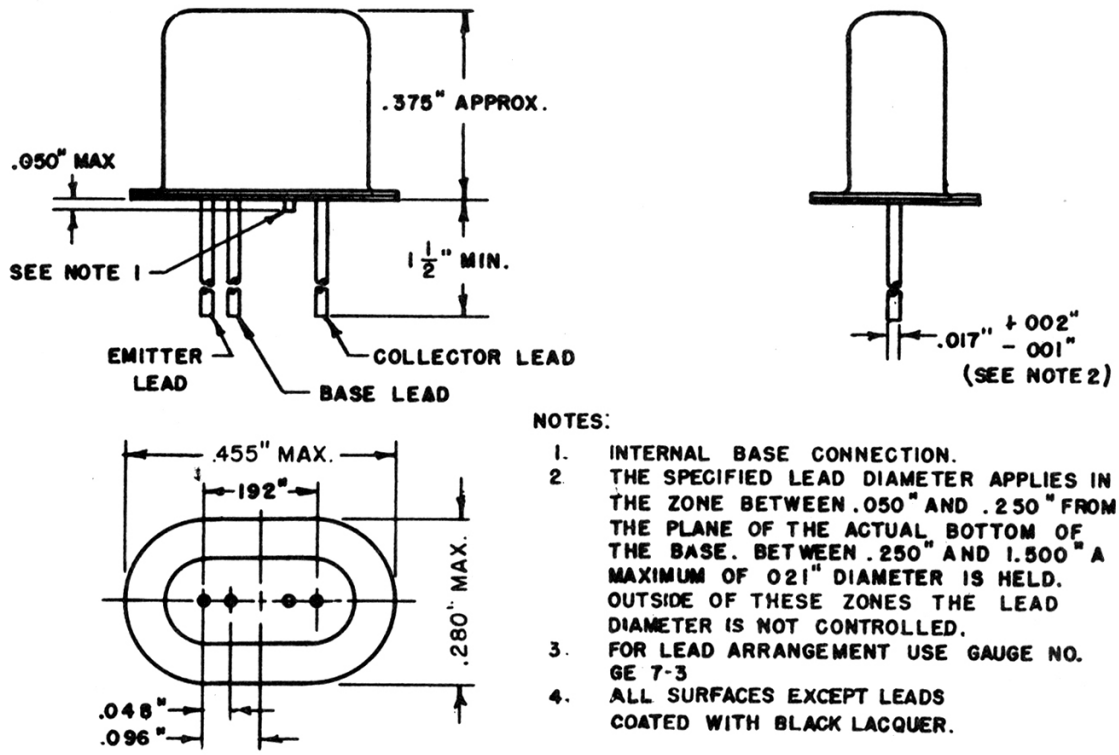
Issue 1
December 30, 1955

TRANSISTOR DATA SHEET
WESTERN ELECTRIC GA-52996 TRANSISTOR
(DEVELOPMENT MODEL 1892)



NOTES:

1. INTERNAL BASE CONNECTION.
2. THE SPECIFIED LEAD DIAMETER APPLIES IN THE ZONE BETWEEN .050" AND .250" FROM THE PLANE OF THE ACTUAL BOTTOM OF THE BASE. BETWEEN .250" AND 1.500" A MAXIMUM OF .021" DIAMETER IS HELD. OUTSIDE OF THESE ZONES THE LEAD DIAMETER IS NOT CONTROLLED.
3. FOR LEAD ARRANGEMENT USE GAUGE NO. GE 7-3
4. ALL SURFACES EXCEPT LEADS COATED WITH BLACK LACQUER.

DESCRIPTION

The GA-52996 is a point contact transistor triode in an hermetically sealed enclosure. It is designed for use in high speed switching circuits where the large-signal parameters of the active device are of primary interest. It is similar to the GA-53080 transistor. Its mechanical features are such that it is considered suitable for severe military use.

GENERAL CHARACTERISTICS

Mechanical Data

Mounting position - any

Socket - See Note 1

Dimensions and pin connections - - - - - - - - - - - - - - See Outline Page 1

Absolute Maximum Ratings (Note 2)

Collector voltage - - - - - - - - - - - - - - - -	V_c	-100 volts
Collector dissipation - - - - - - - - - - - - - -	P_c	250 milliwatts
Emitter voltage - - - - - - - - - - - - - - - - -	V_e	-100 volts
Emitter dissipation - - - - - - - - - - - - - - -	P_e	165 milliwatts
Ambient storage temperature - - - - - - - - - -		(+85°C (-55°C
Shock -		500 g

Suggested Design Maximums (Note 2)

Collector Current - - - - - - - - - - - - - - - -	I_c	-50 ma
Emitter current - - - - - - - - - - - - - - - - -	I_e	+50 ma

ELECTRICAL CHARACTERISTICS (Ambient 25°C)

Small Signal Parameters

		Min.	Max.
Short Circuit Current Multiplication Ratio (Alpha) ($I_e \leq 0.2$ mAdc, V_c = -8 Vdc, f_α = 2 mc)	α	3.0	---

Large Signal Parameters

Collector Current (I_e = 0, V_c = -20 Vdc)	I_c	---	-3.0	mAdc
Collector Current (I_e = 8 mAdc, V_c = -2 Vdc) See Note 3	I_c	-16.0	-20.0	mAdc
Emitter Voltage (I_c = -12 mAdc, V_c = -10 Vdc) See Note 3	V_e	---	-0.6	Vdc
Emitter Voltage (I_e = 0.05 mAdc, V_c = -20 Vdc)	V_e	-0.25	+0.25	Vdc

NOTE 1: The external connections will fit a 5 pin in-line subminiature tube socket, or its equivalent, when the lead length, as measured from the transistor base, is reduced to 0.200". A shearing tool should be used for this purpose.

NOTE 2: Electrical ratings are on the basis of any duration longer than the order of 50 microseconds at an ambient temperature of 25 ± 5°C. An individual maximum rating may not be achievable because of other parameter limitations.

NOTE 3: The effective emitter shunting capacitance should be less than 10 μμf for this measurements in order to prevent spurious oscillations.

OPERATING PRECAUTION

The transistor should not be subjected to service in which excessive transients might cause the ratings of the device to be exceeded, such as may result from inserting the transistor into or removing it from the socket with the power on. Base contact should be made first. If solder connections are made to the transistor leads, heat sink protection on the transistor side of the joint should be provided, as with flat nose pliers. When cutting leads for socketing, a shearing tool should be used.

Operation of the transistor as a linear device in the region of emitter biases between voltage cut-off and saturation is not recommended due to anomalies which appear in this range in some transistors. An anomaly can be defined as a condition in the output characteristics when, for a fixed value of emitter current, the collector voltage can be a multiple valued function of the collector current or the collector current can be a multiple valued function of the collector voltage.

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DEVELOPMENTAL

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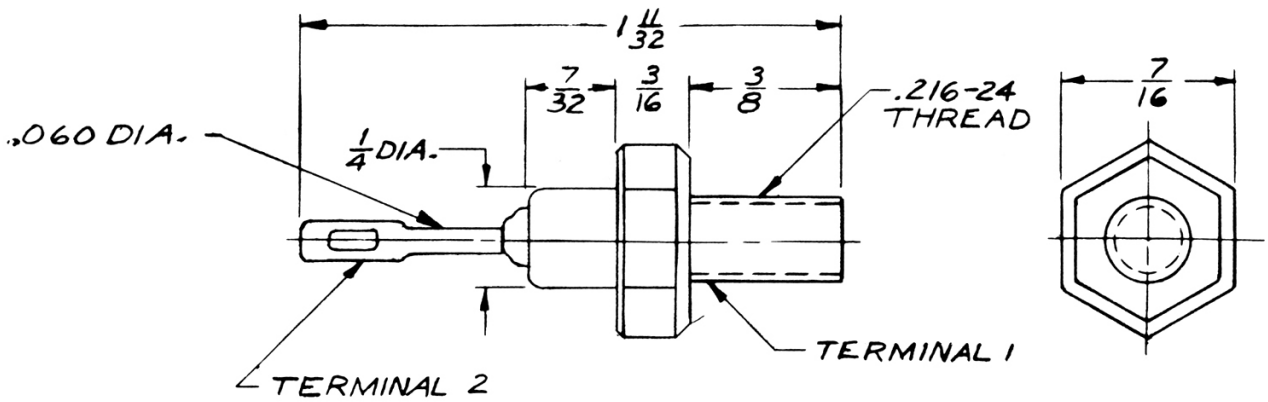
Issue 2
February 10, 1956

INTERMEDIATE VARISTOR DATA SHEET
WESTERN ELECTRIC GA-52998 VARISTOR

THIS VARISTOR IS BEING MADE BY WESTERN ELECTRIC COMPANY IN LIMITED QUANTITIES FOR DEVELOPMENT USE ONLY.



SCHEMATIC

DESCRIPTION

The GA-52998 Varistor is a diffused junction silicon diode intended for general use as a low and moderate current power rectifier. It is characterized by extremely low forward resistance and moderately high reverse voltage breakdown.

GENERAL CHARACTERISTICS

Power Dissipation

Without Heat Sink at 25°C Ambient	1.0 watt
With Adequate Heat Sink (See Note 2) . . .	10 watts

Mechanical Data

Mounting Position	Any
Storage Temp. Range	-40°C to +135°C
Dimensions and Polarity	See outline drawing
Handling	See Note 3

ELECTRICAL CHARACTERISTICS

	Min.	Max.	
Maximum Peak Inverse Voltage	---	200	v
Reverse Current at 200 V	---	1.0	ma
Peak Forward Current (See Note 1).	---	50	a
Average Forward Current			
With no heat sink	---	1.0	a
With heat sink (See Note 2)	---	10	a
Forward Voltage Drop at 1 ampere	---	1.0	v
Forward Voltage Drop at 10 amperes	---	1.5	v
Permissible Hexagon Base Temperature	---	135	°C

Note 1. The rating for peak forward current is based upon a pulse duration of less than 1 millisecond.

Note 2. An adequate heat sink prevents rise of the temperature of the hexagon base above 135°C., in the desired application.

Note 3. When soldering or bending the negative terminal (terminal 2), it should be gripped by pliers between the operation and the body of the rectifier.

CAUTION

Due to the inherently low forward resistance of this device, protective measures must be taken to limit forward current in the event of short circuited load.

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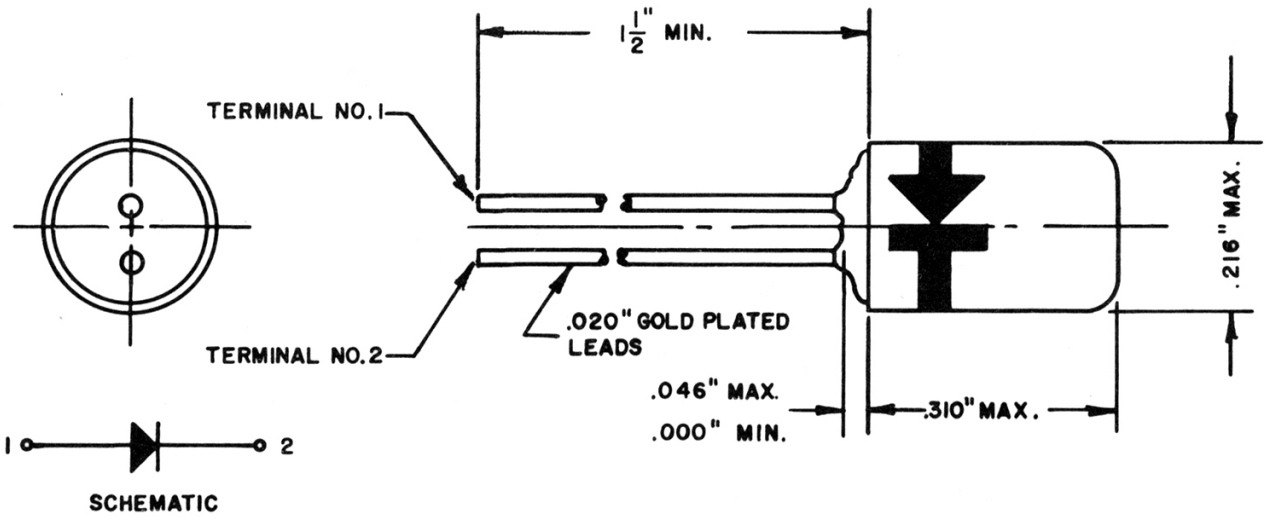
Issue 1
May 20, 1955

VARISTOR DATA SHEET
WESTERN ELECTRIC 1N331 VARISTOR



DESCRIPTION

The 1N331 is a silicon alloy junction type varistor. Its mechanical features are such that it is suitable for military use.

For data applying to all codes of this type varistor see General Data Sheet for Silicon Alloy Junction Varistors, type A.

GENERAL CHARACTERISTICS

MAXIMUM RATINGS, Absolute Values (See Note 1)

Reverse Voltage	16 volts
Forward Current	
Steady State (D-C)	50 milliamperes
Instantaneous Peak (See Note 2)	250 milliamperes
Breakdown Current	
Steady State (D-C)	3 milliamperes
Instantaneous Peak (See Note 2)	10 milliamperes

ELECTRICAL CHARACTERISTICS

Breakdown Voltage	20 ± 3 v
Max. Current at 80% of Breakdown Voltage	100 μa
Max. Average Current in Breakdown Condition	150 ma
Max. Peak Current	20 a

Typical Values

Capacitance at 10v	2500 μμf
Temp. Coef. of Breakdown Voltage	+0.07%/°C
AC Impedance at 10 ma in Breakdown Condition	5.0 ohms

Note 1. An adequate heat sink prevents rise of the temperature of the hexagon base above 135°C., in the desired application.

Note 2. When soldering or bending the negative terminal (terminal 2), it should be gripped by pliers between the operation and the body of the diode.

CAUTION

The effective resistance of this diode is quite low above the breakdown voltage. Destructive currents will flow if the device is connected directly to a low impedance power source having an output voltage above 20 volts.

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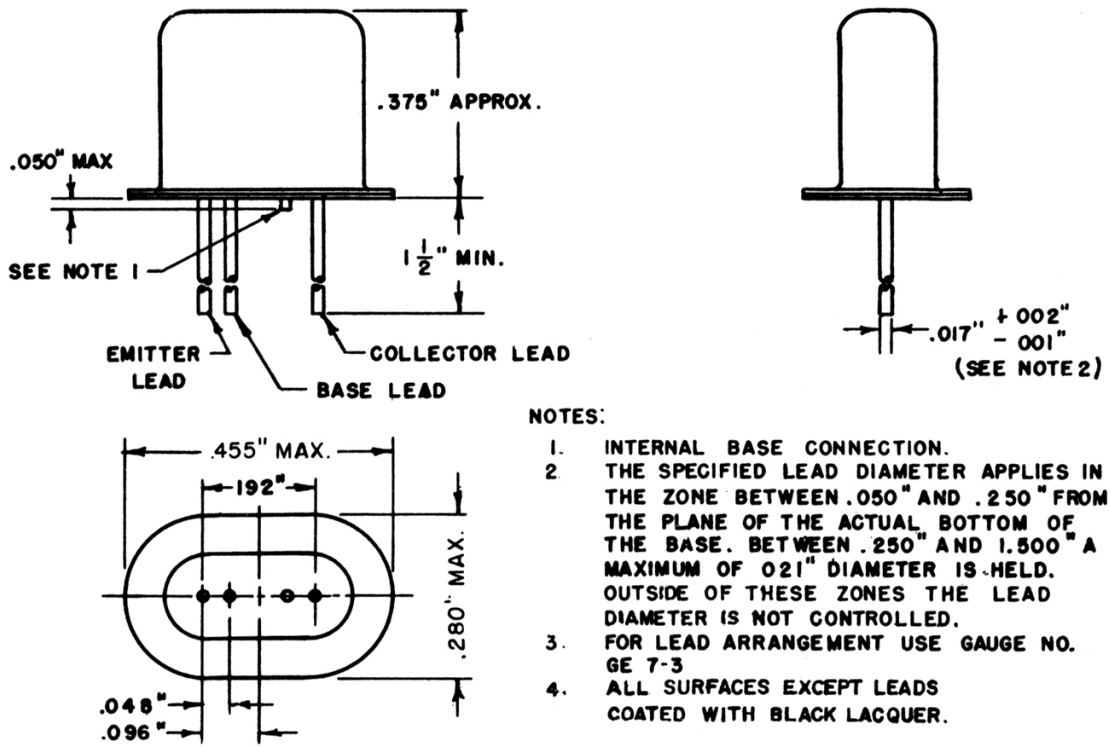
Issue 1
December 30, 1955

TRANSISTOR DATA SHEET
WESTERN ELECTRIC GA-53080 TRANSISTOR
(DEVELOPMENT MODEL 1892)



NOTES:

1. INTERNAL BASE CONNECTION.
2. THE SPECIFIED LEAD DIAMETER APPLIES IN THE ZONE BETWEEN .050" AND .250" FROM THE PLANE OF THE ACTUAL BOTTOM OF THE BASE. BETWEEN .250" AND 1.500" A MAXIMUM OF .021" DIAMETER IS HELD. OUTSIDE OF THESE ZONES THE LEAD DIAMETER IS NOT CONTROLLED.
3. FOR LEAD ARRANGEMENT USE GAUGE NO. GE 7-3
4. ALL SURFACES EXCEPT LEADS COATED WITH BLACK LACQUER.

DESCRIPTION

The GA-53080 is a point contact transistor triode in an hermetically sealed enclosure. It is designed for use in high speed switching circuits where the large-signal parameters of the active device are of primary interest. It is similar to the GA-52996 transistor. Its mechanical features are such that it is considered suitable for severe military use.

GENERAL CHARACTERISTICS

Mechanical Data

Mounting position - any

Socket - See Note 1

Dimensions and pin connections - - - - - - - - - - - - - - See Outline Page 1

Absolute Maximum Ratings (Note 2)

Collector voltage - - - - - - - - - - - - - - - - -	V_c	-100 volts
Collector dissipation - - - - - - - - - - - - - - -	P_c	250 milliwatts
Emitter voltage - - - - - - - - - - - - - - - - - -	V_e	-100 volts
Emitter dissipation - - - - - - - - - - - - - - - -	P_e	165 milliwatts
Ambient storage temperature - - - - - - - - - - -		(+85°C (-55°C
Shock -		500 g

Suggested Design Maximums (Note 2)

Collector current - - - - - - - - - - - - - - - - -	I_c	-50 ma
Emitter current - - - - - - - - - - - - - - - - - -	I_e	+50 ma

ELECTRICAL CHARACTERISTICS (Ambient 25°C)

Small Signal Parameters

		Min.	Max.	
Cut-off frequency of Alpha (I_e = 1.0 mAdc, V_c = -20 Vdc)	$f_{\alpha c}$	10.0	---	mc

Large Signal Parameters

Collector Current (I_e = 0, V_c = -20 Vdc)	I_c	---	-3.0	mAdc
Collector Current (I_e = 8 mAdc, V_c = -2 Vdc) See Note 3	I_c	-16.0	-20.0	mAdc
Emitter Voltage (I_c = -12 mAdc, V_c = -10 Vdc) See Note 3	V_e	---	-0.6	Vdc
Emitter Voltage (I_e = 0.05 mAdc, V_c = -20 Vdc)	V_e	-0.25	+0.25	Vdc

NOTE 1: The external connections will fit a 5 pin in-line subminiature tube socket, or its equivalent, when the lead length, as measured from the transistor base, is reduced to 0.200". A shearing tool should be used for this purpose.

NOTE 2: Electrical ratings are on the basis of any duration longer than the order of 50 microseconds at an ambient temperature of 25 ± 5°C. An individual maximum rating may not be available because of other parameter limitations.

NOTE 3: The effective emitter shunting capacitance should be less than 10 μμf for this measurement in order to prevent spurious oscillations.

OPERATING PRECAUTION

The transistor should not be subjected to service in which excessive transients might cause the ratings of the device to be exceeded, such as may result from inserting the transistor into or removing it from the socket with the power on. Base contact should be made first. If solder connections are made to the transistor leads, heat sink protection on the transistor side of the joint should be provided, as with flat nose pliers. When cutting leads for socketing, a shearing tool should be used.

Operation of the transistor as a linear device in the region of emitter biases between voltage cut-off and saturation is not recommended due to anomalies which appear in this range in some transistors. An anomaly can be defined as a condition in the output characteristics when, for a fixed value of emitter current, the collector voltage can be a multiple valued function of the collector current or the collector current can be a multiple valued function of the collector voltage.

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DEVELOPMENTAL

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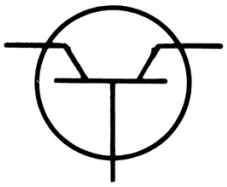
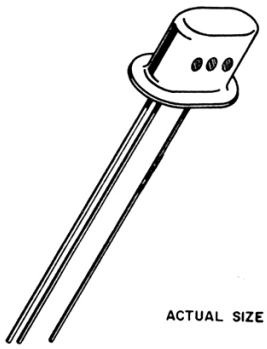
Issue 1
December 30, 1955





ACTUAL SIZE

INTERMEDIATE TRANSISTOR DATA SHEET

WESTERN ELECTRIC GA-53104 TRANSISTOR

DESCRIPTION **p-n-p ALLOY JUNCTION**

Hermetically sealed transistor suitable for use in low power, high gain switching applications.

MOUNTING AND CONNECTIONS

Unit may be mounted in any position.

When cutting leads for socketing, a shearing tool should be used.

When soldering, a heat sink should be provided between the connection and the transistor.

RECOMMENDED MAXIMA (See Note 1)

Current, continuous	50 milliamperes
Voltage	
Collector to base	-10 volts
Emitter to base	-20 volts
Collector to emitter	-10 volts
Junction Temperature	85° Centigrade

POWER DISSIPATION

Temperature drop from collector junction to:

Free air	0.5°C/mw
Heat sink on can	- °C/mw
Heat sink on leads 1/8" from can	- °C/mw

RELIABILITY

Preliminary aging studies indicate that high temperature is the primary cause of changes in characteristics. The characteristics approach an asymptote with time.

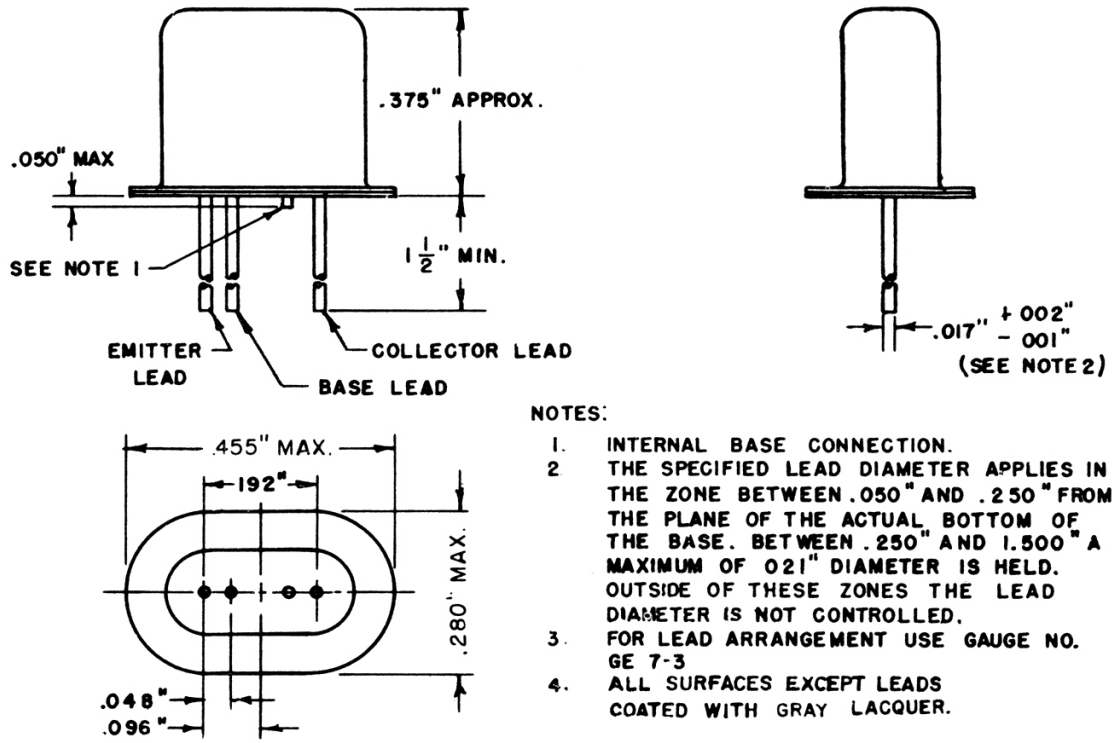
All units have been aged 48 hours at 100°C prior to final test.

NOTE 1: All of these maxima may be exceeded at the expense of transistor life.

ELECTRICAL CHARACTERISTICS (At 25°C unless otherwise specified)

General		Min.	Max.	
Current Multiplication Ratio				
(I_e = 1 mAdc, V_c = -5 Vdc)	α_N	-	-	
(I_e = 50 mAdc, V_c = -0.25 Vdc)	α_N	-	-	
(V_e = -5 Vdc, I_c = 1 mAdc)	α_I	.65	-	
(V_e = -0.25 Vdc, I_c = 50 mAdc)	α_I	-	-	
Breakdown Voltages				
(I_e = 0, I_c = -50 µAdc)	V_{cb}	-10	-	Vdc
(I_e = -50 µAdc, I_c = 0)	V_{eb}	-20	-	Vdc
(V_{be} = 0, I_c = -50 µAdc)	V_{ce}	-10	-	Vdc
Reverse Currents (See note 2)				
(I_e = 0, V_c = -20 Vdc)	I_{co}	-	-	µAdc
(I_e = 0, V_c = -30 Vdc, 55°C)	I_{co}	-	-	µAdc
(V_e = -20 Vdc, I_c = 0)	I_{eo}	-	-	µAdc
Forward Voltages				
(I_e = 0, I_c = 15 mAdc)	V_{cfd}	-	-	Vdc
(I_e = 15 mAdc, I_c = 0)	V_{efd}	-	-	Vdc
Junction Capacitance				
(I_e = 0, V_c = -5 Vdc)	C_c	-	-	µµfd
(V_e = -5 Vdc, I_c = 0)	C_e	-	10	µµfd
Frequency Cutoff				
(I_e = 1 mAdc, V_c = -10 Vdc)	$f_{\alpha ce}$	-	-	Mc
(V_e = -10 Vdc, I_c = 1 mAdc)	$f_{\alpha ec}$	.20	-	Mc
Switching				
Emitter Floating Potential				
(I_e = 0, V_c = -20 Vdc) Measured with VTVM	V_{efl}	-	-	Vdc
Off Currents				
(V_e = -.5 Vdc, V_c = -.5 Vdc)	I_{cr}	-	-	µAdc
(V_e = -.5 Vdc, V_c = -.5 Vdc, 45°C)	I_{er}	-	.40	µAdc
On Voltages				
(I_e = -.20 mAdc, I_c = +2.7 mAdc)	V_{ec}	-	.010	Vdc
(I_e = -.20 mAdc, I_c = +2.7 mAdc)	V_{cb}	-	.300	Vdc

DIMENSIONAL OUTLINE



NOTES:

1. INTERNAL BASE CONNECTION.
2. THE SPECIFIED LEAD DIAMETER APPLIES IN THE ZONE BETWEEN .050" AND .250" FROM THE PLANE OF THE ACTUAL BOTTOM OF THE BASE. BETWEEN .250" AND 1.500" A MAXIMUM OF 021" DIAMETER IS HELD. OUTSIDE OF THESE ZONES THE LEAD DIAMETER IS NOT CONTROLLED.
3. FOR LEAD ARRANGEMENT USE GAUGE NO. GE 7-3
4. ALL SURFACES EXCEPT LEADS COATED WITH GRAY LACQUER.

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