The Semiconductor Data Book

SUPPLEMENT 1

This is the first supplement to the 4th Edition of the Semiconductor Data Book originally published in July 1969. It is produced to keep an up-to-date listing of the most advanced semiconductor products.

Devices characterized in this supplement include only the type numbers introduced after the publication of the Semiconductor Data Book. For a complete compilation of all devices, use this Supplement in conjunction with the Data Book.

The information in this supplement has been carefully checked and is believed to be reliable; however, no responsibility is assumed for inaccuracies.

ERRATA

The following corrections and changes apply to data sheets in the Semiconductor Data Book, Fourth Edition.

Device Number	Instruction
1N1803 thru 1N1836	Add note: 1N1816 thru 1N1836 are available as clipper devices. To order, add suffix "C" for ±10% or suffix "CA" for ±5%.
2N3375	1) Change note for Case 24(TO-102) to read "Collector connected to case, stud isolated." 2) $BV_{CEO(sus)}$ all devices should be tested at I_C = 200 mAdc, I_B = 0 3) f_T, 2N3961 only, test condition should be I_C = 125 mAdc, V_{CE} = 28 Vdc, f = 100 MHz. Value of f_T = 350 MHz (min)
2N4391, 2N4392, 2N4393	Change Case 22(3) to Case 22(4)
MA100	Polarity should be noted as PNP
MCA2211 Series	Change Z_{ZT} max from 40 to 120 ohms; Z_{ZT} for all other series equals 40 ohms max
MPS-A12	1) MAXIMUM RATINGS Collector-Emitter Voltage change V_{CEO} to V_{CES} 2) OFF CHARACTERISTICS Collector-Emitter Breakdown Voltage Change BV_{CEO} to BV_{CES} Change I_C = 10 mAdc to I_C = 100 μAdc
MZ500-1 Series	Change weight from 0.42 gram to 0.18 gram (approximate)

NUMERICAL INDEX

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1N--- TYPE NUMBERS

The following table lists EIA-registered devices introduced since the publication of the Motorola Semiconductor Data Book (4th Edition). Major electrical specifications are provided for your convenience.

KEY

RECTIFIERS

V_R = DC Blocking Voltage
V_F = Average Forward Voltage Drop
I_O = Average Rectifier Forward Current
I_R = Average Reverse Current
I_{surge} = Peak Surge Current

ZENER DIODES

V_Z (min) = Minimum Zener Breakdown Voltage (Volts)
V_Z (max) = Maximum Zener Breakdown Voltage (used only when a corresponding **V_Z (min)** is specified. Otherwise, this column refers to **V_Z (nom)*** Nominal Zener Breakdown Voltage.)

Tol = Tolerance, for specified Nominal Breakdown Voltage

P_D = Maximum Power Dissipation. **M** = milliwatts. **W** = watts

TYPE	MATERIAL	REPLACEMENT	REF.	IDENTIFICATION	RECTIFIERS					ZENER DIODES			
					V_R (volts)	V_F (volts)	I_O (Amp)	I_R (mA)	I_{surge} (Amp)	V_Z (min)	V_Z (nom)* V_Z (max)	Tol V_Z %	P_D
					SIGNAL DIODES					REFERENCE DIODES			
					PRV (volts)	V_F @ I_F (volts)		I_R	t_{rr} (μS)	TC %/°C	V_Z	T (min) °C	T (max) °C

Numerical Listing of Registered Type Numbers

S = Silicon
G = Germanium
SE = Selenium

Type number of recommended replacement or of nearest electrical equivalent fully characterized in this book.

Reference device number indicates specific Data Sheet on which device is characterized.

SHADING INDICATES SIGNAL DIODES

PRV = Peak Reverse Voltage
V_F @ I_F = Maximum Forward Voltage at Indicated Forward Current — M = milliamp, A = amp

I_R = Reverse Current — M = milliamp, * = microamp N = nanoamp

t_{rr} = Reverse Recovery Time

SHADING INDICATES REFERENCE DIODES

TC = Temperature Coefficient
V_Z = Zener Breakdown Voltage

T (min), **T (max)** Temperature Range over which indicated temperature coefficient is applicable.

The codes listed below define the listed device and indicates the appropriate specification column heading.

R* — Rectifiers
DR — Diode, Reference
DZ — Diode, Zener
DS — Diode, Signal

TYPE	MATERIAL	REPLACEMENT	REF.	IDENTIFICATION	RECTIFIERS: V_R (volts) / SIGNAL DIODES: PRV (volts)	RECTIFIERS: V_F (volts) / SIGNAL DIODES: V_F (volts) @	RECTIFIERS: I_O (Amp) / SIGNAL DIODES: I_F	RECTIFIERS: I_R (mA) / SIGNAL DIODES: I_R	RECTIFIERS: I_{surge} (Amp) / SIGNAL DIODES: t_{rr} (μs)	ZENER DIODES: V_Z (min) / REFERENCE DIODES: TC %/°C	ZENER DIODES: V_Z (nom) * / V_Z (max) / REFERENCE DIODES: V_Z	ZENER DIODES: Tol V_Z % / REFERENCE DIODES: T (min) °C	ZENER DIODES: P_D / REFERENCE DIODES: T (max) °C
1N5426	S			DS		1.0	40M	1.0*					
1N5433	S			R*	600		2.0		25				
1N5434	S			R*	600		2.0		60				
1N5435	S			R*	600		12		200				
1N5436	} Microwave Mixers												
1N5437													
1N5438													
1N5439 thru 1N5476	Varactor Diodes, see Table on Page 8												
1N5477	S			R*	6000		0.6	0.350	80				
1N5478	S			R*	7200		0.6	0.350	80				
1N5479	S			R*	8400		0.6	0.350	80				
1N5480	S			R*	9600		0.6	0.350	80				
1N5481	S			R*	12000		0.6	0.350	80				
1N5482	S			R*	2400		1.0	0.350	80				
1N5483	S			R*	3600		1.0	0.350	80				
1N5484	S			R*	4800		1.0	0.350	80				
1N5485	S			R*	6000		1.0	0.350	80				
1N5518	S		1N5518	DZ							3.3*	20	400M
1N5518A	S		1N5518	DZ							3.3*	10	400M
1N5518B	S		1N5518	DZ							3.3*	5.0	400M
1N5518C	S			DZ							3.3*	2.0	400M
1N5518D	S			DZ							3.3*	1.0	400M
1N5519	S		1N5518	DZ							3.6*	20	400M
1N5519A	S		1N5518	DZ							3.6*	10	400M
1N5519B	S		1N5518	DZ							3.6*	5.0	400M
1N5519C	S			DZ							3.6*	2.0	400M
1N5519D	S			DZ							3.6*	1.0	400M
1N5520	S		1N5518	DZ							3.9*	20	400M
1N5520A	S		1N5518	DZ							3.9*	10	400M
1N5520B	S		1N5518	DZ							3.9*	5.0	400M
1N5520C	S			DZ							3.9*	2.0	400M
1N5520D	S			DZ							3.9*	1.0	400M
1N5521	S		1N5518	DZ							4.3*	20	400M
1N5521A	S		1N5518	DZ							4.3*	10	400M
1N5521B	S		1N5518	DZ							4.3*	5.0	400M
1N5521C	S			DZ							4.3*	2.0	400M
1N5521D	S			DZ							4.3*	1.0	400M
1N5522	S		1N5518	DZ							4.7*	20	400M
1N5522A	S		1N5518	DZ							4.7*	10	400M
1N5522B	S		1N5518	DZ							4.7*	5.0	400M
1N5522C	S			DZ							4.7*	2.0	400M
1N5522D	S			DZ							4.7*	1.0	400M
1N5523	S		1N5518	DZ							5.1*	20	400M
1N5523A	S		1N5518	DZ							5.1*	10	400M
1N5523B	S		1N5518	DZ							5.1*	5.0	400M
1N5523C	S			DZ							5.1*	2.0	400M
1N5523D	S			DZ							5.1*	1.0	400M
1N5524	S		1N5518	DZ							5.6*	20	400M
1N5524A	S		1N5518	DZ							5.6*	10	400M
1N5524B	S		1N5518	DZ							5.6*	5.0	400M
1N5524C	S			DZ							5.6*	2.0	400M
1N5524D	S			DZ							5.6*	1.0	400M
1N5525	S		1N5518	DZ							6.2*	20	400M
1N5525A	S		1N5518	DZ							6.2*	10	400M
1N5525B	S		1N5518	DZ							6.2*	5.0	400M
1N5525C	S			DZ							6.2*	2.0	400M
1N5525D	S			DZ							6.2*	1.0	400M
1N5526	S		1N5518	DZ							6.8*	20	400M
1N5526A	S		1N5518	DZ							6.8*	10	400M
1N5526B	S		1N5518	DZ							6.8*	5.0	400M
1N5526C	S			DZ							6.8*	2.0	400M
1N5526D	S			DZ							6.8*	1.0	400M
1N5527	S		1N5518	DZ							7.5*	20	400M
1N5527A	S		1N5518	DZ							7.5*	10	400M
1N5527B	S		1N5518	DZ							7.5*	5.0	400M
1N5527C	S			DZ							7.5*	2.0	400M
1N5527D	S			DZ							7.5*	1.0	400M
1N5528	S		1N5518	DZ							8.2*	20	400M
1N5528A	S		1N5518	DZ							8.2*	10	400M
1N5528B	S		1N5518	DZ							8.2*	5.0	400M
1N5528C	S			DZ							8.2*	2.0	400M
1N5528D	S			DZ							8.2*	1.0	400M
1N5529	S		1N5518	DZ							9.1*	20	400M
1N5529A	S		1N5518	DZ							9.1*	10	400M
1N5529B	S		1N5518	DZ							9.1*	5.0	400M

TYPE	MATERIAL	REPLACEMENT	REF.	IDENTIFICATION	RECTIFIERS: V_R (volts) / SIGNAL DIODES: PRV (volts)	RECTIFIERS: V_F (volts) / SIGNAL DIODES: V_F (volts) @	RECTIFIERS: I_O (Amp) / SIGNAL DIODES: I_F	RECTIFIERS: I_R (mA) / SIGNAL DIODES: I_R	RECTIFIERS: I_{surge} (Amp) / SIGNAL DIODES: t_{rr} (μs)	ZENER DIODES: V_Z (min) / REFERENCE DIODES: TC %/°C	ZENER DIODES: V_Z (nom) * / V_Z (max) / REFERENCE DIODES: V_Z	ZENER DIODES: Tol V_Z % / REFERENCE DIODES: T (min) °C	ZENER DIODES: P_D / REFERENCE DIODES: T (max) °C
1N5529C	S			DZ							9.1*	2.0	400M
1N5529D	S			DZ							9.1*	1.0	400M
1N5530	S		1N5518	DZ							10*	20	400M
1N5530A	S		1N5518	DZ							10*	10	400M
1N5530B	S		1N5518	DZ							10*	5.0	400M
1N5530C	S			DZ							10*	2.0	400M
1N5530D	S			DZ							10*	1.0	400M
1N5531	S		1N5518	DZ							11*	20	400M
1N5531A	S		1N5518	DZ							11*	10	400M
1N5531B	S		1N5518	DZ							11*	5.0	400M
1N5531C	S			DZ							11*	2.0	400M
1N5531D	S			DZ							11*	1.0	400M
1N5532	S		1N5518	DZ							12*	20	400M
1N5532A	S		1N5518	DZ							12*	10	400M
1N5532B	S		1N5518	DZ							12*	5.0	400M
1N5532C	S			DZ							12*	2.0	400M
1N5532D	S			DZ							12*	1.0	400M
1N5533	S		1N5518	DZ							13*	20	400M
1N5533A	S		1N5518	DZ							13*	10	400M
1N5533B	S		1N5518	DZ							13*	5.0	400M
1N5533C	S			DZ							13*	2.0	400M
1N5533D	S			DZ							13*	1.0	400M
1N5534	S		1N5518	DZ							14*	20	400M
1N5534A	S		1N5518	DZ							14*	10	400M
1N5534B	S		1N5518	DZ							14*	5.0	400M
1N5534C	S			DZ							14*	2.0	400M
1N5534D	S			DZ							14*	1.0	400M
1N5535	S		1N5518	DZ							15*	20	400M
1N5535A	S		1N5518	DZ							15*	10	400M
1N5535B	S		1N5518	DZ							15*	5.0	400M
1N5535C	S			DZ							15*	2.0	400M
1N5535D	S			DZ							15*	1.0	400M
1N5536	S		1N5518	DZ							16*	20	400M
1N5536A	S		1N5518	DZ							16*	10	400M
1N5536B	S		1N5518	DZ							16*	5.0	400M
1N5536C	S			DZ							16*	2.0	400M
1N5536D	S			DZ							16*	1.0	400M
1N5537	S		1N5518	DZ							17*	20	400M
1N5537A	S		1N5518	DZ							17*	10	400M
1N5537B	S		1N5518	DZ							17*	5.0	400M
1N5537C	S			DZ							17*	2.0	400M
1N5537D	S			DZ							17*	1.0	400M
1N5538	S		1N5518	DZ							18*	20	400M
1N5538A	S		1N5518	DZ							18*	10	400M
1N5538B	S		1N5518	DZ							18*	5.0	400M
1N5538C	S			DZ							18*	2.0	400M
1N5538D	S			DZ							18*	1.0	400M
1N5539	S		1N5518	DZ							19*	20	400M
1N5539A	S		1N5518	DZ							19*	10	400M
1N5539B	S		1N5518	DZ							19*	5.0	400M
1N5539C	S			DZ							19*	2.0	400M
1N5539D	S			DZ							19*	1.0	400M
1N5540	S		1N5518	DZ							20*	20	400M
1N5540A	S		1N5518	DZ							20*	10	400M
1N5540B	S		1N5518	DZ							20*	5.0	400M
1N5540C	S			DZ							20*	2.0	400M
1N5540D	S			DZ							20*	1.0	400M
1N5541	S		1N5518	DZ							22*	20	400M
1N5541A	S		1N5518	DZ							22*	10	400M
1N5541B	S		1N5518	DZ							22*	5.0	400M
1N5541C	S			DZ							22*	2.0	400M
1N5541D	S			DZ							22*	1.0	400M
1N5542	S		1N5518	DZ							24*	20	400M
1N5542A	S		1N5518	DZ							24*	10	400M
1N5542B	S		1N5518	DZ							24*	5.0	400M
1N5542C	S			DZ							24*	2.0	400M
1N5542D	S			DZ							24*	1.0	400M
1N5543	S		1N5518	DZ							25*	20	400M
1N5543A	S		1N5518	DZ							25*	10	400M
1N5543B	S		1N5518	DZ							25*	5.0	400M
1N5543C	S			DZ							25*	2.0	400M
1N5543D	S			DZ							25*	1.0	400M
1N5544	S		1N5518	DZ							28*	20	400M
1N5544A	S		1N5518	DZ							28*	10	400M
1N5544B	S		1N5518	DZ							28*	5.0	400M

TYPE	MATERIAL	REPLACEMENT	REF.	IDENTIFICATION	RECTIFIERS					ZENER DIODES			
					V_R (volts)	V_F (volts)	I_O (Amp)	I_R (mA)	I_{surge} (Amp)	V_Z (min)	V_Z (nom) * / V_Z (max)	Tol V_Z %	P_D
					SIGNAL DIODES					REFERENCE DIODES			
					PIV (volts)	V_F @ I_F (volts)		I_R	t_{rr} (μs)	TC %/°C	V_Z	T (min) °C	T (max) °C
1N5544C	S			DZ							28*	2.0	400M
1N5544D	S			DZ							28*	1.0	400M
1N5545	S		1N5518	DZ							30*	20	400M
1N5545A	S		1N5518	DZ							30*	10	400M
1N5545B	S		1N5518	DZ							30*	5.0	400M
1N5545C	S			DZ							30*	2.0	400M
1N5545D	S			DZ							30*	1.0	400M
1N5546	S		1N5518	DZ							33*	20	400M
1N5546A	S		1N5518	DZ							33*	10	400M
1N5546B	S		1N5518	DZ							33*	5.0	400M
1N5546C	S			DZ							33*	2.0	400M
1N5546D	S			DZ							33*	1.0	400M
1N5555 thru 1N5558	Transient Suppressors												
1N5559	S			DZ							6.8*	20	1.0W
1N5559A	S			DZ							6.8*	10	1.0W
1N5559B	S			DZ							6.8*	5.0	1.0W
1N5560	S			DZ							7.5*	20	1.0W
1N5560A	S			DZ							7.5*	10	1.0W
1N5560B	S			DZ							7.5*	5.0	1.0W
1N5561	S			DZ							8.2*	20	1.0W
1N5561A	S			DZ							8.2*	10	1.0W
1N5561B	S			DZ							8.2*	5.0	1.0W
1N5562	S			DZ							9.1*	20	1.0W
1N5562A	S			DZ							9.1*	10	1.0W
1N5562B	S			DZ							9.1*	5.0	1.0W
1N5563	S			DZ							10*	20	1.0W
1N5563A	S			DZ							10*	10	1.0W
1N5563B	S			DZ							10*	5.0	1.0W
1N5564	S			DZ							11*	20	1.0W
1N5564A	S			DZ							11*	10	1.0W
1N5564B	S			DZ							11*	5.0	1.0W
1N5565	S			DZ							12*	20	1.0W
1N5565A	S			DZ							12*	10	1.0W
1N5565B	S			DZ							12*	5.0	1.0W
1N5566	S			DZ							13*	20	1.0W
1N5566A	S			DZ							13*	10	1.0W
1N5566B	S			DZ							13*	5.0	1.0W
1N5567	S			DZ							15*	20	1.0W
1N5567A	S			DZ							15*	10	1.0W
1N5567B	S			DZ							15*	5.0	1.0W
1N5568	S			DZ							16*	20	1.0W
1N5568A	S			DZ							16*	10	1.0W
1N5568B	S			DZ							16*	5.0	1.0W
1N5569	S			DZ							18*	20	1.0W
1N5569A	S			DZ							18*	10	1.0W
1N5569B	S			DZ							18*	5.0	1.0W
1N5570	S			DZ							20*	20	1.0W
1N5570A	S			DZ							20*	10	1.0W
1N5570B	S			DZ							20*	5.0	1.0W
1N5571	S			DZ							22*	20	1.0W
1N5571A	S			DZ							22*	10	1.0W
1N5571B	S			DZ							22*	5.0	1.0W
1N5572	S			DZ							24*	20	1.0W
1N5572A	S			DZ							24*	10	1.0W
1N5572B	S			DZ							24*	5.0	1.0W
1N5573	S			DZ							27*	20	1.0W
1N5573A	S			DZ							27*	10	1.0W
1N5573B	S			DZ							27*	5.0	1.0W
1N5574	S			DZ							30*	20	1.0W
1N5574A	S			DZ							30*	10	1.0W
1N5574B	S			DZ							30*	5.0	1.0W
1N5575	S			DZ							33*	20	1.0W
1N5575A	S			DZ							33*	10	1.0W
1N5575B	S			DZ							33*	5.0	1.0W
1N5576	S			DZ							36*	20	1.0W
1N5576A	S			DZ							36*	10	1.0W
1N5576B	S			DZ							36*	5.0	1.0W
1N5577	S			DZ							39*	20	1.0W
1N5577A	S			DZ							39*	10	1.0W
1N5577B	S			DZ							39*	5.0	1.0W
1N5578	S			DZ							43*	20	1.0W

TYPE	MATERIAL	REPLACEMENT	REF.	IDENTIFICATION	RECTIFIERS V_R (volts)	V_F (volts)	I_O (Amp)	I_R (mA)	I_{surge} (Amp)	ZENER DIODES V_Z (min)	V_Z (nom) * / V_Z (max)	Tol V_Z %	P_D
					SIGNAL DIODES PRV (volts)	V_F @ I_F (volts)		I_R	t_{rr} (μs)	REFERENCE DIODES TC %/°C	V_Z	T (min) °C	T (max) °C
1N5578A	S			DZ							43*	10	1.0W
1N5578B	S			DZ							43*	5.0	1.0W
1N5579	S			DZ							47*	20	1.0W
1N5579A	S			DZ							47*	10	1.0W
1N5579B	S			DZ							47*	5.0	1.0W
1N5580	S			DZ							51*	20	1.0W
1N5580A	S			DZ							51*	10	1.0W
1N5580B	S			DZ							51*	5.0	1.0W
1N5581	S			DZ							56*	20	1.0W
1N5581A	S			DZ							56*	10	1.0W
1N5581B	S			DZ							56*	5.0	1.0W
1N5582	S			DZ							62*	20	1.0W
1N5582A	S			DZ							62*	10	1.0W
1N5582B	S			DZ							62*	5.0	1.0W
1N5583	S			DZ							68*	20	1.0W
1N5583A	S			DZ							68*	10	1.0W
1N5583B	S			DZ							68*	5.0	1.0W
1N5584	S			DZ							75*	20	1.0W
1N5584A	S			DZ							75*	10	1.0W
1N5584B	S			DZ							75*	5.0	1.0W
1N5585	S			DZ							82*	20	1.0W
1N5585A	S			DZ							82*	10	1.0W
1N5585B	S			DZ							82*	5.0	1.0W
1N5586	S			DZ							91*	20	1.0W
1N5586A	S			DZ							91*	10	1.0W
1N5586B	S			DZ							91*	5.0	1.0W
1N5587	S			DZ							100*	20	1.0W
1N5587A	S			DZ							100*	10	1.0W
1N5587B	S			DZ							100*	5.0	1.0W
1N5588	S			DZ							110*	20	1.0W
1N5588A	S			DZ							110*	10	1.0W
1N5588B	S			DZ							110*	5.0	1.0W
1N5589	S			DZ							120*	20	1.0W
1N5589A	S			DZ							120*	10	1.0W
1N5589B	S			DZ							120*	5.0	1.0W
1N5590	S			DZ							130*	20	1.0W
1N5590A	S			DZ							130*	10	1.0W
1N5590B	S			DZ							130*	5.0	1.0W
1N5591	S			DZ							150*	20	1.0W
1N5591A	S			DZ							150*	10	1.0W
1N5591B	S			DZ							150*	5.0	1.0W
1N5592	S			DZ							160*	20	1.0W
1N5592A	S			DZ							160*	10	1.0W
1N5592B	S			DZ							160*	5.0	1.0W
1N5593	S			DZ							180*	20	1.0W
1N5593A	S			DZ							180*	10	1.0W
1N5593B	S			DZ							180*	5.0	1.0W
1N5594	S			DZ							200*	20	1.0W
1N5594A	S			DZ							200*	10	1.0W
1N5594B	S			DZ							200*	5.0	1.0W

VARACTOR DIODES

INDEX AND SHORT-FORM SPECIFICATIONS

The following table provides a numerical index and short-form specifications for varactor diodes with EIA-registered type number introduced since the publication of the Motorola Semiconductor Data Book (4th Edition).

KEY

TYPE	REF.	CAPACITANCE					BV_R	Q @ f	Max R_S	GUARANTEED MULTIPLIER PERFORMANCE					
		C_J C_T*	C Tol	C (max) / C (min)	Voltage Range					P_D @ 25°C	P_{in}	f_{in}	Min P_{out}	f_{out}	Min η
					V_1	V_2									
		pF	%		Volts	Volts	Volts	GHz	Ohms	Watts	Watts	GHz	Watts	GHz	%

- TYPE: Numerical Listing of Registered Type Numbers
- REF.: Reference device number indicates specific Data Sheet on which device is characterized
- C_J / C_T*: Nominal Capacitance usually C_J (junction capacitance) With *, specified value is C_T (total capacitance) $C_T = C_J + C_C$
- C Tol: Tolerance of capacitance listed in preceding column
- C (max)/C (min): Effective tuning Ratio (Capacitance at Voltage V_1 divided by capacitance at Voltage V_2)
- V_1, V_2: Voltage range over which the tuning range is measured
- BV_R: Reverse Breakdown Voltage
- Q @ f: Figure of Merit at this specified frequency
- Max R_S: Maximum Series Resistance
- P_D: Power Dissipation at 25°C
- P_{in}: Input Power
- f_{in}: Input Frequency
- Min P_{out}: Minimum Output Power at output frequency
- f_{out}: Output frequency
- Min η: Minimum efficiency ($P_{out}/P_{in} \times 100$)

VARACTOR DIODE INDEX (continued)

TYPE	REF.	CAPACITANCE C_J C_T* pF	C Tol %	C (max) / C (min)	Voltage Range V_1 Volts	V_2 Volts	BV_R Volts	Q	@ f GHz	Max R_S Ohms	P_D @ 25°C Watts	MULTIPLIER PERFORMANCE P_{in} Watts	f_{in} GHz	Min P_{out} Watts	f_{out} GHz	Min η %
1N5439		3.3*	20	2.3	2.0	30	30	450	0.05		0.4					
1N5439A		3.3*	10	2.3	2.0	30	30	450	0.05		0.4					
1N5439B		3.3*	5.0	2.3	2.0	30	30	450	0.05		0.4					
1N5439C		3.3*	2.0	2.3	2.0	30	30	450	0.05		0.4					
1N5439D		3.3*	1.0	2.3	2.0	30	30	450	0.05		0.4					
1N5440		4.7*	20	2.4	2.0	30	30	450	0.05		0.4					
1N5440A		4.7*	10	2.4	2.0	30	30	450	0.05		0.4					
1N5440B		4.7*	5.0	2.4	2.0	30	30	450	0.05		0.4					
1N5440C		4.7*	2.0	2.4	2.0	30	30	450	0.05		0.4					
1N5440D		4.7*	1.0	2.4	2.0	30	30	450	0.05		0.4					
1N5441		6.8*	20	2.5	2.0	30	30	450	0.05		0.4					
1N5441A		6.8*	10	2.5	2.0	30	30	450	0.05		0.4					
1N5441B		6.8*	5.0	2.5	2.0	30	30	450	0.05		0.4					
1N5441C		6.8*	2.0	2.5	2.0	30	30	450	0.05		0.4					
1N5441D		6.8*	1.0	2.5	2.0	30	30	450	0.05		0.4					
1N5442		8.2*	20	2.5	2.0	30	30	450	0.05		0.4					
1N5442A		8.2*	10	2.5	2.0	30	30	450	0.05		0.4					
1N5442B		8.2*	5.0	2.5	2.0	30	30	450	0.05		0.4					
1N5442C		8.2*	2.0	2.5	2.0	30	30	450	0.05		0.4					
1N5442D		8.2*	1.0	2.5	2.0	30	30	450	0.05		0.4					
1N5443		10*	20	2.6	2.0	30	30	400	0.05		0.4					
1N5443A		10*	10	2.6	2.0	30	30	400	0.05		0.4					
1N5443B		10*	5.0	2.6	2.0	30	30	400	0.05		0.4					
1N5443C		10*	2.0	2.6	2.0	30	30	400	0.05		0.4					
1N5443D		10*	1.0	2.6	2.0	30	30	400	0.05		0.4					
1N5444		12*	20	2.6	2.0	30	30	400	0.05		0.4					
1N5444A		12*	10	2.6	2.0	30	30	400	0.05		0.4					
1N5444B		12*	5.0	2.6	2.0	30	30	400	0.05		0.4					
1N5444C		12*	2.0	2.6	2.0	30	30	400	0.05		0.4					
1N5444D		12*	1.0	2.6	2.0	30	30	400	0.05		0.4					
1N5445		15*	20	2.6	2.0	30	30	400	0.05		0.4					
1N5445A		15*	10	2.6	2.0	30	30	400	0.05		0.4					
1N5445B		15*	5.0	2.6	2.0	30	30	400	0.05		0.4					
1N5445C		15*	2.0	2.6	2.0	30	30	400	0.05		0.4					
1N5445D		15*	1.0	2.6	2.0	30	30	400	0.05		0.4					
1N5446		18*	20	2.6	2.0	30	30	350	0.05		0.4					
1N5446A		18*	10	2.6	2.0	30	30	350	0.05		0.4					
1N5446B		18*	5.0	2.6	2.0	30	30	350	0.05		0.4					
1N5446C		18*	2.0	2.6	2.0	30	30	350	0.05		0.4					
1N5446D		18*	1.0	2.6	2.0	30	30	350	0.05		0.4					
1N5447		20*	20	2.6	2.0	30	30	350	0.05		0.4					
1N5447A		20*	10	2.6	2.0	30	30	350	0.05		0.4					
1N5447B		20*	5.0	2.6	2.0	30	30	350	0.05		0.4					
1N5447C		20*	2.0	2.6	2.0	30	30	350	0.05		0.4					
1N5447D		20*	1.0	2.6	2.0	30	30	350	0.05		0.4					
1N5448		22*	20	2.6	2.0	30	30	350	0.05		0.4					
1N5448A		22*	10	2.6	2.0	30	30	350	0.05		0.4					
1N5448B		22*	5.0	2.6	2.0	30	30	350	0.05		0.4					
1N5448C		22*	2.0	2.6	2.0	30	30	350	0.05		0.4					
1N5448D		22*	1.0	2.6	2.0	30	30	350	0.05		0.4					
1N5449		27*	20	2.6	2.0	30	30	350	0.05		0.4					
1N5449A		27*	10	2.6	2.0	30	30	350	0.05		0.4					
1N5449B		27*	5.0	2.6	2.0	30	30	350	0.05		0.4					
1N5449C		27*	2.0	2.6	2.0	30	30	350	0.05		0.4					
1N5449D		27*	1.0	2.6	2.0	30	30	350	0.05		0.4					
1N5450		33*	20	2.6	2.0	30	30	350	0.05		0.4					
1N5450A		33*	10	2.6	2.0	30	30	350	0.05		0.4					
1N5450B		33*	5.0	2.6	2.0	30	30	350	0.05		0.4					
1N5450C		33*	2.0	2.6	2.0	30	30	350	0.05		0.4					
1N5450D		33*	1.0	2.6	2.0	30	30	350	0.05		0.4					
1N5451		39*	20	2.6	2.0	30	30	300	0.05		0.4					
1N5451A		39*	10	2.6	2.0	30	30	300	0.05		0.4					
1N5451B		39*	5.0	2.6	2.0	30	30	300	0.05		0.4					
1N5451C		39*	2.0	2.6	2.0	30	30	300	0.05		0.4					
1N5451D		39*	1.0	2.6	2.0	30	30	300	0.05		0.4					
1N5452		47*	20	2.6	2.0	30	30	250	0.05		0.4					
1N5452A		47*	10	2.6	2.0	30	30	250	0.05		0.4					
1N5452B		47*	5.0	2.6	2.0	30	30	250	0.05		0.4					
1N5452C		47*	2.0	2.6	2.0	30	30	250	0.05		0.4					
1N5452D		47*	1.0	2.6	2.0	30	30	250	0.05		0.4					

TYPE	REF.	CAPACITANCE C_J / C_T* pF	C Tol %	C (max) / C (min)	Voltage Range V_1 Volts	Voltage Range V_2 Volts	BV_R Volts	Q	@ f GHz	Max R_S Ohms	P_D @ 25°C Watts	MULTIPLIER PERFORMANCE P_{in} Watts	f_{in} GHz	Min P_{out} Watts	f_{out} GHz	Min η %
1N5453		56*	20	2.6	2.0	30	30	200	0.05		0.4					
1N5453A		56*	10	2.6	2.0	30	30	200	0.05		0.4					
1N5453B		56*	5.0	2.6	2.0	30	30	200	0.05		0.4					
1N5453C		56*	2.0	2.6	2.0	30	30	200	0.05		0.4					
1N5453D		56*	1.0	2.6	2.0	30	30	200	0.05		0.4					
1N5454		68*	20	2.7	2.0	30	30	175	0.05		0.4					
1N5454A		68*	10	2.7	2.0	30	30	175	0.05		0.4					
1N5454B		68*	5.0	2.7	2.0	30	30	175	0.05		0.4					
1N5454C		68*	2.0	2.7	2.0	30	30	175	0.05		0.4					
1N5454D		68*	1.0	2.7	2.0	30	30	175	0.05		0.4					
1N5455		82*	20	2.7	2.0	30	30	175	0.05		0.4					
1N5455A		82*	10	2.7	2.0	30	30	175	0.05		0.4					
1N5455B		82*	5.0	2.7	2.0	30	30	175	0.05		0.4					
1N5455C		82*	2.0	2.7	2.0	30	30	175	0.05		0.4					
1N5455D		82*	1.0	2.7	2.0	30	30	175	0.05		0.4					
1N5456		100*	20	2.7	2.0	30	30	175	0.05		0.4					
1N5456A		100*	10	2.7	2.0	30	30	175	0.05		0.4					
1N5456B		100*	5.0	2.7	2.0	30	30	175	0.05		0.4					
1N5456C		100*	2.0	2.7	2.0	30	30	175	0.05		0.4					
1N5456D		100*	1.0	2.7	2.0	30	30	175	0.05		0.4					
1N5457		120*	20	2.7	2.0	30	30	150	0.05		0.4					
1N5457A		120*	10	2.7	2.0	30	30	150	0.05		0.4					
1N5457B		120*	5.0	2.7	2.0	30	30	150	0.05		0.4					
1N5457C		120*	2.0	2.7	2.0	30	30	150	0.05		0.4					
1N5457D		120*	1.0	2.7	2.0	30	30	150	0.05		0.4					
1N5458		3.9*	20	2.5	2.0	30	30	600	0.05		0.4					
1N5458A		3.9*	10	2.5	2.0	30	30	600	0.05		0.4					
1N5458B		3.9*	5.0	2.5	2.0	30	30	600	0.05		0.4					
1N5458C		3.9*	2.0	2.5	2.0	30	30	600	0.05		0.4					
1N5458D		3.9*	1.0	2.5	2.0	30	30	600	0.05		0.4					
1N5459		4.7*	20	2.6	2.0	30	30	600	0.05		0.4					
1N5459A		4.7*	10	2.6	2.0	30	30	600	0.05		0.4					
1N5459B		4.7*	5.0	2.6	2.0	30	30	600	0.05		0.4					
1N5459C		4.7*	2.0	2.6	2.0	30	30	600	0.05		0.4					
1N5459D		4.7*	1.0	2.6	2.0	30	30	600	0.05		0.4					
1N5460		5.6*	20	2.6	2.0	30	30	600	0.05		0.4					
1N5460A		5.6*	10	2.6	2.0	30	30	600	0.05		0.4					
1N5460B		5.6*	5.0	2.6	2.0	30	30	600	0.05		0.4					
1N5460C		5.6*	2.0	2.6	2.0	30	30	600	0.05		0.4					
1N5460D		5.6*	1.0	2.6	2.0	30	30	600	0.05		0.4					
1N5461		6.8*	20	2.7	2.0	30	30	600	0.05		0.4					
1N5461A		6.8*	10	2.7	2.0	30	30	600	0.05		0.4					
1N5461B		6.8*	5.0	2.7	2.0	30	30	600	0.05		0.4					
1N5461C		6.8*	2.0	2.7	2.0	30	30	600	0.05		0.4					
1N5461D		6.8*	1.0	2.7	2.0	30	30	600	0.05		0.4					
1N5462		8.2*	20	2.8	2.0	30	30	600	0.05		0.4					
1N5462A		8.2*	10	2.8	2.0	30	30	600	0.05		0.4					
1N5462B		8.2*	5.0	2.8	2.0	30	30	600	0.05		0.4					
1N5462C		8.2*	2.0	2.8	2.0	30	30	600	0.05		0.4					
1N5462D		8.2*	1.0	2.8	2.0	30	30	600	0.05		0.4					
1N5463		10*	20	2.8	2.0	30	30	550	0.05		0.4					
1N5463A		10*	10	2.8	2.0	30	30	550	0.05		0.4					
1N5463B		10*	5.0	2.8	2.0	30	30	550	0.05		0.4					
1N5463C		10*	2.0	2.8	2.0	30	30	550	0.05		0.4					
1N5463D		10*	1.0	2.8	2.0	30	30	550	0.05		0.4					
1N5464		12*	20	2.8	2.0	30	30	550	0.05		0.4					
1N5464A		12*	10	2.8	2.0	30	30	550	0.05		0.4					
1N5464B		12*	5.0	2.8	2.0	30	30	550	0.05		0.4					
1N5464C		12*	2.0	2.8	2.0	30	30	550	0.05		0.4					
1N5464D		12*	1.0	2.8	2.0	30	30	550	0.05		0.4					
1N5465		15*	20	2.8	2.0	30	30	550	0.05		0.4					
1N5465A		15*	10	2.8	2.0	30	30	550	0.05		0.4					
1N5465B		15*	5.0	2.8	2.0	30	30	550	0.05		0.4					
1N5465C		15*	2.0	2.8	2.0	30	30	550	0.05		0.4					
1N5465D		15*	1.0	2.8	2.0	30	30	550	0.05		0.4					
1N5466		18*	20	2.9	2.0	30	30	500	0.05		0.4					
1N5466A		18*	10	2.9	2.0	30	30	500	0.05		0.4					
1N5466B		18*	5.0	2.9	2.0	30	30	500	0.05		0.4					
1N5466C		18*	2.0	2.9	2.0	30	30	500	0.05		0.4					
1N5466D		18*	1.0	2.9	2.0	30	30	500	0.05		0.4					

TYPE	REF.	CAPACITANCE C_J C_T* pF	C Tol %	C (max)/C (min)	Voltage Range V_1 Volts	V_2 Volts	BV_R Volts	Q	@ f GHz	Max R_S Ohms	P_D @ 25°C Watts	MULTIPLIER PERFORMANCE P_{in} Watts	f_{in} GHz	Min P_{out} Watts	f_{out} GHz	Min η %
1N5467		20*	20	2.9	2.0	30	30	500	0.05		0.4					
1N5467A		20*	10	2.9	2.0	30	30	500	0.05		0.4					
1N5467B		20*	5.0	2.9	2.0	30	30	500	0.05		0.4					
1N5467C		20*	2.0	2.9	2.0	30	30	500	0.05		0.4					
1N5467D		20*	1.0	2.9	2.0	30	30	500	0.05		0.4					
1N5468		22*	20	2.9	2.0	30	30	500	0.05		0.4					
1N5468A		22*	10	2.9	2.0	30	30	500	0.05		0.4					
1N5468B		22*	5.0	2.9	2.0	30	30	500	0.05		0.4					
1N5468C		22*	2.0	2.9	2.0	30	30	500	0.05		0.4					
1N5468D		22*	1.0	2.9	2.0	30	30	500	0.05		0.4					
1N5469		27*	20	2.9	2.0	30	30	500	0.05		0.4					
1N5469A		27*	10	2.9	2.0	30	30	500	0.05		0.4					
1N5469B		27*	5.0	2.9	2.0	30	30	500	0.05		0.4					
1N5469C		27*	2.0	2.9	2.0	30	30	500	0.05		0.4					
1N5469D		27*	1.0	2.9	2.0	30	30	500	0.05		0.4					
1N5470		33*	20	2.9	2.0	30	30	500	0.05		0.4					
1N5470A		33*	10	2.9	2.0	30	30	500	0.05		0.4					
1N5470B		33*	5.0	2.9	2.0	30	30	500	0.05		0.4					
1N5470C		33*	2.0	2.9	2.0	30	30	500	0.05		0.4					
1N5470D		33*	1.0	2.9	2.0	30	30	500	0.05		0.4					
1N5471		39*	20	2.9	2.0	30	30	450	0.05		0.4					
1N5471A		39*	10	2.9	2.0	30	30	450	0.05		0.4					
1N5471B		39*	5.0	2.9	2.0	30	30	450	0.05		0.4					
1N5471C		39*	2.0	2.9	2.0	30	30	450	0.05		0.4					
1N5471D		39*	1.0	2.9	2.0	30	30	450	0.05		0.4					
1N5472		47*	20	2.9	2.0	30	30	400	0.05		0.4					
1N5472A		47*	10	2.9	2.0	30	30	400	0.05		0.4					
1N5472B		47*	5.0	2.9	2.0	30	30	400	0.05		0.4					
1N5472C		47*	2.0	2.9	2.0	30	30	400	0.05		0.4					
1N5472D		47*	1.0	2.9	2.0	30	30	400	0.05		0.4					
1N5473		56*	20	2.9	2.0	30	30	300	0.05		0.4					
1N5473A		56*	10	2.9	2.0	30	30	300	0.05		0.4					
1N5473B		56*	5.0	2.9	2.0	30	30	300	0.05		0.4					
1N5473C		56*	2.0	2.9	2.0	30	30	300	0.05		0.4					
1N5473D		56*	1.0	2.9	2.0	30	30	300	0.05		0.4					
1N5474		68*	20	2.9	2.0	30	30	250	0.05		0.4					
1N5474A		68*	10	2.9	2.0	30	30	250	0.05		0.4					
1N5474B		68*	5.0	2.9	2.0	30	30	250	0.05		0.4					
1N5474C		68*	2.0	2.9	2.0	30	30	250	0.05		0.4					
1N5474D		68*	1.0	2.9	2.0	30	30	250	0.05		0.4					
1N5475		82*	20	2.9	2.0	30	30	225	0.05		0.4					
1N5475A		82*	10	2.9	2.0	30	30	225	0.05		0.4					
1N5475B		82*	5.0	2.9	2.0	30	30	225	0.05		0.4					
1N5475C		82*	2.0	2.9	2.0	30	30	225	0.05		0.4					
1N5475D		82*	1.0	2.9	2.0	30	30	225	0.05		0.4					
1N5476		100*	20	2.9	2.0	30	30	200	0.05		0.4					
1N5476A		100*	10	2.9	2.0	30	30	200	0.05		0.4					
1N5476B		100*	5.0	2.9	2.0	30	30	200	0.05		0.4					
1N5476C		100*	2.0	2.9	2.0	30	30	200	0.05		0.4					
1N5476D		100*	1.0	2.9	2.0	30	30	200	0.05		0.4					

NUMERICAL INDEX

Numerical Listing of EIA-Registered 2N and 3N Type Numbers and Short-Form specifications for devices introduced since the publication of the Motorola Semiconductor Data Book (4th Edition).

KEY

TYPE	MATERIAL	POLARITY	REPLACEMENT	REF.	USE	MAXIMUM RATINGS						ELECTRICAL CHARACTERISTICS								
						P_D @ 25°C	Ref Point	T_J °C	V_{CBO} (volts)	V_{CE-} (volts)	Subscript	h_{FE} (min) (max) @ I_C	Units	$V_{CE(SAT)}$ (volts) @ I_C	Units	h_{f-}	Subscript	f_-	Units	Subscript

TYPE: Numerical Listing of 2N and 3N Registered Type Numbers

MATERIAL: S = Silicon, G = Germanium

POLARITY: P = PNP, N = NPN

REPLACEMENT: Type number of recommended replacement or of nearest electrical equivalent fully characterized in this book

REF.: Reference device number indicates specific Data Sheet on which device is characterized

USE:

APPLICATION CODE

- A = Amplifier
- AH = Amplifier, High frequency
- AHP = Amplifier, High frequency power
- AL = Amplifier, Light sensitive
- AM = Amplifier, Multiple device
- AP = Amplifier, Power
- S = Switch
- SC = Switch, Chopper
- SH = Switch, High speed
- SHP = Switch, High speed power
- SP = Switch, Power

P_D: Power Dissipation at 25°C

Units: M = milliwatts
W = Watts

Ref. Point: A, C, J, S, Indicates Ambient, Case, Junction or Stud

T_J: Maximum Operating Junction Temperature

V_{CBO}: Maximum Collector - Base Voltage

V_{CE}: Maximum Collector-Emitter Voltage (Subscript Identifies Condition)

Subscript:
- O = V_{CEO} = Base Open
- R = V_{CER} = Specified Resistance
- S = V_{CES} = Base Shorted
- V = V_{CEV} = Used when only voltage bias is used
- X = V_{CEX} = Base-Emitter Back Biased
- U = V_{CE} = Termination Undefined

h_{FE}: Common-Emitter DC Short-Circuit Forward-Current Transfer Ratio at Specified Collector Current

I_C Units: A = Amps
M = milliamps
* = microamps
N = nanoamps

$V_{CE(SAT)}$: Collector-Emitter Saturation Voltage at Specified Collector Current

I_C Units:
A = Amps
M = milliamps

h_{f-}: Small-Signal Forward-Current Transfer Ratio (E, B or C defines the parameter)

- E = h_{fe} = Common-Emitter Current Transfer Ratio
- B = h_{fb} = Common-Base Current Transfer Ratio
- C = h_{fc} = Common-Collector Current Transfer Ratio

f_-:

CUTOFF FREQUENCY

Units: K = KHz
M = MHz
G = GHz

(B, E, M or T Indicate the Parameter)

- B = f_{hfb} = f_{ab} = Common-Base Cutoff Frequency
- E = f_{hfe} = f_{ae} = Common-Emitter Cutoff Frequency
- M = f_{max} = Maximum Frequency of Oscillations
- T = f_T = Current Gain - Bandwidth Product

TYPE	MATERIAL	POLARITY	REPLACE-MENT	REF.	USE	MAXIMUM RATINGS P_D @ 25°C	Ref Point	T_J °C	V_{CB} (volts)	V_{CE-} (volts)	Subscript	ELECTRICAL CHARACTERISTICS h_{FE} (min)	h_{FE} (max)	@ I_C Units	$V_{CE(SAT)}$ (volts)	@ I_C Units	h_{f-}	Subscript	f_- Units	Subscript
2N3684A	Field-Effect Transistor, see Table on Page 14																			
2N3685A	Field-Effect Transistor, see Table on Page 14																			
2N3686A	Field-Effect Transistor, see Table on Page 14																			
2N3687A	Field-Effect Transistor, see Table on Page 14																			
2N3740A	S	P		2N3740	AP	25W	C	200	60	60	0	30	100	250M	0.6	1.0A	25	E	4.0M	T
2N3741A	S	P		2N3740	AP	25W	C	200	80	80	0	30	100	250M	0.6	1.0A	25	E	4.0M	T
2N4091A	Field-Effect Transistor, see Table on Page 14																			
2N4092A	Field-Effect Transistor, see Table on Page 14																			
2N4093A	Field-Effect Transistor, see Table on Page 14																			
2N4877	S	N			SP	10W	C	200	70	60	0	20	10	4.0A	1.0	4.0A	4.0	E		
2N5031	S	N		2N5031	AH	200M	A		15	10	0	25	300	1.0M					1.0G	T
2N5032	S	N		2N5031	AH	200M	A		15	10	0	25	300	1.0M					1.0G	T
2N5050	S	N		2N5050	AP	40W	C	175	125	125	0	25	100	750M	1.0	750M	25	E	10M	T
2N5051	S	N		2N5050	AP	40W	C	175	150	150	0	25	100	750M	1.0	750M	25	E	10M	T
2N5052	S	N		2N5050	AP	40W	C	175	200	200	0	25	100	750M	1.0	750M	25	E	10M	T
2N5117	S	P			AM	400M	C		45	45	0	100	300	10*					100M	T
2N5118	S	P			AM	400M	C		45	45	0	100	300	10*					100M	T
2N5119	S	P			AM	400M	C		45	45	0	50	800	10*					100M	T
2N5120	S	P			AM	300M	C		45	45	0	100	300	10*					100M	T
2N5121	S	P			AM	300M	C		45	45	0	100	300	10*					100M	T
2N5122	S	P			AM	300M	C		45	45	0	50	800	10*					100M	T
2N5123	S	P			AM	400M	C		45	45	0	100	300	10*					100M	T
2N5124	S	P			AM	400M	C		45	45	0	100	300	10*					100M	T
2N5125	S	P			AM	400M	C		45	45	0	50	800	10*					100M	T
2N5239	S	N			AP	100W	C	200	300			20	80	2.0A	5.0	4.5A	20	E	5.0M	T
2N5240	S	N			AP	100W	C	200	375			20	80	2.0A	5.0	4.5A	20	E	5.0M	T
2N5244	S	P			SH	1.0W	C	200		40	0	150	300	10M	0.12	10M			400M	T
2N5368	S	N			A	360M	A	150	60	30	0	60	200	150M	0.3	150M			250M	T
2N5369	S	N			A	360M	A	150	60	30	0	100	300	150M	0.3	150M			250M	T
2N5370	S	N			A	360M	A	150	60	30	0	200	600	150M	0.3	150M			250M	T
2N5371	S	N			A	360M	A	150	40	30	0	60	600	150M	0.3	150M			250M	T
2N5372	S	P			A	360M	A	150	60	30	0	40	120	150M	0.3	150M			150M	T
2N5373	S	P			A	360M	A	150	60	30	0	100	300	150M	0.3	150M			150M	T
2N5374	S	P			A	360M	A	150	60	30	0	200	400	150M	0.3	150M			150M	T
2N5375	S	P			A	360M	A	150	40	30	0	40	400	150M	0.3	150M			150M	T
2N5376	S	N			A	360M	A	150	60	30	0	100	500	10*	0.2	10M	120	E	300M	T
2N5377	S	N			A	360M	A	150	60	30	0	40	200	10*	0.2	10M	100	E	300M	T
2N5378	S	P			A	360M	A	150	40	30	0	100	500	10*	0.2	10M	120	E	200M	T
2N5379	S	P			A	360M	A	150	40	30	0	40	200	10*	0.2	10M	100	E	200M	T
2N5400	S	P		2N5400	A	310M	A		130	120	0	40	180	10M	0.25	50M	30	E	100M	T
2N5401	S	P		2N5400	A	310M	A		160	150	0	60	240	10M	0.25	50M	40	E	100M	T
2N5418	S	N			A	360M	A		25	25	0	40	120	50M	0.25	50M	25	E		
2N5419	S	N			A	360M	A		25	25	0	100	300	50M	0.25	50M	70	E		
2N5420	S	N			A	360M	A		25	25	0	250	500	50M	0.25	50M	150	E		
2N5539	S	N			SP			200	175	130	0	25	75	10A	3.0	20A			20M	T
2N5540	S	N			SP			200	325	300	0	20	60	5.0A	2.5	10A			20M	T
2N5541	S	N			SP			200	175	130	0	30	90	5.0A	2.5	10A			20M	T
2N5542	S	N			SP			200	175	130	0	30	90	5.0A	2.5	10A			20M	T
2N5550	S	N		2N5550	A	310M	A		160	140	0	60	250	10M	0.25	50M	50	E	100M	T
2N5551	S	N		2N5550	A	310M	A		180	160	0	80	250	10M	0.20	50M	50	E	100M	T
2N5561 thru 2N5566	Field-Effect Transistors, see Table on Page 14																			
2N5581	S	N		2N5581	SH	2.0W	C		75	40	0	40	120	150M	0.3	150M			250M	T
2N5582	S	N		2N5581	SH	2.0W	C		75	40	0	100	300	150M	0.3	150M			300M	T
2N5583	S	P		2N5581	SH	5.0W	C		30	30	0	25	100	100M	0.8	100M			1.3G	T
2N5584	S	N			SP			200	225	180	0	40	120	10A	1.8	20A				
2N5589	S	N		2N5589	AP	15W	C		36	18	0	5.0		100M					200M	T
2N5590	S	N		2N5589	AP	30W	C		36	18	0	5.0		250M					200M	T
2N5591	S	N		2N5589	AP	70W	C		36	18	0	5.0		200M					200M	T
2N5592 thru 2N5594	Field-Effect Transistors, see Table on Page 14																			
2N5595	S	N			AP	20W	C		55	30	0	20		50M					1.5G	T
2N5596	S	N			AP	40W	C		55	30	0	20		50M					1.5G	T
2N5597	S	P			AP	20W	C	200	80	60	0	70	200	1.0A	0.46	1.0A	50	E	60M	T
2N5598	S	N			AP	20W	C	200	80	60	0	70	200	1.0A	0.46	1.0A	50	E	60M	T
2N5599	S	P			AP	20W	C	200	100	80	0	30	90	1.0A	0.46	1.0A	20	E	50M	T
2N5600	S	N			AP	20W	C	200	100	80	0	30	90	1.0A	0.46	1.0A	20	E	50M	T
2N5601	S	P			AP	20W	C	200	100	80	0	70	200	1.0A	0.46	1.0A	50	E	60M	T
2N5602	S	N			AP	20W	C	200	10	80	0	70	200	1.0A	0.46	1.0A	50	E	60M	T
2N5603	S	P			AP	20W	C	200	120	100	0	30	90	1.0A	0.46	1.0A	20	E	50M	T
2N5604	S	N			AP	20W	C	200	120	100	0	30	90	1.0A	0.46	1.0A	20	E	50M	T
2N5605	S	P			AP	25W	C	200	80	60	0	70	200	2.5A	0.75	2.5A	50	E	70M	T
2N5606	S	N			AP	25W	C	200	80	60	0	70	200	2.5A	0.75	2.5A	50	E	70M	T
2N5607	S	P			AP	25W	C	200	100	80	0	30	90	2.5A	0.75	2.5A	20	E	60M	T
2N5608	S	N			AP	25W	C	200	100	80	0	30	90	2.5A	0.75	2.5A	20	E	60M	T
2N5609	S	P			AP	25W	C	200	100	80	0	70	200	2.5A	0.75	2.5A	50	E	70M	T
2N5610	S	N			AP	25W	C	200	100	80	0	70	200	2.5A	0.75	2.5A	50	E	70M	T
2N5611	S	P			AP	25W	C	200	120	100	0	30	90	2.5A	1.45	2.5A	20	E	60M	T
2N5612	S	N			AP	25W	C	200	120	100	0	30	90	2.5A	1.45	2.5A	20	E	60M	T
2N5613	S	P			AP			200	80	60	0	70	200	2.5A	0.75	2.5A	50	E	70M	T

NUMERICAL INDEX (continued)

TYPE	MATERIAL	POLARITY	REPLACEMENT	REF.	USE	MAXIMUM RATINGS: P_D @ 25°C	Ref Point	T_J °C	V_{CB} (volts)	V_{CE-} (volts)	Subscript	ELECTRICAL CHARACTERISTICS: h_{FE} (min)	h_{FE} (max)	@ I_C Units	$V_{CE(SAT)}$ (volts)	@ I_C Units	h_{f-}	Subscript	f_- Units	Subscript
2N5614	S	N			AP			200	80	60	0	70	200	2.5A	0.75	2.5A	50	E	70M	T
2N5615	S	P			AP			200	100	80	0	30	90	2.5A	0.75	2.5A	20	E	60M	T
2N5616	S	N			AP			200	100	80	0	30	90	2.5A	0.75	2.5A	20	E	60M	T
2N5617	S	P			AP			200	100	80	0	70	200	2.5A	0.75	2.5A	50	E	70M	T
2N5618	S	N			AP			200	100	80	0	70	200	2.5A	0.75	2.5A	50	E	70M	T
2N5619	S	P			AP			200	120	100	0	30	90	2.5A	0.75	2.5A	20	E	60M	T
2N5620	S	N			AP			200	120	100	0	30	90	2.5A	0.75	2.5A	20	E	60M	T
2N5621	S	P			AP			200	80	60	0	70	200	5.0A	0.9	5.0A	50	E	40M	T
2N5622	S	N			AP			200	80	60	0	70	200	5.0A	0.9	5.0A	50	E	40M	T
2N5623	S	P			AP			200	100	80	0	30	90	5.0A	0.9	5.0A	20	E	30M	T
2N5624	S	N			AP			200	100	80	0	30	90	5.0A	0.9	5.0A	20	E	30M	T
2N5625	S	P			AP			200	100	80	0	70	200	5.0A	0.9	5.0A	50	E	40M	T
2N5626	S	N			AP			200	100	80	0	70	200	5.0A	0.9	5.0A	50	E	40M	T
2N5627	S	P			AP			200	120	100	0	30	90	5.0A	0.9	5.0A	20	E	30M	T
2N5628	S	N			AP			200	120	100	0	30	90	5.0A	0.9	5.0A	20	E	30M	T
2N5629	S	N		2N5629	AP	200W	C	200	100	100	0	25	100	8.0A	2.0	16A	15	E	1.0M	T
2N5630	S	N		2N5629	AP	200W	C	200	120	120	0	20	80	8.0A	2.0	16A	15	E	1.0M	T
2N5631	S	N		2N5629	AP	200W	C	200	140	140	0	15	60	8.0A	2.0	16A	15	E	1.0M	T
2N5632	S	N		2N5632	AP	150W	C	200	100	100	0	25	100	5.0A	2.0	10A	15	E	1.0M	T
2N5633	S	N		2N5632	AP	150W	C	200	120	120	0	20	80	5.0A	2.0	10A	15	E	1.0M	T
2N5634	S	N		2N5632	AP	150W	C	200	140	140	0	15	60	5.0A	2.0	10A	15	E	1.0M	T
2N5635	S	N		2N5635	A	7.5W	C		60	35	0	5.0		100M					500M	T
2N5636	S	N		2N5635	A	15W	C		60	35	0	5.0		200M					450M	T
2N5637	S	N		2N5635	A	30W	C		60	35	0	5.0		500M					400M	T
2N5641	S	N		2N5641	A	15W	C		65	35	0	5.0		100M					300M	T
2N5642	S	N		2N5641	A	30W	C		65	35	0	5.0		200M					250M	T
2N5643	S	N		2N5641	A	60W	C		65	35	0	5.0		200M					200M	T
2N5644	S	N			AP	3.5W	C		36	18	0	15		100M					400M	T
2N5645	S	N			AP	12W	C		36	18	0	15		500M					400M	T
2N5646	S	N			AP	30W	C		36	18	0	15		1.0A					400M	T
2N5647 thru 2N5649	Field-Effect Transistors, see Table on Page 14																			
2N5650	S	N			AH	150M	A		20	15	0	30	300	3.0M					2.0G	T
2N5651	S	N			AH	150M	A		20	15	0	30	300	3.0M					2.0G	T
2N5652	S	N			AH	150M	A		20	15	0	30	300	3.0M					2.0G	T
2N5658	S	N			SP	30W	C	200	120	80	0	50	150	5.0A	1.0	1.0A			30M	T
2N5659	S	N			SP	30W	C	200	120	80	0	50	150	5.0A	1.0	1.0A			30M	T
2N5668 thru 2N5670	Field-Effect Transistors, see Table on Page 14																			
2N5679	S	P		2N5679	AP	10W	C	200	100	100	0	40	150	250M	0.6	250M	40	E	30M	T
2N5680	S	P		2N5679	AP	10W	C	200	120	120	0	40	150	250M	0.6	250M	40	E	30M	T
2N5681	S	N		2N5681	AP	10W	C	200	100	100	0	40	150	250M	0.6	250M	40	E	30M	T
2N5682	S	N		2N5681	AP	10W	C	200	120	120	0	40	150	250M	0.6	250M	40	E	30M	T
2N5683	S	P		2N5683	AP	300W	C	200	60	60	0	15	60	25A	5.0	50A	15	E	2.0M	T
2N5684	S	P		2N5683	AP	300W	C	200	80	80	0	15	60	25A	5.0	50A	15	E	2.0M	T
2N5685	S	N		2N5685	AP	300W	C	200	60	60	0	15	60	25A	5.0	50A	15	E	2.0M	T
2N5686	S	N		2N5685	AP	300W	C	200	80	80	0	15	60	25A	5.0	50A	15	E	2.0M	T
2N5692	G	P			SP	125W	C	110	50	30	0	20	65	25A	0.75	60A			200M	T
2N5693	G	P			SP	125W	C	110	80	60	0	20	65	25A	0.75	60A			200M	T
2N5694	G	P			SP	125W	C	110	100	80	0	20	65	25A	0.75	60A			200M	T
2N5695	G	P			SP	125W	C	110	120	100	0	20	65	25A	0.75	60A			200M	T
2N5696	G	P			SP	125W	C	110	140	120	0	20	65	25A	0.75	60A			200M	T
2N5707	S	N			AP	70W	S	200	70	50	0	5.0	50	100M					50M	T
2N5708	S	N			AP	100W	S	200	70	50	0	5.0	50	100M					50M	T
2N5709	S	N			AP	140W	S	200	70	50	0	5.0	50	200M					50M	T
2N5715	S	N			AP	6.0W	S		50	3.0	0	20	200	50M					3.5G	T
3N151	Field-Effect Transistor, see Table on Page 14																			
3N162 thru 3N166	Field-Effect Transistors, see Table on Page 14																			
3N169 thru 3N174	Field-Effect Transistors, see Table on Page 14																			

FIELD-EFFECT TRANSISTORS

INDEX AND SHORT-FORM SPECIFICATIONS

This table contains a numerical listing and short-form specifications for field-effect transistors with EIA-registered 2N and 3N numbers, introduced since the publication of the Motorola Semiconductor Data Book (4th Edition).

KEY

TYPE	POLARITY	CONST.	NEAREST EQUIV.	REF.	I_{DSS} Min mA	I_{DSS} Max mA(*nA)	I_{GSS} I_{DGO}* nA	Breakdown Voltage $V_{(BR)}$ Volts	Breakdown Voltage Sub-script	y_{fs} Min μmhos	y_{fs} Max μmhos	C_{iss} pF	NF dB μV*/√Hz	@ f	Units	NOTE D = Dual MP = Matched Pair

- TYPE: Numerical Listing of Registered Type Numbers
- POLARITY: N = n-channel, P = p-channel
- CONST.: J = Junction FET, M = MOS FET
- NEAREST EQUIV.: Type number of nearest electrical equivalent fully characterized in this book
- REF.: Reference device number indicates specific Data Sheet on which device is characterized
- I_{DSS}: Minimum and Maximum Drain Current with gate connected to source
- I_{GSS}: Maximum Gate Current (leakage) with drain connected to source; *Maximum leakage from drain to gate with source open
- Breakdown Voltage: Minimum Breakdown Voltage (Subscript defines conditions)
  - GS = Gate to source, drain connection not specified
  - GSS = Gate to source, drain connected to source
  - GD = Gate to drain, source connection not specified
  - GDS = Gate to drain, source connected to drain
  - DGO = Drain to gate, source open
  - DGS = Drain to gate, source connected to drain
  - DS = Drain to source, gate connection not specified
  - DSX = Drain to source, gate biased to cutoff or beyond
- y_{fs}: Minimum and Maximum Forward Transadmittance
- C_{iss}: Maximum Input Capacitance
- NF @ f: Noise Figure in dB or *, μV / √Hz at a specified frequency
  - frequency units: H = Hz, K = kHz, M = MHz

FIELD-EFFECT TRANSISTORS INDEX

TYPE	POLARITY	CONST.	NEAREST EQUIVALENT	REF.	I_{DSS} Min mA	I_{DSS} Max mA (*nA)	I_{GSS} I_{DGO}* nA	Breakdown Voltage $V_{(BR)}$ Volts	Breakdown Voltage Sub-script	y_{fs} Min μmhos	y_{fs} Max μmhos	C_{ISS} pF	NF dB μV*/√Hz	@ f	Units	NOTE
2N3684A	N	J	2N4221A		2.5	7.5	0.1	50	GSS			4.0	0.5	100	H	
2N3685A	N	J	2N4220A		1.0	3.0	0.1	50	GSS			4.0	0.5	100	H	
2N3686A	N	J	2N4220A		0.4	1.2	0.1	50	GSS			4.0	0.5	100	H	
2N3687A	N	J	2N4220A		0.1	0.5	0.1	50	GSS			4.0	0.5	100	H	
2N4091A	N	J	2N4091		30		0.04	50	GSS			16				
2N4092A	N	J	2N4092		15		0.04	50	GSS			16				
2N4093A	N	J	2N4093		8.0		0.04	50	GSS			16				
2N5561	N	J			1.0	10	0.1	50	GSS			7.0	1.0	10	H	MP
2N5562	N	J			1.0	10	0.1	50	GSS			7.0	1.0	10	H	MP
2N5563	N	J			1.0	10	0.1	50	GSS			7.0	1.0	10	H	MP
2N5564	N	J			5.0	30	0.1	40	GSS			12	1.0	10	H	MP
2N5565	N	J			5.0	30	0.1	40	GSS			12	1.0	10	H	MP
2N5566	N	J			5.0	30	0.1	40	GSS			12	1.0	10	H	MP
2N5592	N	J			1.0	10	0.25	50	GSS			20	2.6	10	H	
2N5593	N	J			1.0	10	0.25	50	GSS			20	6.0	10	H	
2N5594	N	J			1.0	10	0.25	50	GSS			20	10	10	H	
2N5647	N	J			0.3	0.6	0.01	50	GSS			3.0	1.0	1.0	K	
2N5648	N	J			0.5	1.0	0.01	50	GSS			3.0	1.0	1.0	K	
2N5649	N	J			0.8	1.6	0.01	50	GSS			3.0	1.0	1.0	K	
2N5668	N	J		2N5668	1.0	5.0	2.0	25	GSS			7.0	2.5	100	M	
2N5669	N	J		2N5668	4.0	10	2.0	25	GSS			7.0	2.5	100	M	
2N5670	N	J		2N5668	8.0	20	2.0	25	GSS			7.0	2.5	100	M	
3N151	P	M				5.0*						12	10	100	H	D
3N162	P	M	MFE3003			150*						20				
3N163	P	M				0.2*	0.01					2.5				
3N164	P	M				0.4*	0.01					2.5				
3N165	P	M				0.2*	0.01					3.0				
3N166	P	M				0.2*	0.01					3.0				
3N169	N	M		3N169		10*						5.0				
3N170	N	M		3N169		10*						5.0				
3N171	N	M		3N169		10*						5.0				
3N172	P	M				0.4*						3.5				
3N173	P	M				10*						3.5				
3N174	P	M				5.0*	0.0025					4.0				

DEVICE INDEX

DEVICE INDEX

Devices characterized in this supplement are identified by a 1 in supplement column. All other devices are in the Semiconductor Data Book -- 4th Edition. The number shown in the reference column indicates the first device number listed on the page in the Data Book or Supplement where the device is characterized.

DEVICE	REFERENCE	SUPP.
1N91	1N91	
1N92	1N91	
1N93	1N91	
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1N249B,C	1N248B	
1N250B,C	1N248B	
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1N747,A	1N702	
1N748,A	1N702	
1N749,A	1N702	
1N750,A	1N702	
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1N755,A	1N702	
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1N758,A	1N702	
1N759,A	1N702	
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1N937,A,B	1N935	
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1N986	1N957	

DEVICE	REFERENCE	SUPP.
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1N2623,A,B	1N2620	

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DEVICE INDEX (continued)

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DEVICE	REFERENCE	SUPP.
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1N4003	1N4001	

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2N4958	2N4957	
2N4959	2N4957	
2N4974	2N4974	
2N4975	2N4974	
2N5031	2N5031	1
2N5032	2N5031	1
2N5050	2N5050	1
2N5051	2N5050	1
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2N5063	2N5060	
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2N5067	2N5067	
2N5068	2N5067	
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2N5086	2N5086	
2N5087	2N5086	
2N5088	2N5088	
2N5089	2N5088	
2N5108	2N5108	1
2N5146	2N5146	
2N5155	2N5155	1
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2N5161	2N5161	
2N5162	2N5161	
2N5164,R	2N5164	
2N5165,R	2N5164	
2N5166,R	2N5164	
2N5167,R	2N5164	
2N5168,R	2N5164	
2N5169,R	2N5164	
2N5170,R	2N5164	
2N5171,R	2N5164	
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2N5190	2N5190	
2N5191	2N5190	
2N5192	2N5190	
2N5193	2N5193	

DEVICE	REFERENCE	SUPP.
2N5194	2N5193	
2N5195	2N5193	
2N5208	2N5208	
2N5209	2N5209	
2N5210	2N5209	
2N5219	2N5219	
2N5220	2N5220	
2N5221	2N5221	
2N5222	2N5222	
2N5223	2N5223	
2N5224	2N5224	
2N5225	2N5225	
2N5226	2N5226	
2N5227	2N5227	
2N5228	2N5228	
2N5229	2N5229	1
2N5230	2N5229	1
2N5231	2N5229	1
2N5265	2N5265	
2N5266	2N5265	
2N5267	2N5265	
2N5268	2N5265	
2N5269	2N5265	
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2N5301	2N5301	
2N5302	2N5301	
2N5303	2N5301	
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2N5339	2N5336	
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2N5345	2N5344	
2N5346	2N5346	
2N5347	2N5346	
2N5348	2N5346	
2N5349	2N5346	
2N5357	2N5357	
2N5358	2N5358	
2N5359	2N5358	
2N5360	2N5358	
2N5361	2N5358	
2N5362	2N5358	
2N5363	2N5358	
2N5364	2N5358	
2N5400	2N5400	1
2N5401	2N5400	1
2N5427	2N5427	
2N5428	2N5427	
2N5429	2N5427	
2N5430	2N5427	
2N5431	2N5431	
2N5435	2N5435	
2N5436	2N5435	
2N5437	2N5435	
2N5438	2N5435	
2N5439	2N5435	
2N5440	2N5435	
2N5457	2N5457	
2N5458	2N5457	
2N5459	2N5457	
2N5460	2N5460	
2N5461	2N5460	
2N5462	2N5460	
2N5463	2N5460	
2N5464	2N5460	
2N5465	2N5460	
2M5471	2N5471	
2N5472	2N5471	
2N5473	2N5471	
2N5474	2N5471	
2N5475	2N5471	
2N5476	2N5471	

DEVICE	REFERENCE	SUPP.
2N5477	2N5477	
2N5478	2N5477	
2N5479	2N5477	
2N5480	2N5477	
2N5484	2N5484	
2N5485	2N5484	
2N5486	2N5484	
2N5550	2N5550	1
2N5551	2N5550	1
2N5555	2N5555	
2N5556	2N5556	
2N5557	2N5556	
2N5558	2N5556	
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2N5582	2N5581	1
2N5583	2N5583	1
2N5589	2N5589	1
2N5590	2N5590	1
2N5591	2N5591	1
2N5629	2N5629	1
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2N5632	2N5632	1
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2N5636	2N5635	1
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2N5638	2N5638	1
2N5639	2N5638	1
2N5640	2N5638	1
2N5641	2N5641	1
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2N5643	2N5641	1
2N5653	2N5653	1
2N5654	2N5653	1
2N5668	2N5668	1
2N5669	2N5668	1
2N5670	2N5668	1
2N5679	2N5679	1
2N5680	2N5679	1
2N5681	2N5681	1
2N5682	2N5681	1
2N5683	2N5683	1
2N5684	2N5683	1
2N5685	2N5685	1
2N5686	2N5685	1
3N124	3N124	
3N125	3N124	
3N126	3N124	
3N140	3N140	
3N155,A	3N155	
3N156,A	3N155	
3N157,A	3N157	
3N158,A	3N157	
3N169	3N169	1
3N170	3N169	1
3N171	3N169	1

DEVICE	REFERENCE	SUPP.
¼M2.4AZ	¼M2.4AZ	
¼M2.7AZ	¼M2.4AZ	
¼M3.0AZ	¼M2.4AZ	
¼M3.3AZ	¼M2.4AZ	
¼M3.6AZ	¼M2.4AZ	
¼M3.9AZ	¼M2.4AZ	
½M4.3AZ	¼M2.4AZ	
¼M4.7AZ	¼M2.4AZ	
¼M5.1AZ	¼M2.4AZ	
¼M5.6AZ	¼M2.4AZ	
¼M6.2AZ	¼M2.4AZ	
¼M6.8Z	¼M2.4AZ	
¼M7.5Z	¼M2.4AZ	
¼M8.2Z	¼M2.4AZ	
¼M9.1Z	¼M2.4AZ	
¼M10Z	¼M2.4AZ	
¼M11Z	¼M2.4AZ	
¼M12Z	¼M2.4AZ	
¼M13Z	¼M2.4AZ	
¼M14Z	¼M2.4AZ	
¼M15Z	¼M2.4AZ	
¼M16Z	¼M2.4AZ	
¼M17Z	¼M2.4AZ	
¼M18Z	¼M2.4AZ	
¼M19Z	¼M2.4AZ	
¼M20Z	¼M2.4AZ	
¼M22Z	¼M2.4AZ	
¼M24Z	¼M2.4AZ	
¼M25Z	¼M2.4AZ	
¼M27Z	¼M2.4AZ	
¼M30Z	¼M2.4AZ	
¼M33Z	¼M2.4AZ	
¼M36Z	¼M2.4AZ	
¼M39Z	¼M2.4AZ	
¼M43Z	¼M2.4AZ	
¼M45Z	¼M2.4AZ	
¼M47Z	¼M2.4AZ	
¼M50Z	¼M2.4AZ	
¼M52Z	¼M2.4AZ	
¼M56Z	¼M2.4AZ	
¼M62Z	¼M2.4AZ	
¼M68Z	¼M2.4AZ	
¼M75Z	¼M2.4AZ	
¼M82Z	¼M2.4AZ	
¼M91Z	¼M2.4AZ	
¼M100Z	¼M2.4AZ	
¼M105Z	¼M2.4AZ	
¼M110Z	¼M2.4AZ	
¼M120Z	¼M2.4AZ	
¼M130Z	¼M2.4AZ	
¼M140Z	¼M2.4AZ	
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¼M175Z	¼M2.4AZ	
¼M200Z	¼m2.4AZ	
.4M.64FR10	1N816	
.4M1.36FR5	1N816	
.4M1.36FR2	1N816	
.4M2.04FR5	1N816	
.4M2.04FR2	1N816	
1M110ZS10,5	1N4728	
1M120ZS10,5	1N4728	
1M130ZS10,5	1N4728	
1M150ZS10,5	1N4728	
1M160ZS10,5	1N4728	
1M180ZS10,5	1N4728	
1M200ZS10,5	1N4728	
AF239	AF239	1
MA100	MA100	
MA112	MA112	
MA113	MA112	
MA114	MA112	
MA115	MA112	
MA116	MA112	
MA117	MA112	
MA200	MA200	
MA201	MA200	
MA202	MA200	

DEVICE	REFERENCE	SUPP.
MA203	MA200	
MA204	MA200	
MA205	MA200	
MA206	MA200	
MA286	MA286	
MA287	MA286	
MA288	MA286	
MA881	MA881	
MA882	MA881	
MA883	MA881	
MA884	MA881	
MA885	MA881	
MA886	MA881	
MA887	MA881	
MA888	MA881	
MA889	MA881	
MA909	MA909	
MA910	MA909	
MA1702	MA1702	
MA1703	MA1702	
MA1704	MA1702	
MA1705	MA1702	
MA1706	MA1702	
MA1707	MA1702	
MA1708	MA1702	
MAC1	MAC1	
MAC2	MAC1	
MAC3	MAC1	
MAC21	MAC21	1
MCA1911	MCA1911	
MCA1912	MCA1911	
MCA1913	MCA1911	
MCA1914	MCA1911	
MCA1921	MCA1911	
MCA1922	MCA1911	
MCA1923	MCA1911	
MCA1924	MCA1911	
MCA1931	MCA1911	
MCA1932	MCA1911	
MCA1933	MCA1911	
MCA1934	MCA1911	
MCA2011	MCA1911	
MCA2012	MCA1911	
MCA2013	MCA1911	
MCA2014	MCA1911	
MCA2021	MCA1911	
MCA2022	MCA1911	
MCA2023	MCA1911	
MCA2024	MCA1911	
MCA2031	MCA1911	
MCA2032	MCA1911	
MCA2033	MCA1911	
MCA2034	MCA1911	
MCA2111	MCA1911	
MCA2112	MCA1911	
MCA2113	MCA1911	
MCA2114	MCA1911	
MCA2121	MCA1911	
MCA2122	MCA1911	
MCA2123	MCA1911	
MCA2124	MCA1911	
MCA2131	MCA1911	
MCA2132	MCA1911	
MCA2133	MCA1911	
MCA2134	MCA1911	
MCA2211	MCA1911	
MCA2212	MCA1911	
MCA2213	MCA1911	
MCA2214	MCA1911	
MCA2221	MCA1911	
MCA2222	MCA1911	
MCA2223	MCA1911	
MCA2224	MCA1911	
MCA2231	MCA1911	
MCA2232	MCA1911	
MCA2233	MCA1911	
MCA2234	MCA1911	

DEVICE	REFERENCE	SUPP.
MCL1300	MCL1300	
MCL1301	MCL1300	
MCL1302	MCL1300	
MCL1303	MCL1300	
MCL1304	MCL1300	
MCR406	MCR406	
MCR407	MCR407	1
MCR649	MCR649	
MCR729	MCR729	
MCR846	MCR846	
MCR1336	MCR1336	
MCR1718	MCR1718	
MCR1906	MCR1906	
MCR1907	MCR1907	
MCR2315	MCR2315	1
MCR2604	MCR1907	
MCR2605	MCR1907	
MCR2614L	MCR2315	1
MCR2818	MCR1907	
MCR2835	MCR2835	
MCR2918	MCR1907	
MCR2935	MCR2835	
MD708	MD708	
MD918	MD918	
MD984	MD984	
MD986	MD986	
MD1120	MD1120	
MD1121	MD1120	
MD1122	MD1120	
MD1126	MD1126	
MD1127	MD1126	
MD1128	MD1128	
MD1129	MD1129	
MD1130	MD1130	
MD1131	MD1131	
MD1132	MD1132	
MD1134	MD1134	
MD2218	MD2218	1
MD2219	MD2219	1
MD2369	MD2369	
MD2904	MD2904	1
MD2905	MD2905	1
MD3133	MD3133	
MD3134	MD3133	
MD3250	MD3250	
MD3251	MD3251	
MD3467	MD3467	
MD3725	MD3725	
MD3762	MD3762	
MD4957	MD4957	
MD5000	MD5000	
MD6001	MD6001	
MD6002	MD6001	
MD6100	MD6100	
MDA920	MDA920	
MDA930	MDA920	
MDA940	MDA920	
MDA942	MDA942	
MDA950	MDA920	
MDA952	MDA942	
MDA960	MDA960	
MDA962	MDA942	
MDA970	MDA960	
MDA972	MDA942	
MDA980	MDA980	1
MDA990	MDA980	1
MDA1330H	MDA1330H	
MDA1331H	MDA1330H	
MDA1332H	MDA1330H	
MDA1333H	MDA1330H	
MDA1491	MDA942	
MDA1505	MDA942	
MDA1591	MDA942	
MF3304	MF3304	
MFE2000	MFE2000	
MFE2001	MFE2000	
MFE2004	MFE2004	

DEVICE	REFERENCE	SUPP.
MFE2005	MFE2004	
MFE2006	MFE2004	
MFE2007	MFE2007	
MFE2008	MFE2007	
MFE2009	MFE2007	
MFE2010	MFE2010	
MFE2011	MFE2010	
MFE2012	MFE2010	
MFE2093	MFE2093	
MFE2094	MFE2093	
MFE2095	MFE2093	
MFE2097	MFE2097	
MFE2098	MFE2097	
MFE2133	MFE2133	
MFE3001	MFE3001	
MFE3002	MFE3002	
MFE3003	MFE3003	
MFE3004	MFE3004	
MFE3005	MFE3004	
MFE3006	MFE3006	1
MFE3007	MFE3006	1
MFE3008	MFE3006	1
MFE4007	MFE4007	
MFE4008	MFE4007	
MFE4009	MFE4007	
MFE4010	MFE4007	
MFE4011	MFE4007	
MFE4012	MFE4007	
MJ400	MJ400	
MJ413	MJ413	
MJ420	MJ420	
MJ421	MJ420	
MJ423	MJ413	
MJ431	MJ413	
MJ500	MJ500	1
MJ501	MJ500	1
MJ802	MJ802	1
MJ1800	MJ1800	1
MJ2249	MJ2249	
MJ2250	MJ2249	
MJ2251	MJ2251	
MJ2252	MJ2251	
MJ2267	MJ2267	
MJ2268	MJ2267	
MJ3029	MJ3029	
MJ3030	MJ3029	
MJ3101	MJ2249	
MJ3201	MJ3201	
MJ3202	MJ3201	
MJ3771	2N3771	1
MJ3772	2N3771	1
MJ3801	MJ3801	1
MJ3802	MJ3801	1
MJ4502	MJ4502	1
MJ6700	MJ6700	1
MJ6701	MJ6700	1
MJ7000	MJ7000	1
MJ7200	MJ7200	1
MJ7201	MJ7200	1
MJ8100	MJ8100	1
MJ8101	MJ8100	1
MJ8400	MJ8400	1
MJ9000	MJ9000	1
MJE105	MJE105	
MJE205	MJE205	
MJE340	MJE340	1
MJE370	MJE370	1
MJE371	MJE371	1
MJE520	MJE520	1
MJE521	MJE521	1
MJE2801	MJE2801	
MJE2901	MJE2901	
MJE2955	MJE2955	
MJE3055	MJE3055	
MM380	MM380	
MM709	MM709	
MM1139	MM1139	

DEVICE	REFERENCE	SUPP.
MM1500	MM1500	
MM1501	MM1500	
MM1549	MM1549	
MM1550	MM1549	
MM1551	MM1549	
MM1557	MM1557	
MM1558	MM1557	
MM1559	MM1557	
MM1603	MM1603	
MM1748	MM1748	
MM1803	2N3137	
MM1812	MM1803	
MM1941	MM1941	
MM2258	MM2258	
MM2259	MM2258	
MM2260	MM2258	
MM2483	MM2483	
MM2484	MM2483	
MM2894	MM2894	
MM3000	MM3000	
MM3001	MM3000	
MM3002	MM3000	
MM3003	MM3000	
MM3008	MM3008	
MM3009	MM3008	
MM3724	MM3724	
MM3725	MM3724	
MM3726	MM3726	
MM3903	MM3903	1
MM3904	MM3903	1
MM3905	MM3905	1
MM3906	MM3905	1
MM4000	MM4000	
MM4001	MM4000	
MM4002	MM4000	
MM4003	MM4000	
MM4048	MM4048	
MM4049	MM4049	1
MM4052	MM4052	1
MM4261H	MM4261H	1
MM4429	MM4429	1
MM4430	MM4430	1
MM5000	MM5000	
MM5001	MM5000	
MM5002	MM5000	
MM8000	MM8000	
MM8001	MM8000	
MM8002	MM8002	
MM8003	MM8003	
MM8006	MM8006	1
MM8007	MM8006	1
MM8008	MM8008	1
MM8009	MM8009	1
MM8010	MM8008	1
MM8011	MM8008	1
MMD6050	MMD6050	
MMD6100	MMD6050	
MMD6150	MMD6050	
MMD7000	MMD6050	
MMD7001	MMD7001	1
MMF1	MMF1	
MMF2	MMF1	
MMF3	MMF1	
MMF4	MMF1	
MMF5	MMF1	
MMF6	MMF1	
MMT918	MMT918	
MMT930	MMT930	
MMT2222	MMT2222	
MMT2369	MMT2369	
MMT2484	MMT930	
MMT2857	MMT2857	
MMT2907	MMT2907	
MMT3014	MMT3014	1
MMT3546	MMT3546	
MMT3798	MMT3798	
MMT3799	MMT3798	

DEVICE	REFERENCE	SUPP.
MMT3823	MMT3823	
MMT3903	MMT3903	
MMT3904	MMT3903	
MMT3905	MMT3905	
MMT3906	MMT3905	
MMT3960A	MMT3960A	
MP110	MP110	
MP110B	MP110B	
MP500	MP500	
MP501	MP500	
MP502	MP500	
MP504	MP500	
MP505	MP500	
MP506	MP500	
MP525	MP525	
MP600	MP600	
MP601	MP600	
MP602	MP600	
MP603	MP600	
MP800	MP800	
MP801	MP800	
MP900	MP900	
MP901	MP900	
MP902	MP900	
MP1612,A,B	MP1612	
MP1613	MP1613	
MP2000A	MP2000A	
MP2060	MP2060	
MP2061	MP2060	
MP2062	MP2060	
MP2063	MP2060	
MP2100A	MP2000A	
MP2200A	MP2000A	
MP2300A	MP2000A	
MP2400A	MP2000A	
MP3730	MP3730	
MP3731	MP3730	
MPF102	MPF102	
MPF108	MPF108	
MPF109	MPF109	
MPF161	MPF161	
MPS404,A	MPS404	
MPS706,A	MPS706	
MPS834	MPS834	
MPS918	MPS918	
MPS2369	MPS2369	
MPS2711	MPS2711	
MPS2712	MPS2711	
MPS2713	MPS2713	
MPS2714	MPS2713	
MPS2923	MPS2923	
MPS2924	MPS2923	
MPS2925	MPS2923	
MPS2926	MPS2926	
MPS3392	MPS3392	
MPS3393	MPS3392	
MPS3394	MPS3392	
MPS3395	MPS3392	
MPS3563	MPS918	
MPS3638,A	MPS3638	
MPS3639	MPS3639	
MPS3640	MPS3640	
MPS3646	MPS3646	
MPS3693	MPS3693	
MPS3694	MPS3693	
MPS3702	MPS3702	
MPS3703	MPS3702	
MPS3704	MPS3704	
MPS3705	MPS3704	
MPS3706	MPS3704	
MPS3707	MPS3707	
MPS3708	MPS3707	
MPS3709	MPS3707	
MPS3710	MPS3707	
MPS3711	MPS3707	
MPS3721	MPS2926	
MPS5172	MPS5172	1

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DEVICE	REFERENCE	SUPP.
MPS6507	MPS6507	
MPS6511	MPS6511	
MPS6512	MPS6512	
MPS6513	MPS6512	
MPS6514	MPS6512	
MPS6515	MPS6512	
MPS6516	MPS6516	
MPS6517	MPS6516	
MPS6518	MPS6516	
MPS6519	MPS6516	
MPS6520	MPS6512	
MPS6521	MPS6512	
MPS6522	MPS6516	
MPS6523	MPS6516	
MPS6530	MPS6530	
MPS6531	MPS6530	
MPS6532	MPS6530	
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MPS6540	MPS6540	
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MPS6543	MPS6543	
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MPS6545	MPS6544	
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MPS6547	MPS6546	
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MPS6562	MPS6560	
MPS6563	MPS6560	
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MPS6566	MPS6565	
MPS6567	MPS6567	
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MPS6570	MPS6568	
MPS6571	MPS6571	
MPS-A05	MPS-A05	1
MPS-A06	MPS-A05	1
MPS-A09	MPS-A09	
MPS-A10	MPS-A10	1
MPS-A12	MPS-A12	
MPS-A13	MPS-A13	1
MPS-A14	MPS-A13	1
MPS-A20	MPS-A20	1
MPS-A55	MPS-A55	1
MPS-A56	MPS-A55	1
MPS-A65	MPS-A65	1
MPS-A66	MPS-A65	1
MPS-A70	MPS-A70	1
MPS-H02	MPS-H02	1
MPS-H10	MPS-H10	1
MPS-H11	MPS-H10	1
MPS-H20	MPS-H20	1
MPS-H30	MPS-H30	1
MPS-H31	MPS-H30	1
MPS-H32	MPS-H32	1
MPS-H37	MPS-H37	1
MPS-K10	MPS-A10	1
MPS-K11	MPS-A10	1
MPS-K12	MPS-A10	1
MPS-K20	MPS-A20	1
MPS-K21	MPS-A20	1
MPS-K22	MPS-A20	1
MPS-K70	MPS-A70	1
MPS-K71	MPS-A70	1
MPS-K72	MPS-A70	1
MPS-L01	MPS-L01	1
MPS-L07	MPS-L07	1
MPS-L08	MPS-L07	1
MPS-L51	MPS-L51	1
MPS-U01	MPS-U01	
MPS-U02	MPS-U02	
MPS-U03	MPS-U03	

DEVICE	REFERENCE	SUPP.
MPS-U04	MPS-U03	
MPS-U05	MPS-U05	1
MPS-U06	MPS-U05	1
MPS-U10	MPS-U10	1
MPS-U51	MPS-U51	
MPS-U52	MPS-U52	
MPS-U55	MPS-U55	1
MPS-U56	MPS-U55	1
MPT20	MPT20	
MPT28	MPT28	
MPT32	MPT28	
MPZ5-16	MPZ5-16	
MPZ5-32	MPZ5-16	
MPZ5-180	MPZ5-16	
MQ2218	MD2218	1
MQ2219	MD2219	1
MQ2904	MD2904	1
MQ2905	MD2905	1
MQ3467	MD3467	
MQ3725	MD3725	
MQ3762	MD3762	
MQ3799,A	MQ3799	
MR322	1N3491	
MR323	1N3491	
MR324	1N3491	
MR325	1N3491	
MR326	1N3491	
MR327	1N3491	
MR328	1N3491	
MR330	1N3491	
MR331	1N3491	
MR810	MR322	
MR811	MR322	
MR812	MR322	
MR814	MR322	
MR816	MR322	
MR830	1N4933	
MR831	1N4933	
MR832	1N4933	
MR833	1N4933	
MR834	1N4933	
MR835	1N4933	
MR836	1N4933	
MR840	MR322	
MR841	MR322	
MR842	MR322	
MR844	MR322	
MR846	MR322	
MR880	MR322	
MR881	MR322	
MR882	MR322	
MR884	MR322	
MR886	MR322	
MR890	MR322	
MR891	MR322	
MR892	MR322	
MR894	MR322	
MR896	MR322	
MR990A	MR990A	
MR991A	MR990A	
MR992A	MR990A	
MR993A	MR990A	
MR994A	MR990A	
MR995A	MR990A	
MR996A	MR990A	
MR1030	1N4719	
MR1031	1N4719	
MR1032	1N4719	
MR1033	1N4719	
MR1034	1N4719	
MR1035	1N4719	
MR1036	1N4719	
MR1038	1N4719	
MR1040	1N4719	
MR1120	MR1120	
MR1121	MR1120	
MR1122	MR1120	

DEVICE INDEX (continued)

DEVICE	REFERENCE	SUPP.
MR1123	MR1120	
MR1124	MR1120	
MR1125	MR1120	
MR1126	MR1120	
MR1128	MR1120	
MR1130	MR1120	
MR1200	MR1200	
MR1201	MR1200	
MR1202	MR1200	
MR1203	MR1200	
MR1205	MR1200	
MR1207	MR1200	
MR1208	MR1200	
MR1209	MR1200	
MR1210	MR1210	1
MR1211	MR1210	1
MR1212	MR1210	1
MR1213	MR1210	1
MR1214	MR1210	1
MR1215	MR1210	1
MR1216	MR1210	1
MR1217	MR1210	1
MR1218	MR1210	1
MR1219	MR1210	1
MR1220	MR1220	
MR1221	MR1220	
MR1222	MR1220	
MR1223	MR1220	
MR1225	MR1220	
MR1227	MR1220	
MR1228	MR1220	
MR1229	MR1220	
MR1230	MR1230	
MR1231	MR1230	
MR1232	MR1230	
MR1233	MR1230	
MR1235	MR1230	
MR1237	MR1230	
MR1238	MR1230	
MR1239	MR1230	
MR1240	MR1240	
MR1241	MR1240	
MR1242	MR1240	
MR1243	MR1240	
MR1245	MR1240	
MR1247	MR1240	
MR1248	MR1240	
MR1249	MR1240	
MR1260	MR1260	
MR1261	MR1260	
MR1262	MR1260	
MR1263	MR1260	
MR1265	MR1260	
MR1267	MR1260	
MR1268	MR1260	
MR1269	MR1260	
MR1290	MR1290	
MR1291	MR1290	
MR1292	MR1290	
MR1293	MR1290	
MR1295	MR1290	
MR1297	MR1290	
MR1298	MR1290	
MR1299	MR1290	
MR1337	MR1337	
MR1366	1N4933	
MR1376	1N4933	
MR1386	1N4933	
MR1396	1N4933	
MR1810	MR1210	1
MR1811	MR1210	1
MR1812	MR1210	1
MR1813	MR1210	1
MR1814	MR1210	1
MR1815	MR1210	1
MR1816	MR1210	1
MR1817	MR1210	1

DEVICE	REFERENCE	SUPP.
MR1818	MR1210	1
MR1819	MR1210	1
MR2080HA	MR2080HA	
MR2081HA	MR2080HA	
MR2082HA	MR2080HA	
MR2083HA	MR2080HA	
MR2084HA	MR2080HA	
MR2100HA	MR2100HA	
MR2101HA	MR2100HA	
MR2102HA	MR2100HA	
MR2103HA	MR2100HA	
MR2104HA	MR2100HA	
MR2266	MR2266	
MR2271	MR2271	
MR2272	MR2272	
MR2273	MR2266	
MRA130	MRA130	
MRA131	MRA130	
MRA132	MRA130	
MRA133	MRA130	
MRA134	MRA130	
MRA160	MRA160	
MRA161	MRA160	
MRA162	MRA160	
MRA163	MRA160	
MRA164	MRA160	
MRA330	MRA330	
MRA331	MRA330	
MRA332	MRA330	
MRA333	MRA330	
MRA334	MRA330	
MRA360	MRA360	
MRA361	MRA360	
MRA362	MRA360	
MRA363	MRA360	
MRA364	MRA360	
MRD100	MRD100	
MRD150	MRD100	
MRD200	MRD200	
MRD210	MRD210	
MRD250	MRD250	
MRD300	MRD300	
MRD310	MRD310	
MRD450	MRD450	
MRD600	MRD600	
MSD6100	MSD6100	
MSD6101	MSD6101	
MSD6102	MSD6102	
MSD6150	MSD6150	
MU4891	MU4891	
MU4892	MU4891	
MU4893	MU4891	
MU4894	MU4891	
MV830	MV830	
MV831	MV830	
MV832	MV830	
MV833	MV830	
MV834	MV830	
MV835	MV830	
MV836	MV830	
MV837	MV830	
MV838	MV830	
MV839	MV830	
MV840	MV830	
MV1620	MV1620	
MV1622	MV1620	
MV1624	MV1620	
MV1626	MV1620	
MV1628	MV1620	
MV1630	MV1620	
MV1632	MV1620	
MV1634	MV1620	
MV1636	MV1620	
MV1638	MV1620	
MV1640	MV1620	
MV1642	MV1620	
MV1644	MV1620	

DEVICE	REFERENCE	SUPP.
MV1646	MV1620	
MV1648	MV1620	
MV1650	MV1620	
MV1652	MV1652	
MV1654	MV1652	
MV1656	MV1652	
MV1658	MV1652	
MV1660	MV1652	
MV1662	MV1652	
MV1664	MV1652	
MV1666	MV1652	
MV1804	1N4387	
MV1805C	MV1805C	
MV1806	1N4388	
MV1806C	1N5149	
MV1807C	1N5149	
MV1807C1	1N5150A	
MV1808A,B,C	1N5151	
MV1808B1,C1	1N5150A	
MV1809C,C1	MV1809C	
MV1810A,B	1N5154	
MV1810B1	1N5150A	
MV1812A,B	1N5156	
MV1816A,B	MV1816A	
MV1816A1,B1	MV1816A	
MV1817A,B	MV1817A	
MV1817A1,B1	MV1817A	
MV1858D	MV1858D	
MV1860D	MV1858D	
MV1862D	MV1858D	
MV1863D	MV1858D	
MV1864D	MV1858D	
MV1865D	MV1858D	
MV1866D	MV1858D	
MV1868D	MV1858D	
MV1870D	MV1858D	
MV2101	MV2101	
MV2102	MV2101	
MV2103	MV2101	
MV2104	MV2101	
MV2105	MV2101	
MV2106	MV2101	
MV2107	MV2101	
MV2108	MV2101	
MV2109	MV2101	
MV2110	MV2101	
MV2111	MV2101	
MV2112	MV2101	
MV2113	MV2101	
MV2114	MV2101	
MV2115	MV2101	
MV2201	MV2201	1
MV2203	MV2201	1
MV2205	MV2201	1
MV2209	MV2201	1
MZ500	MZ500	
MZ605	MZ600	
MZ610	MZ600	
MZ620	MZ600	
MZ640	MZ600	
MZ805	MZ600	
MZ810	MZ600	
MZ820	MZ600	
MZ840	MZ600	
MZ1000	MZ1000	
MZ4614	1N4099	
MZ4615	1N4099	
MZ4616	1N4099	
MZ4617	1N4099	
MZ4618	1N4099	
MZ4619	1N4099	
MZ4620	1N4099	
MZ4621	1N4099	
MZ4622	1N4099	
MZ4623	1N4099	
MZ4624	1N4099	
MZ4625	1N4099	

DEVICE	REFERENCE	SUPP.
MZ4626	1N4099	
MZ4627	1N4099	
M4L3052	1N5158	
M4L3053	1N5158	
M4L3054	1N5158	
M4L3055	1N5158	
M4L3056	1N5158	

1N... JEDEC REGISTERED DEVICE SPECIFICATIONS

DIODES

Zener

1N5518, A, B (SILICON)
thru
1N5546, A, B

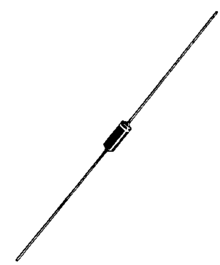
LOW VOLTAGE AVALANCHE SILICON OXIDE PASSIVATED ZENER REGULATOR DIODES

Highly reliable silicon regulators utilizing an oxide-passivated junction for long-term voltage stability. RamRod construction provides a rugged, glass-enclosed, hermetically sealed structure.

- Low Zener Noise Specified
- Low Maximum Regulation Factor
- Low Zener Impedance
- Low Leakage Current
- Controlled Forward Characteristics
- Temperature Range: –65 to +200°C

LOW VOLTAGE AVALANCHE ZENER DIODES

400 MILLIWATTS
3.3 THRU 33 VOLTS



MAXIMUM RATINGS

Rating	Symbol	Value	Unit
DC Power Dissipation @ T_A = 50°C Derate above 50°C	P_D	400 3.2	mW mW/°C
DC Power Dissipation @ T_L = 50°C Lead Length = 1/8" Derate above 50°C (Figure 1)	P_D	500 3.3	mW mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	-65 to +200	°C

MECHANICAL CHARACTERISTICS

CASE: Hermetically sealed, all-glass

DIMENSIONS: See outline drawing.

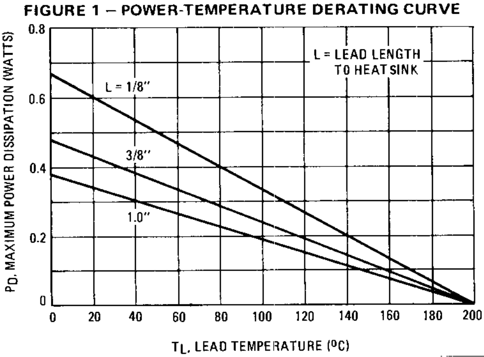
FINISH: All external surfaces are corrosion resistant and leads are readily solderable and weldable.

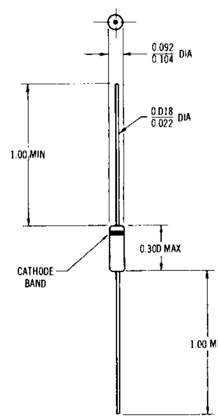
POLARITY: Cathode indicated by polarity band.

WEIGHT: 0.2 Gram (approx)

MOUNTING POSITION: Any

FIGURE 1 – POWER-TEMPERATURE DERATING CURVE





CASE 51
(DO-7)

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted. Based on dc measurements at thermal equilibrium; V_F = 1.1 Max @ I_F = 200 mA for all types)

JEDEC Type No. (Note 1)	Nominal Zener Voltage V_Z @ I_{ZT} Volts (Note 2)	Test Current I_{ZT} mAdc	Max Zener Impedance B-C-D Suffix Z_{ZT} @ I_{ZT} Ohms (Note 3)	Max Reverse Leakage Current			B-C-D Suffix Maximum DC Zener Current I_{ZM} mAdc (Note 5)	B-C-D Suffix Max Noise Density at I_Z = 250 µA N_D (Figure 1) (micro-volts per square root cycle)	Regulation Factor ΔV_Z Volts (Note 6)	Low V_Z Current I_{ZL} mAdc
				I_R µAdc (Note 4)	V_R – Volts Non & A-Suffix	V_R – Volts B-C-D Suffix				
1N5518	3.3	20	26	5.0	0.90	1.0	115	0.5	0.90	2.0
1N5519	3.6	20	24	3.0	0.90	1.0	105	0.5	0.90	2.0
1N5520	3.9	20	22	1.0	0.90	1.0	98	0.5	0.85	2.0
1N5521	4.3	20	18	3.0	1.0	1.5	88	0.5	0.75	2.0
1N5522	4.7	10	22	2.0	1.5	2.0	81	0.5	0.60	1.0
1N5523	5.1	5.0	26	2.0	2.0	2.5	75	0.5	0.65	0.25
1N5524	5.6	3.0	30	2.0	3.0	3.5	68	1.0	0.30	0.25
1N5525	6.2	1.0	30	1.0	4.5	5.0	61	1.0	0.20	0.01
1N5526	6.8	1.0	30	1.0	5.5	6.2	56	1.0	0.10	0.01
1N5527	7.5	1.0	35	0.5	6.0	6.8	51	2.0	0.05	0.01
1N5528	8.2	1.0	40	0.5	6.5	7.5	46	4.0	0.05	0.01
1N5529	9.1	1.0	45	0.1	7.0	8.2	42	4.0	0.05	0.01
1N5530	10.0	1.0	60	0.05	8.0	9.1	38	4.0	0.10	0.01
1N5531	11.0	1.0	80	0.05	9.0	9.9	35	5.0	0.20	0.01
1N5532	12.0	1.0	90	0.05	9.5	10.8	32	10	0.20	0.01
1N5533	13.0	1.0	90	0.01	10.5	11.7	29	15	0.20	0.01
1N5534	14.0	1.0	100	0.01	11.5	12.6	27	20	0.20	0.01
1N5535	15.0	1.0	100	0.01	12.5	13.5	25	20	0.20	0.01
1N5536	16.0	1.0	100	0.01	13.0	14.4	24	20	0.20	0.01
1N5537	17.0	1.0	100	0.01	14.0	15.3	22	20	0.20	0.01
1N5538	18.0	1.0	100	0.01	15.0	16.2	21	20	0.20	0.01
1N5539	19.0	1.0	100	0.01	16.0	17.1	20	20	0.20	0.01
1N5540	20.0	1.0	100	0.01	17.0	18.0	19	20	0.20	0.01
1N5541	22.0	1.0	100	0.01	18.0	19.8	17	20	0.25	0.01
1N5542	24.0	1.0	100	0.01	20.0	21.6	16	20	0.30	0.01
1N5543	25.0	1.0	100	0.01	21.0	22.4	15	20	0.35	0.01
1N5544	28.0	1.0	100	0.01	23.0	25.2	14	20	0.40	0.01
1N5545	30.0	1.0	100	0.01	24.0	27.0	13	20	0.45	0.01
1N5546	33.0	1.0	100	0.01	28.0	29.7	12	20	0.50	0.01

NOTE 1 – TOLERANCE AND VOLTAGE DESIGNATION

The JEDEC type numbers shown are ±20% with guaranteed limits for only V_Z, I_R, and V_F. Units with "A" suffix are ±10% with guaranteed limits for V_Z, I_R, and V_F. Units with guaranteed limits for all six parameters are indicated by a "B" suffix for ±5.0% units, "C" suffix for ±2.0% and "D" suffix for ±1.0%.

NOTE 2 – ZENER VOLTAGE (V_Z) MEASUREMENT

Nominal zener voltage is measured with the device junction in thermal equilibrium with ambient temperature of 25°C.

NOTE 3 – ZENER IMPEDANCE (Z_Z) DERIVATION

The zener impedance is derived from the 60 Hz ac voltage, which results when an ac current having an rms value equal to 10% of the dc zener current (I_{ZT}) is superimposed on I_{ZT}.

NOTE 4 – REVERSE LEAKAGE CURRENT (I_R)

Reverse leakage currents are guaranteed and are measured at V_R as shown on the table.

NOTE 5 – MAXIMUM REGULATOR CURRENT (I_{ZM})

The maximum current shown is based on the maximum voltage of a 5.0% type unit, therefore, it applies only to the "B" suffix device. The actual I_{ZM} for any device may not exceed the value of 400 milliwatts divided by the actual V_Z of the device.

NOTE 6 – MAXIMUM REGULATION FACTOR (ΔV_Z)

ΔV_Z is the maximum difference between V_Z at I_{ZT} and V_Z at I_{ZL} measured with the device junction in thermal equilibrium.

ZENER NOISE DENSITY

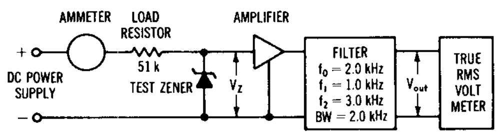
A zener diode generates noise when it is biased in the zener direction. A small part of this noise is due to the internal resistance associated with the device. A larger part of zener noise is a result of the zener breakdown phenomenon and is called microplasma noise. To eliminate the higher frequency components of noise a small shunting capacitor can be used. The lower frequency noise generally must be tolerated since a capacitor required to eliminate the lower frequencies would degrade the regulation properties of the zener in many applications.

Motorola is rating this series with a maximum noise density at 250 microamperes, a bandwidth of 2.0 kHz and a center frequency of 2.0 kHz.

Noise density decreases as zener current increases. The junction temperature will also change the zener noise levels, thus the noise rating must indicate frequency, bandwidth, current level and temperature.

The block diagram shown in Figure 2 represents the method used to measure noise density. The input voltage and load resistance is high so that the zener is driven from a constant current source. The amplifier must be low noise so that the amplifier noise is negligible compared to the test zenar. The filter frequency and bandpass is known so that the noise density in volts RMS per square root cycle can be calculated.

FIGURE 2 – NOISE DENSITY MEASUREMENT METHOD



$$\text{NOISE DENSITY (VOLTS PER SQUARE ROOT BANDWIDTH)} = \frac{V_{out}}{\text{OVERALL GAIN}\sqrt{BW}}$$

WHERE: BW = FILTER BANDWIDTH (Hz)
V_{out} = OUTPUT NOISE (VOLTS RMS)

FIGURE 3 – TYPICAL CAPACITANCE

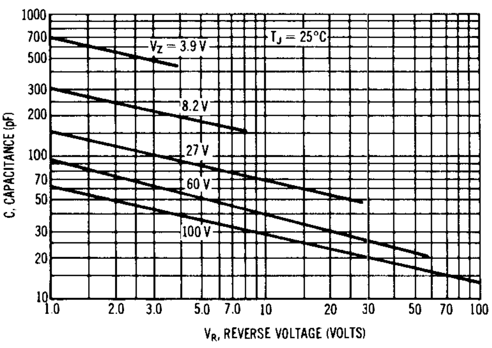


FIGURE 4 – TYPICAL FORWARD CHARACTERISTICS

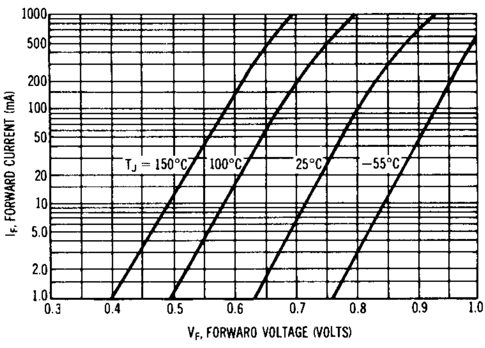
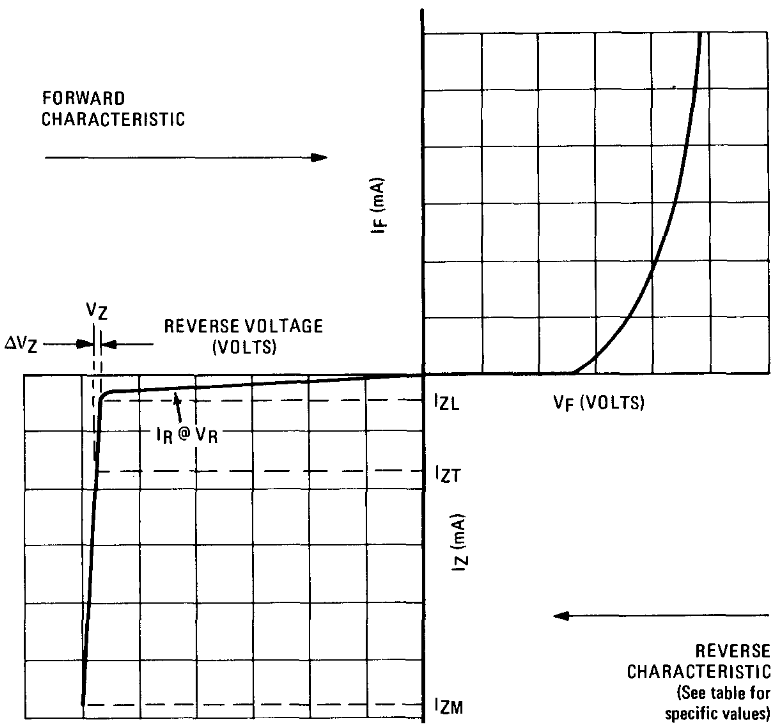


FIGURE 5 – ZENER DIODE CHARACTERISTICS AND SYMBOL IDENTIFICATION



[redacted]

2N... & 3N... JEDEC REGISTERED DEVICE SPECIFICATIONS

TRANSISTORS

- Amplifier
- Chopper
- Light Sensitive
- Multiple Device
- Power
- Switching

2N1038 thru 2N1041 (GERMANIUM)
2N2552 thru 2N2559

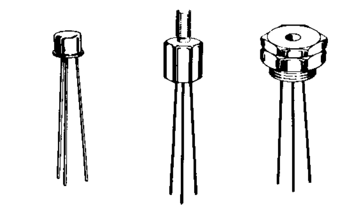
PNP GERMANIUM MEDIUM POWER TRANSISTORS

. . . designed for relay drivers, pulse amplifiers, audio amplifiers and high-current switching applications.

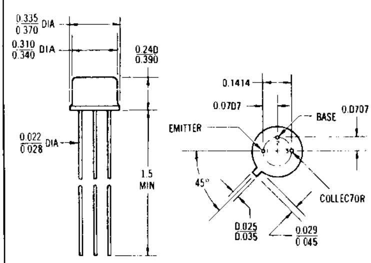
- High Current Capability – I_C = 3.0 Amperes
- Guaranteed Excellent Collector-Emitter Sustaining Voltage
- 20-Watt Power Dissipation at 25°C Case Temperature
- 100°C Maximum Junction Temperature

PNP GERMANIUM POWER TRANSISTORS

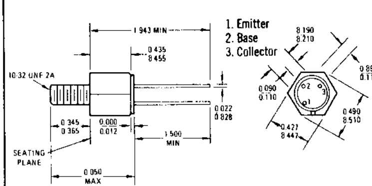
40–100 VOLTS
20 WATTS



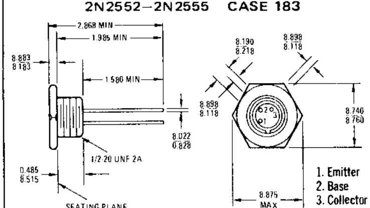
CASE 180 CASE 183 CASE 184



2N1038–2N1041 CASE 180



2N2552–2N2555 CASE 183



2N2556–2N2559 CASE 184
Collector Connected to Case
(All Types)

*MAXIMUM RATINGS

Rating	Symbol	2N1038 2N2552 2N2556	2N1039 2N2553 2N2557	2N1040 2N2554 2N2558	2N1041 2N2555 2N2559	Unit
Collector-Emitter Voltage	V_{CEO}	30	40	50	60	Vdc
Collector-Base Voltage	V_{CB}	40	60	80	100	Vdc
Emitter-Base Voltage	V_{EB}	← 20 →				Vdc
Collector Current – Continuous	I_C	← 3.0 →				Adc
Base Current – Continuous	I_B	← 1.0 →				Adc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	← 450 → ← 6.0 →				mW mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C (Note 1)	P_D	← 20 → ← 0.267 →				Watts W/°C
**Operating and Storage Junction Temperature Range	T_J, T_{stg}	← -65 to +100 →				°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	θ_{JC}	3.75	°C/W

*Indicates JEDEC Registered Data.

Note 1: Case Temperature shall be measured 0.100 ± 0.010 inches above the seating plane.

**Motorola guarantees this data in addition to the JEDEC Registered Data shown.

*ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Sustaining Voltage (I_C = 100 mAdc, I_B = 0)	2N1038, 2N2552, 2N2556	$V_{CEO(sus)}$	30	-	Vdc
	2N1039, 2N2553, 2N2557		40	-	
	2N1040, 2N2554, 2N2558		50	-	
	2N1041, 2N2555, 2N2559		60	-	
Collector Cutoff Current (V_{CE} = 15 Vdc, I_B = 0)	2N1038, 2N2552, 2N2556	I_{CEO}	-	25	mAdc
(V_{CE} = 20 Vdc, I_B = 0)	2N1039, 2N2553, 2N2557		-	20	
(V_{CE} = 25 Vdc, I_B = 0)	2N1040, 2N2554, 2N2558		-	20	
(V_{CE} = 30 Vdc, I_B = 0)	2N1041, 2N2555, 2N2559		-	20	
Collector-Emitter Cutoff Current (V_{CE} = 40 Vdc, $V_{BE(off)}$ = 0.2 Vdc)	2N1038, 2N2552, 2N2556	I_{CEX}	-	0.65	mAdc
(V_{CE} = 60 Vdc, $V_{BE(off)}$ = 0.2 Vdc)	2N1039, 2N2553, 2N2557		-	0.65	
(V_{CE} = 80 Vdc, $V_{BE(off)}$ = 0.2 Vdc)	2N1040, 2N2554, 2N2558		-	0.65	
(V_{CE} = 100 Vdc, $V_{BE(off)}$ = 0.2 Vdc)	2N1041, 2N2555, 2N2559		-	0.65	
(V_{CE} = 20 Vdc, $V_{BE(off)}$ = 0.2 Vdc, T_C = 85°C)	2N1038, 2N2552, 2N2556		-	5.0	
(V_{CE} = 30 Vdc, $V_{BE(off)}$ = 0.2 Vdc, T_C = 85°C)	2N1039, 2N2553, 2N2557		-	5.0	
(V_{CE} = 40 Vdc, $V_{BE(off)}$ = 0.2 Vdc, T_C = 85°C)	2N1040, 2N2554, 2N2558		-	5.0	
(V_{CE} = 50 Vdc, $V_{BE(off)}$ = 0.2 Vdc, T_C = 85°C)	2N1041, 2N2555, 2N2559		-	5.0	
Collector Cutoff Current (V_{CB} = 20 Vdc, I_E = 0)	2N1038, 2N2552, 2N2556	I_{CBO}	-	125	μAdc
(V_{CB} = 30 Vdc, I_E = 0)	2N1039, 2N2553, 2N2557		-	125	
(V_{CB} = 40 Vdc, I_E = 0)	2N1040, 2N2554, 2N2558		-	125	
(V_{CB} = 50 Vdc, I_E = 0)	2N1041, 2N2555, 2N2559		-	125	
**(V_{CB} = 40 Vdc, I_E = 0)	2N1038, 2N2552, 2N2556		-	750	
**(V_{CB} = 60 Vdc, I_E = 0)	2N1039, 2N2553, 2N2557		-	750	
**(V_{CB} = 80 Vdc, I_E = 0)	2N1040, 2N2554, 2N2558		-	750	
**(V_{CB} = 100 Vdc, I_E = 0)	2N1041, 2N2555, 2N2559		-	750	
Emitter Cutoff Current (V_{BE} = 20 Vdc, I_C = 0)		I_{EBO}	-	650	μAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 50 mAdc, V_{CE} = 0.5 Vdc)		h_{FE}	33	200	-
(I_C = 1.0 Adc, V_{CE} = 0.5 Vdc)			20	60	
Collector-Emitter Saturation Voltage (I_C = 1.0 Adc, I_B = 100 mAdc)		$V_{CE(sat)}$	-	0.25	Vdc
Base-Emitter Input Voltage (I_C = 1.0 Adc, V_{CE} = 0.5 Vdc)		V_{BE}	-	1.0	Vdc
SMALL-SIGNAL CHARACTERISTICS					
Small-Signal Current Gain (I_C = 500 mAdc, V_{CE} = 1.5 Vdc, f = 1.0 kHz)		h_{fe}	18	72	-
Small-Signal Current Gain (I_C = 500 mAdc, V_{CE} = 1.5 Vdc, f = 112.5 kHz)		$\|h_{fe}\|$	2.0	-	-

*Indicates JEDEC Registered Data.
**Motorola Guarantees this data in addition to the JEDEC Registered Data Shown.

2N1042 thru 2N1045 (GERMANIUM)
2N2560 thru 2N2567

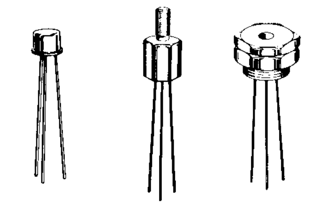
PNP GERMANIUM MEDIUM POWER TRANSISTORS

. . . designed for relay drivers, pulse amplifiers, audio amplifiers and high-current switching applications.

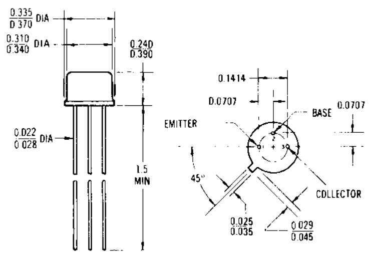
- High Current Capability – I_C = 3.5 Amperes
- Guaranteed Excellent Collector-Emitter Sustaining Voltage
- 20-Watt Power Dissipation at 25°C Case Temperature
- 100°C Maximum Junction Temperature

PNP GERMANIUM POWER TRANSISTORS

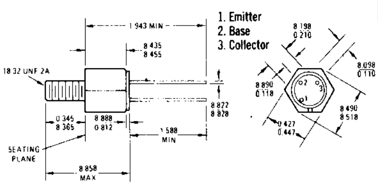
40–100 VOLTS
20 WATTS



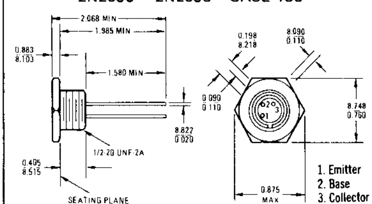
CASE 180 CASE 183 CASE 184



2N2564 – 2N2567 CASE 180



2N2560 – 2N2563 CASE 183



2N1042 – 2N1045 CASE 184
Collector Connected to Case
(All Types)

*MAXIMUM RATINGS

Rating	Symbol	2N1042 2N2560 2N2564	2N1043 2N2561 2N2565	2N1044 2N2562 2N2566	2N1045 2N2563 2N2567	Unit
Collector-Emitter Voltage	V_{CEO}	30	40	50	60	Vdc
Collector-Base Voltage	V_{CB}	40	60	80	100	Vdc
Emitter-Base Voltage	V_{EB}	← 20 →				Vdc
Collector Current – Continuous	I_C	← 3.5 →				Adc
Base Current – Continuous	I_B	← 1.0 →				Adc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	← 450 → ← 6.0 →				mW mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C (Note 1)	P_D	← 20 → ← 0.267 →				Watts W/°C
**Operating and Storage Junction Temperature Range	T_J, T_{stg}	← -65 to +100 →				°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	θ_{JC}	3.75	°C/W

*Indicates JEDEC Registered Data.

Note 1: Case Temperature shall be measured 0.100 ± 0.010 inches above the seating plane.

**Motorola guarantees this data in addition to the JEDEC Registered Data shown.

2N1042 thru 2N1045/2N2560 thru 2N2567 (continued)

*ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Sustaining Voltage		$V_{CEO(sus)}$			Vdc
(I_C = 100 mAdc, I_B = 0)	2N1042,2N2560,2N2564		30	–	
	2N1043,2N2561,2N2565		40	–	
	2N1044,2N2562,2N2566		50	–	
	2N1045,2N2563,2N2567		60	–	
Collector Cutoff Current		I_{CEO}			mAdc
(V_{CE} = 15 Vdc, I_B = 0)	2N1042,2N2560,2N2564		–	25	
(V_{CE} = 20 Vdc, I_B = 0)	2N1043,2N2561,2N2565		–	20	
(V_{CE} = 25 Vdc, I_B = 0)	2N1044,2N2562,2N2566		–	20	
(V_{CE} = 30 Vdc, I_B = 0)	2N1045,2N2563,2N2567		–	20	
Collector-Emitter Cutoff Current		I_{CEX}			mAdc
(V_{CE} = 40 Vdc, $V_{BE(off)}$ = 0.2 Vdc)	2N1042,2N2560,2N2564		–	0.65	
(V_{CE} = 60 Vdc, $V_{BE(off)}$ = 0.2 Vdc)	2N1043,2N2561,2N2565		–	0.65	
(V_{CE} = 80 Vdc, $V_{BE(off)}$ = 0.2 Vdc)	2N1044,2N2562,2N2566		–	0.65	
(V_{CE} = 100 Vdc, $V_{BE(off)}$ = 0.2 Vdc)	2N1045,2N2563,2N2567		–	0.65	
(V_{CE} = 20 Vdc, $V_{BE(off)}$ = 0.2 Vdc, T_C = 85°C)	2N1042,2N2560,2N2564		–	5.0	
(V_{CE} = 30 Vdc, $V_{BE(off)}$ = 0.2 Vdc, T_C = 85°C)	2N1043,2N2561,2N2565		–	5.0	
(V_{CE} = 40 Vdc, $V_{BE(off)}$ = 0.2 Vdc, T_C = 85°C)	2N1044,2N2562,2N2566		–	5.0	
(V_{CE} = 50 Vdc, $V_{BE(off)}$ = 0.2 Vdc, T_C = 85°C)	2N1045,2N2563,2N2567		–	5.0	
Collector Cutoff Current		I_{CBO}			μAdc
(V_{CB} = 20 Vdc, I_E = 0)	2N1042,2N2560,2N2564		–	125	
(V_{CB} = 30 Vdc, I_E = 0)	2N1043,2N2561,2N2565		–	125	
(V_{CB} = 40 Vdc, I_E = 0)	2N1044,2N2562,2N2566		–	125	
(V_{CB} = 50 Vdc, I_E = 0)	2N1045,2N2563,2N2567		–	125	
**(V_{CB} = 40 Vdc, I_E = 0)	2N1042,2N2560,2N2564		–	750	
**(V_{CB} = 60 Vdc, I_E = 0)	2N1043,2N2561,2N2565		–	750	
**(V_{CB} = 80 Vdc, I_E = 0)	2N1044,2N2562,2N2566		–	750	
**(V_{CB} = 100 Vdc, I_E = 0)	2N1045,2N2563,2N2567		–	750	
Emitter Cutoff Current (V_{BE} = 20 Vdc, I_C = 0)		I_{EBO}	–	650	μAdc
ON CHARACTERISTICS					
DC Current Gain		h_{FE}			–
(I_C = 50 mAdc, V_{CE} = 0.5 Vdc)			50	–	
(I_C = 1.0 Adc, V_{CE} = 1.0 Vdc)			–	150	
(I_C = 3.0 Adc, V_{CE} = 1.0 Vdc)			20	60	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$			Vdc
(I_C = 1.0 Adc, I_B = 100 mAdc)			–	0.25	
(I_C = 3.0 Adc, I_B = 300 mAdc)			–	0.75	
Base-Emitter Input Voltage (I_C = 3.0 Adc, V_{CE} = 1.0 Vdc)		V_{BE}	–	1.5	Vdc
SMALL-SIGNAL CHARACTERISTICS					
Small-Signal Current Gain (I_C = 500 mAdc, V_{CE} = 1.5 Vdc, f = 1.0 kHz)		h_{fe}	25	100	–
Small-Signal Current Gain (I_C = 500 mAdc, V_{CE} = 1.5 Vdc, f = 125 kHz)		$\|h_{fe}\|$	2.0	–	–

*Indicates JEDEC Registered Data.
**Motorola Guarantees this data in addition to the JEDEC Registered Data Shown.

2N2552 thru 2N2559

For Specifications, See 2N1038 Data.

2N2560 thru 2N2567

For Specifications, See 2N1042 Data.

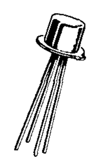
SILICON P-CHANNEL JUNCTION FIELD-EFFECT TRANSISTOR

Depletion Mode (Type A) Junction Field-Effect Transistor designed primarily for low-power audio-amplifier applications.

- High AC Input Resistance – Typically > 30 Megohms @ f = 1.0 kHz
- Drain and Source Interchangeable
- Active Elements Isolated from Case

P-CHANNEL JUNCTION FIELD-EFFECT TRANSISTOR

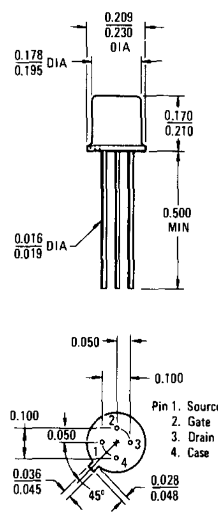
(Type A)



MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain-Gate Voltage	V_{DG}	20	Vdc
Reverse Gate-Source Voltage	V_{GSR}	20	Vdc
*Gate Current	I_G	10	mAdc
*Total Device Dissipation @ $T_A = 25^oC$ Derate above 25^oC	P_D	300 2.0	mW $mW/^oC$
*Storage Temperature Range	T_{stg}	-65 to +200	^oC

*Indicates JEDEC Registered Data.



TO-72
CASE 20 (5)

2N3330 (continued)

*ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Gate-Source Breakdown Voltage (I_C = 10 μAdc, V_{DS} = 0)	$V_{(BR)GSS}$	20	–	Vdc
Gate Reverse Current	I_{GSS}			
(V_{GS} = 10 Vdc, V_{DS} = 0)		–	10	nAdc
(V_{GS} = 10 Vdc, V_{DS} = 0, T_A = 150°C)		–	10	μAdc
Zero-Gate Voltage Drain Current (Note 1) (V_{DS} = –10 Vdc, V_{GS} = 0)	I_{DSS}	2.0	6.0	mAdc
ON CHARACTERISTICS				
Gate-Source Voltage (V_{DG} = –15 Vdc, I_D = 10 μAdc)	V_{GS}	–	6.0	Vdc
Drain-Source Resistance (I_D = 100 μAdc, V_{GS} = 0)	r_{DS}	–	800	Ohms
SMALL-SIGNAL CHARACTERISTICS				
Forward Transadmittance (Note 1)	$\|y_{fs}\|$			μmhos
(V_{DS} = –10 Vdc, I_D = 2.0 mAdc, f = 1.0 kHz)		1500	3000	
(V_{DS} = –10 Vdc, I_D = 2.0 mAdc, f = 10 MHz)		1350	–	
Output Admittance (V_{DS} = –10 Vdc, I_D = 2.0 mAdc, f = 1.0 kHz)	$\|y_{os}\|$	–	40	μmhos
Reverse Transfer Conductance (V_{DS} = –10 Vdc, I_D = 2.0 mAdc, f = 1.0 kHz)	$\|y_{rs}\|$	–	0.1	μmhos
Input Conductance (V_{DS} = –10 Vdc, I_D = 2.0 mAdc, f = 1.0 kHz)	$\|y_{is}\|$	–	0.2	μmhos
Input Capacitance (V_{DS} = –10 Vdc, V_{GS} = 1.0 Vdc, f = 1.0 MHz)	C_{iss}	–	20	pF
Common-Source Noise Figure (V_{DS} = –5.0 Vdc, I_D = 1.0 mAdc, R_G = 1.0 Megohm, f = 1.0 kHz)	NF	–	3.0	dB

*Indicates JEDEC Registered Data.

Note 1: Pulse Test: Pulse Width ≤ 630 ms, Duty Cycle ≤ 10%.

2N3740, A (SILICON)
2N3741, A

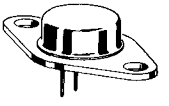
MEDIUM-POWER PNP TRANSISTORS

. . . ideal for use as drivers, switches and direct replacement of germanium medium-power devices. These devices feature:

- Low Saturation Voltage — $V_{CE(sat)}$ = 0.6 Vdc @ I_C = 1.0 Amp
- High Gain Characteristics — h_{FE} = 30–100 @ I_C = 250 mAdc
- Direct Substitution for Germanium Equivalents
- Excellent Safe Area Limits (See Figure 2)
- Low Collector Cutoff Current — 100 nA (Max) 2N3740A, 2N3741A
- Complementary to NPN 2N3766 (2N3740) and 2N3767 (2N3741)

POWER TRANSISTORS

PNP SILICON
60–80 VOLTS
25 WATTS

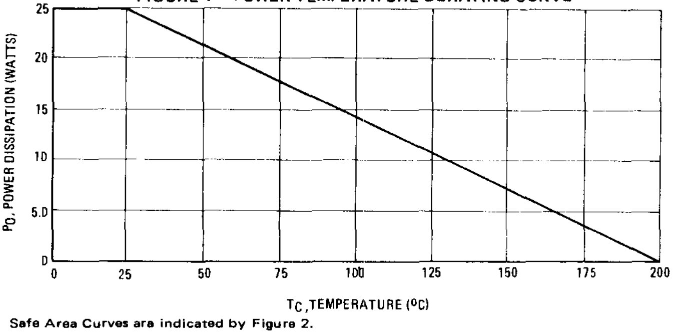


*MAXIMUM RATINGS

Rating	Symbol	2N3740 2N3740A	2N3741 2N3741A	Unit
Collector-Emitter Voltage	V_{CEO}	60	80	Vdc
Emitter-Base Voltage	V_{EB}	7.0	7.0	Vdc
Collector-Base Voltage	V_{CB}	60	80	Vdc
Collector Current — Continuous — Peak (Note 1)	I_C	4.0 10		Adc
Base Current	I_B	2.0		Adc
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	25 0.143		Watts W/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	-65 to +200		°C

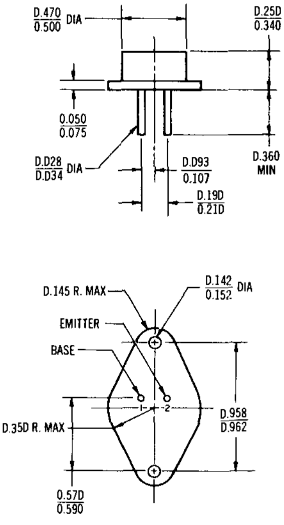
Note 1: See Figure 2

FIGURE 1 — POWER-TEMPERATURE DERATING CURVE



Safe Area Curves are indicated by Figure 2.
Both limits are applicable and must be observed.

*Indicates JEDEC Registered Data.



CASE 80
(TO-66)

COLLECTOR CONNECTED TO CASE

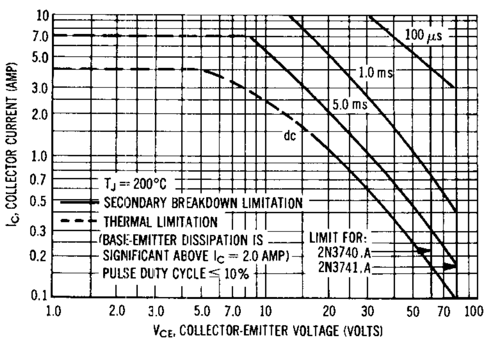
*ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristic		Figure No.	Symbol	Min	Max	Unit
OFF CHARACTERISTICS						
Collector-Emitter Sustaining Voltage ①		2	$V_{CEO(sus)}$ ①			Vdc
(I_C = 100 mAdc, I_B = 0)	2N3740, 2N3740A			60	—	
	2N3741, 2N3741A			80	—	
Emitter Base Cutoff Current		—	I_{EBO}			
(V_{EB} = 7.0 Vdc)	2N3740, 2N3741			—	0.5	mAdc
	2N3740A, 2N3741A				100	nAdc
Collector Cutoff Current		5, 6②	I_{CEX}			
(V_{CE} = 60 Vdc, $V_{BE(off)}$ = 1.5 Vdc)	2N3740			—	100	μAdc
	2N3740A			—	100	nAdc
(V_{CE} = 80 Vdc, $V_{BE(off)}$ = 1.5 Vdc)	2N3741			—	100	μAdc
	2N3741A			—	100	nAdc
(V_{CE} = 40 Vdc, $V_{BE(off)}$ = 1.5 Vdc, T_C = 150°C)	2N3740			—	1.0	mAdc
	2N3740A			—	0.5	
(V_{CE} = 60 Vdc, $V_{BE(off)}$ = 1.5 Vdc, T_C = 150°C)	2N3741			—	1.0	mAdc
	2N3741A			—	0.5	
Collector-Emitter Cutoff Current		5, 6②	I_{CEO}			
(V_{CE} = 40 Vdc, I_B = 0)	2N3740			—	1.0	mAdc
	2N3740A			—	1.0	μAdc
(V_{CE} = 60 Vdc, I_B = 0)	2N3741			—	1.0	mAdc
	2N3741A			—	1.0	μAdc
Collector Base Cutoff Current		—	I_{CBO}			
(V_{CB} = 60 Vdc, I_E = 0)	2N3740			—	100	μAdc
	2N3740A			—	100	nAdc
(V_{CB} = 80 Vdc, I_E = 0)	2N3741			—	100	μAdc
	2N3741A			—	100	nAdc
ON CHARACTERISTICS						
DC Current Gain		7	h_{FE} ①			—
(I_C = 100 mAdc, V_{CE} = 1.0 Vdc)				40	—	
(I_C = 250 mAdc, V_{CE} = 1.0 Vdc)				30	100	
(I_C = 500 mAdc, V_{CE} = 1.0 Vdc)				20	—	
(I_C = 1.0 Adc, V_{CE} = 1.0 Vdc)				10	—	
Collector-Emitter Saturation Voltage (I_C = 1.0 Adc, I_B = 125 mAdc)		8, 9, 10	$V_{CE(sat)}$ ①	—	0.6	Vdc
Base-Emitter Voltage (I_C = 250 mAdc, V_{CE} = 1.0 Vdc)		3, 4, 9, 10	V_{BE} ①	—	1.0	Vdc
TRANSIENT CHARACTERISTICS						
Current-Gain—Bandwidth Product (I_C = 100 mAdc, V_{CE} = 10 Vdc, f = 1.0 MHz)		—	f_T	3.0 4.0†	— —	MHz
Common Base Output Capacitance (V_{CB} = 10 Vdc, I_C = 0, f = 100 kHz)		14	C_{ob}	—	100	pF
Small-Signal Current Gain (I_C = 50 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)		—	h_{fe}	25	—	—

*Indicates JEDEC Registered Data.
†Motorola guarantees this value in addition to the JEDEC registered data shown.

① Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.
② Figures 5 and 6 apply to 2N3740 and 2N3741 only.

FIGURE 2 — ACTIVE REGION SAFE OPERATING AREA



The Safe Operating Area Curves indicate $I_C - V_{CE}$ limits below which the device will not enter secondary breakdown. Collector load lines for specific circuits must fall within the applicable Safe Area to avoid causing a catastrophic failure. To insure operation below the maximum T_J, power-temperature derating must be observed for both steady state and pulse power conditions.

LARGE SIGNAL CHARACTERISTICS

FIGURE 3 – TRANSCONDUCTANCE

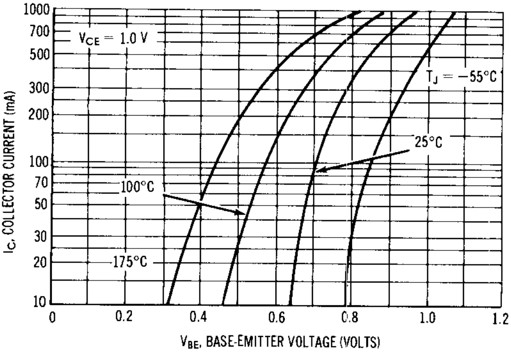
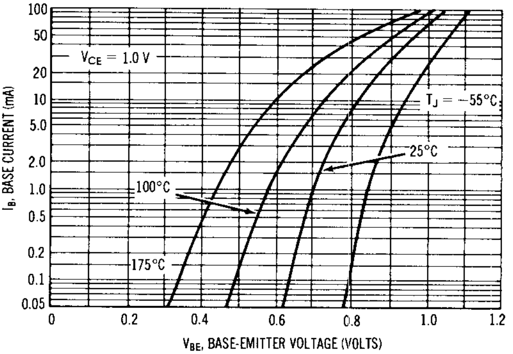


FIGURE 4 – INPUT ADMITTANCE



"OFF" REGION CHARACTERISTICS

FIGURE 5 – TRANSCONDUCTANCE

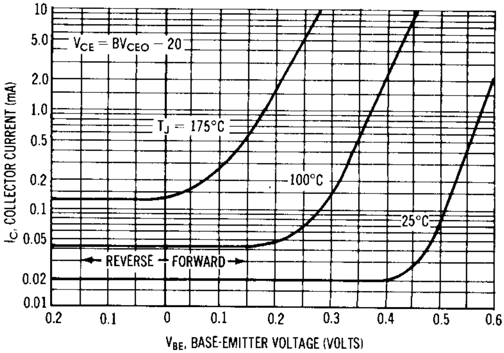
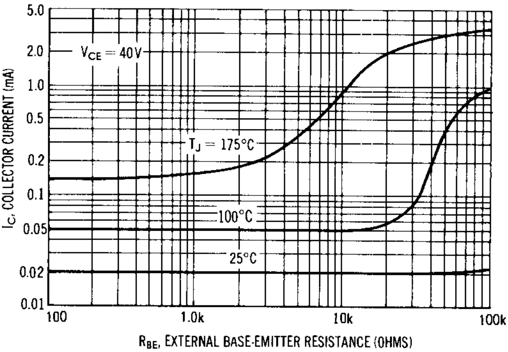


FIGURE 6 – EFFECTS OF BASE-EMITTER RESISTANCE



② Figures 5 and 6 apply to 2N3740 and 2N3741.

FIGURE 7 – THERMAL RESPONSE

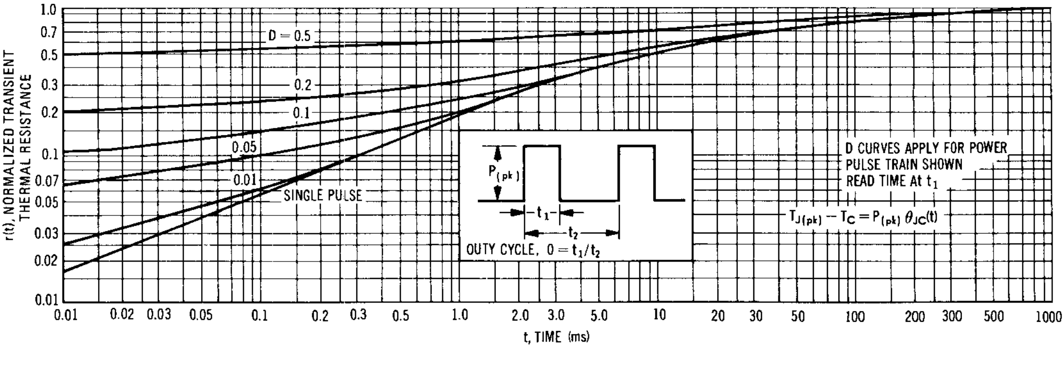
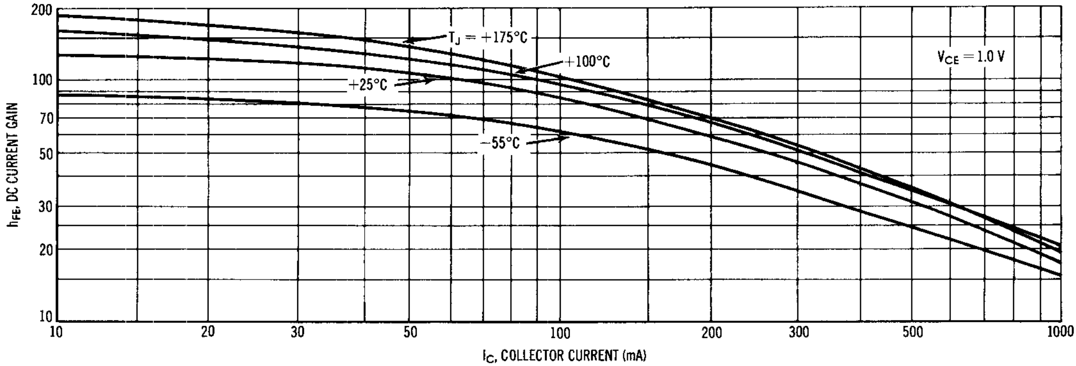


FIGURE 8 – CURRENT GAIN



SATURATION REGION CHARACTERISTICS

FIGURE 9 – COLLECTOR SATURATION REGION

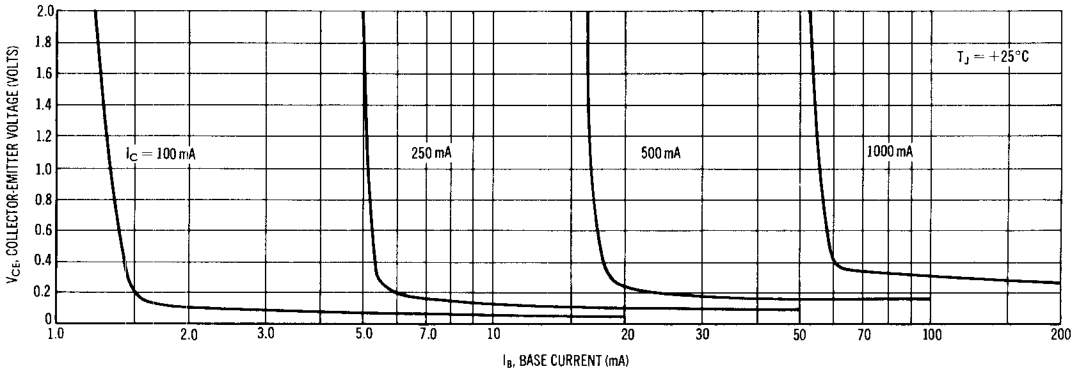


FIGURE 10 – "ON" VOLTAGES

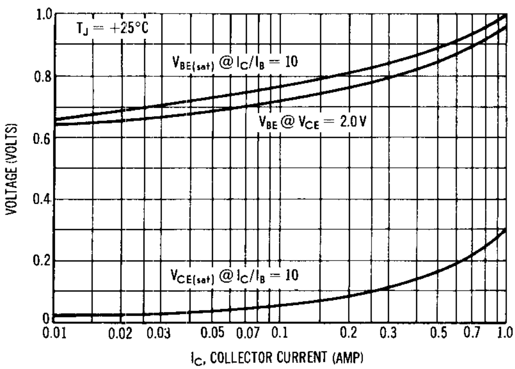


FIGURE 11 – TEMPERATURE COEFFICIENTS

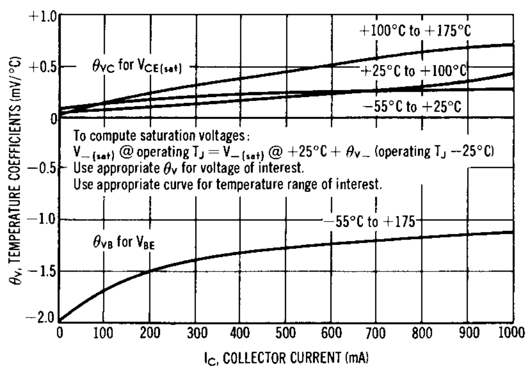


FIGURE 12 – TURN-ON TIME

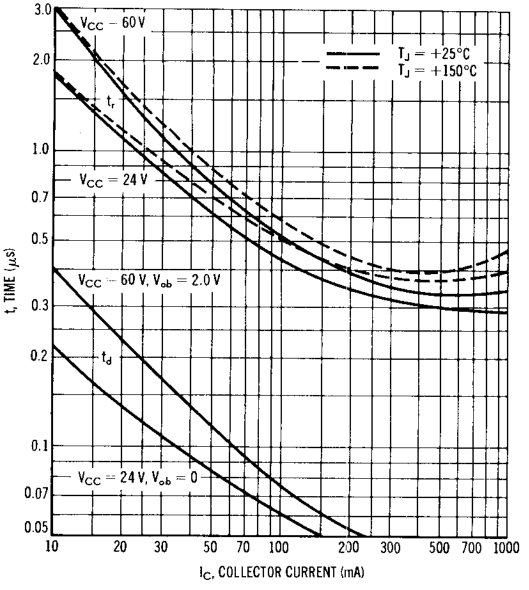


FIGURE 13 – CAPACITANCE

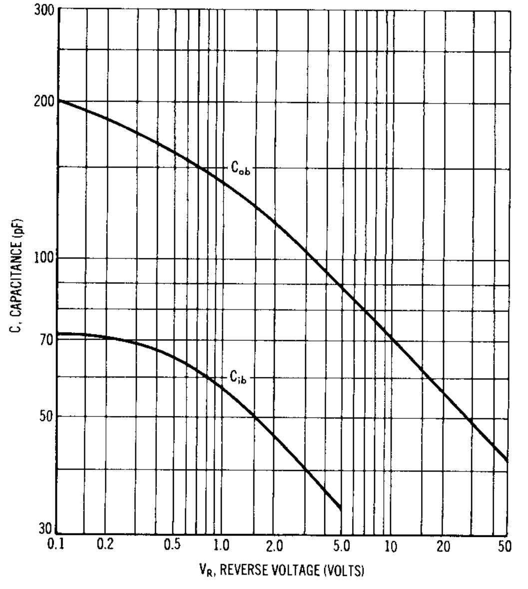


FIGURE 14 – STORAGE TIME

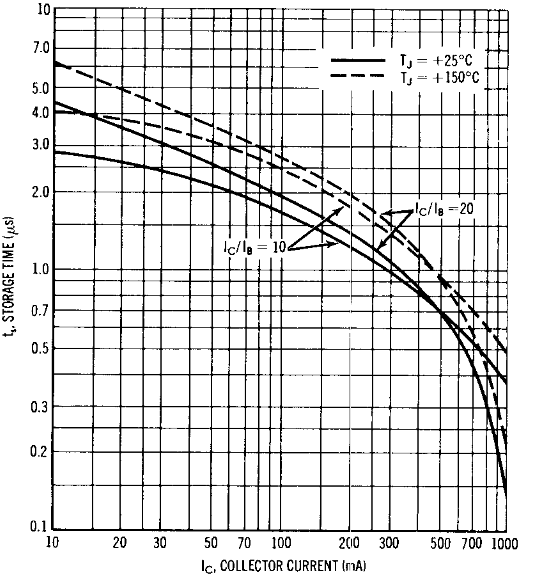
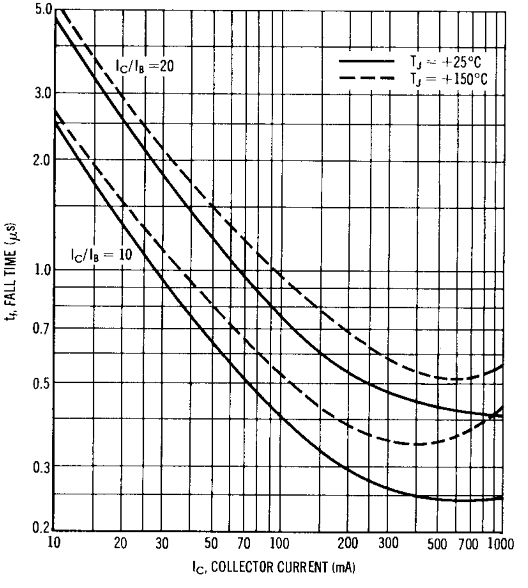


FIGURE 15 – FALL TIME



2N3771 (SILICON)
2N3772
MJ3771
MJ3772

HIGH-POWER NPN SILICON TRANSISTORS

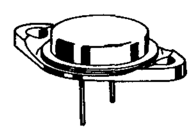
. . . designed for use in power amplifier and switching circuits applications.

- High DC Current Gain –
  h_{FE} = 15 (Min) @ I_C = 15 Adc – 2N3771, MJ3771
  15 (Min) @ I_C = 10 Adc – 2N3772, MJ3772
- Low Collector-Emitter Saturation Voltage –
  $V_{CE(sat)}$ = 1.0 Vdc (Max) @ I_C = 15 Adc – MJ3771
  1.0 Vdc (Max) @ I_C = 10 Adc – MJ3772

20 AND 30 AMPERE POWER TRANSISTORS

NPN SILICON

40-60 VOLTS
150 WATTS



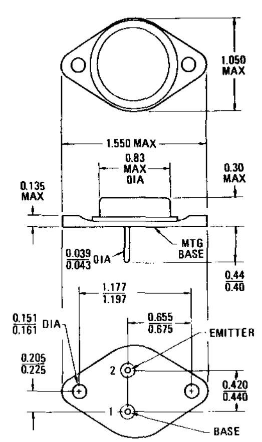
*MAXIMUM RATINGS

Rating	Symbol	2N3771 MJ3771	2N3772 MJ3772	Unit
Collector-Emitter Voltage	V_{CEO}	40	60	Vdc
Collector-Emitter Voltage	V_{CEX}	50	80	Vdc
Collector-Base Voltage	V_{CB}	50	100	Vdc
Emitter-Base Voltage	V_{EB}	5.0	7.0	Vdc
Collector Current – Continuous Peak	I_C	30 30	20 30	Adc
Base Current – Continuous	I_B	7.5	5.0	Adc
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	150 0.86		Watts W/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	-65 to +200		°C

*THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	θ_{JC}	1.17	°C/W

*Indicates JEDEC Registered Data (2N3771, 2N3772).



CASE 11
TO-3

Collector Connected to Case

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
*Collector-Emitter Sustaining Voltage (Note 1)		$V_{CEO(sus)}$				Vdc
(I_C = 200 mAdc, I_B = 0)	2N3771, MJ3771		40	–	–	
	2N3772, MJ3772		60	–	–	
*Collector Cutoff Current		I_{CEO}				mAdc
(V_{CE} = 30 Vdc, I_B = 0)	2N3771, MJ3771		–	–	10	
(V_{CE} = 50 Vdc, I_B = 0)	2N3772, MJ3772		–	–	10	
*Collector Cutoff Current		I_{CEX}				mAdc
(V_{CE} = Rated V_{CB}, $V_{EB(off)}$ = 1.5 Vdc)	2N3771, MJ3771		–	–	2.0	
	2N3772, MJ3772		–	–	5.0	
(V_{CE} = 30 Vdc, $V_{EB(off)}$ = 1.5 Vdc, T_C = 150°C)	All Types		–	–	10	
Collector Cutoff Current		I_{CBO}				mAdc
*(V_{CB} = Rated V_{CB}, I_E = 0)	2N3771, MJ3771		–	–	2.0	
	2N3772, MJ3772		–	–	5.0	
(V_{CB} = 30 Vdc, I_E = 0, T_C = 150°C)	All Types		–	–	10	
*Emitter Cutoff Current		I_{EBO}				mAdc
(V_{BE} = Rated V_{BE}, I_C = 0)			–	–	5.0	
ON CHARACTERISTICS						
*DC Current Gain (Note 1)		h_{FE}				–
(I_C = 15 Adc, V_{CE} = 4.0 Vdc)	2N3771, MJ3771		15	–	60	
(I_C = 10 Adc, V_{CE} = 4.0 Vdc)	2N3772, MJ3772		15	–	60	
(I_C = 30 Adc, V_{CE} = 4.0 Vdc)	2N3771, MJ3771		5.0	–	–	
(I_C = 20 Adc, V_{CE} = 4.0 Vdc)	2N3772, MJ3772		5.0	–	–	
*Collector-Emitter Saturation Voltage (Note 1)		$V_{CE(sat)}$				Vdc
(I_C = 15 Adc, I_B = 1.5 Adc)	2N3771		–	–	2.0	
	MJ3771		–	–	1.0	
(I_C = 10 Adc, I_B = 1.0 Adc)	2N3772		–	–	1.4	
	MJ3772		–	–	1.0	
(I_C = 30 Adc, I_B = 6.0 Adc)	2N3771, MJ3771		–	–	4.0	
(I_C = 20 Adc, I_B = 4.0 Adc)	2N3772, MJ3772		–	–	4.0	
Base-Emitter Saturation Voltage (Note 1)		$V_{BE(sat)}$				Vdc
(I_C = 10 Adc, I_B = 1.0 Adc)	MJ3771, MJ3772		–	–	1.7	
(I_C = 15 Adc, I_B = 1.5 Adc)	MJ3771, MJ3772		–	–	1.8	
(I_C = 20 Adc, I_B = 2.0 Adc)	MJ3771, MJ3772		–	–	2.5	
*Base-Emitter On Voltage (Note 1)		$V_{BE(on)}$				Vdc
(I_C = 15 Adc, V_{CE} = 4.0 Vdc)	2N3771		–	–	2.7	
	MJ3771		–	–	1.7	
(I_C = 10 Adc, V_{CE} = 4.0 Vdc)	2N3772		–	–	2.2	
	MJ3772		–	–	1.7	
DYNAMIC CHARACTERISTICS						
Current-Gain—Bandwidth Product		f_T				MHz
(I_C = 1.0 Adc, V_{CE} = 4.0 Vdc, f = 50 kHz)	2N3771, 2N3772		0.2	–	–	
(I_C = 1.0 Adc, V_{CE} = 10 Vdc, f = 1.0 MHz)	MJ3771, MJ3772		2.0	–	–	
Small Signal Current Gain (I_C = 10 Adc, V_{CE} = 4.0 Vdc, f = 1.0 kHz)		h_{fe}	40	–	–	–
SWITCHING CHARACTERISTICS						
Rise Time (V_{CC} = 10 Vdc, I_C = 10 Adc, I_{B1} = I_{B2} = 1.0 Adc)	MJ3771, MJ3772	t_r	–	350	–	ns
Storage Time (V_{CC} = 10 Vdc, I_C = 10 Adc, I_{B1} = I_{B2} = 1.0 Adc)	MJ3771, MJ3772	t_s	–	700	–	ns
Fall Time (V_{CC} = 10 Vdc, I_C = 10 Adc, I_{B1} = I_{B2} = 1.0 Adc)	MJ3771, MJ3772	t_f	–	300	–	ns

*Indicates JEDEC Registered Data (2N3771, 2N3772).
Note 1: Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

ACTIVE REGION DC SAFE OPERATING AREA

FIGURE 1 – 2N3771, 2N3772

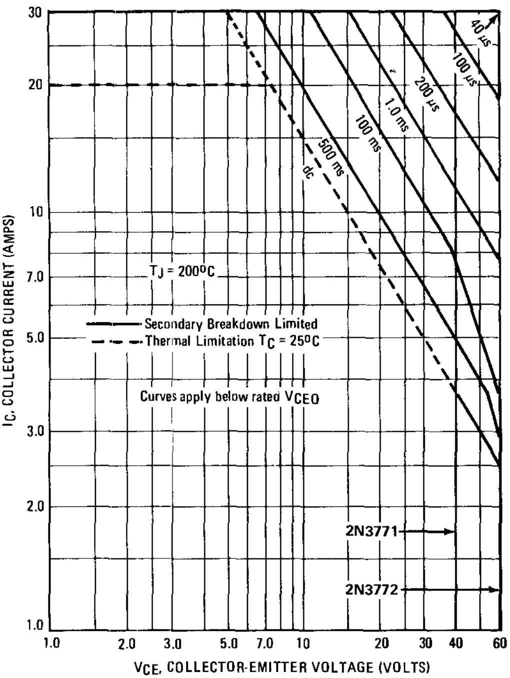
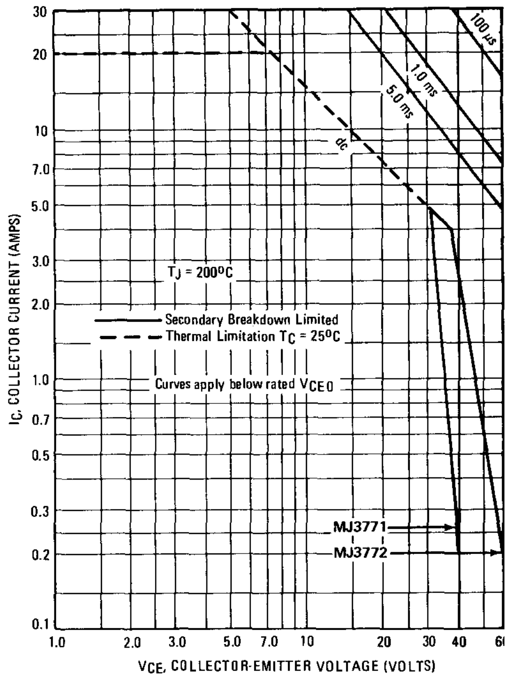


FIGURE 2 – MJ3771, MJ3772



The Safe Operating Area Curves indicate $I_C - V_{CE}$ limits below which the device will not enter secondary breakdown. Collector load lines for specific circuits must fall within the applicable Safe Area to avoid causing a catastrophic failure. To insure operation below the maximum T_J, power-temperature derating must be observed for both steady state and pulse power conditions.

2N3909 (SILICON)
2N3909A

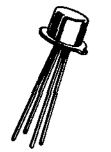
P-CHANNEL JUNCTION FIELD-EFFECT TRANSISTORS

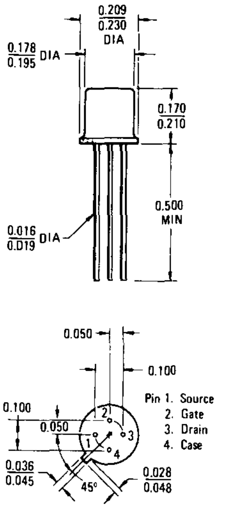
(Type A)

SILICON P-CHANNEL JUNCTION FIELD-EFFECT TRANSISTORS

Depletion Mode (Type A) Junction Field-Effect Transistors designed primarily for low-power audio amplifier applications.

- High AC Input Resistance – Typically > 30 Megohms @ f = 1.0 kHz
- Drain and Source Interchangeable
- Active Elements Isolated from Case





TO-72
CASE 20 (5)

Case Connected to Source

*MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain-Source Voltage	V_{DS}	-20	Vdc
Drain-Gate Voltage	V_{DG}	-20	Vdc
Reverse Gate-Source Voltage	V_{GSR}	20	Vdc
Forward Gate-Source Voltage	V_{GSF}	20	Vdc
Forward Gate Current	I_{GF}	10	mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	300 2.0	mW mW/°C
Storage Temperature Range	T_{stg}	-65 to +200	°C

*Indicates JEDEC Registered Data.

***ELECTRICAL CHARACTERISTICS** (T_A = 25°C unless otherwise noted) (Note 1)

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Gate-Source Breakdown Voltage (I_G = 10 μAdc, V_{DS} = 0)		$V_{(BR)GSS}$	20	–	Vdc
Gate-Source Cutoff Voltage (V_{DS} = 10 Vdc, I_D = 10 μAdc)	2N3909 2N3909A	$V_{GS(off)}$	– –	8.0 8.0	Vdc
Gate Reverse Current (V_{GS} = 10 Vdc, V_{DS} = 0) (V_{GS} = 10 Vdc, V_{DS} = 0, T_A = 100°C)		I_{GSS}	– –	10 1.0	nAdc μAdc
ON CHARACTERISTICS					
Zero-Gate Voltage Drain Current (Note 2) (V_{DS} = −10 Vdc, V_{GS} = 0)	2N3909 2N3909A	I_{DSS}	0.3 1.0	15 15	mAdc
Gate-Source Voltage (V_{DS} = −10 Vdc, I_D = 30 μAdc)		V_{GS}	0.3	7.9	Vdc
SMALL-SIGNAL CHARACTERISTICS					
Forward Transadmittance (Note 2) (V_{DS} = −10 Vdc, V_{GS} = 0, f = 1.0 kHz)	2N3909 2N3909A	$\|y_{fs}\|$	1000 2200	5000 5000	μmhos
(V_{DS} = −10 Vdc, V_{GS} = 0, f = 10 MHz)	2N3909 2N3909A		900 2000	– –	
Output Admittance (V_{DS} = −10 Vdc, V_{GS} = 0, f = 1.0 kHz)		$\|y_{os}\|$	–	100	μmhos
Input Capacitance (V_{DS} = −10 Vdc, V_{GS} = 0, f = 1.0 MHz)	2N3909 2N3909A	C_{iss}	– –	32 9.0	pF
Reverse Transfer Capacitance (V_{DS} = −10 Vdc, V_{GS} = 0, f = 1.0 MHz)	2N3909 2N3909A	C_{rss}	– –	16 3.0	pF

*Indicates JEDEC Registered Data.

Note 1: The fourth lead (case) is connected to the source for all measurements.
Note 2: Pulse Test: Pulse Width ≤ 630 ms, Duty Cycle ≤ 10%.

2N4066 (SILICON)
2N4067

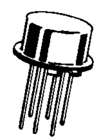
DUAL P-CHANNEL MOS FIELD-EFFECT TRANSISTORS

Enhancement Mode (Type C) MOS Field-Effect Transistors designed primarily for low-power, chopper or switching applications.

- High Forward Transadmittance – $|y_{fs}|$ = 2.5 mmhos (Min) @ V_{DS} = -15 Vdc (2N4067)
- Low Forward Gate Current – I_{GF} = 2.5 pAdc (Max) @ V_{GS} = -25 Vdc
- Low Drain-Source "ON" Resistance – $r_{ds(on)}$ = 250 Ohms (Max) @ V_{GS} = -15 Vdc (2N4067)

DUAL P-CHANNEL MOS FIELD-EFFECT TRANSISTORS

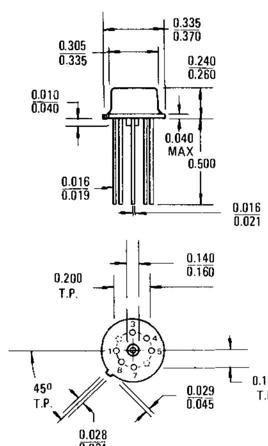
(Type C)



*MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain-Source Voltage	V_{DS}	-30	Vdc
Drain-Gate Voltage	V_{DG}	-25	Vdc
Reverse Gate-Source Voltage	V_{GSR}	+25	Vdc
Forward Gate-Source Voltage	V_{GSF}	-25	Vdc
Drain Current	I_D	200	mAdc
Total Device Dissipation @ $T_A = 25^oC$ Derate above 25^oC	P_D	0.6 4.0	Watt $mW/^oC$
Total Device Dissipation @ $T_C = 25^oC$ Derate above 25^oC	P_D	1.7 11.3	Watts $mW/^oC$
Storage Temperature Range	T_{stg}	-65 to +200	^oC
Operating Junction Temperature Range	T_J	-65 to +175	^oC

*Indicates JEDEC Registered Data.



Pin 1. Drain 1
3. Gate 1
4. Substrate.
5. Gate 2
7. Drain 2
8. Source 1 and 2

CASE 196(1)
TO-76

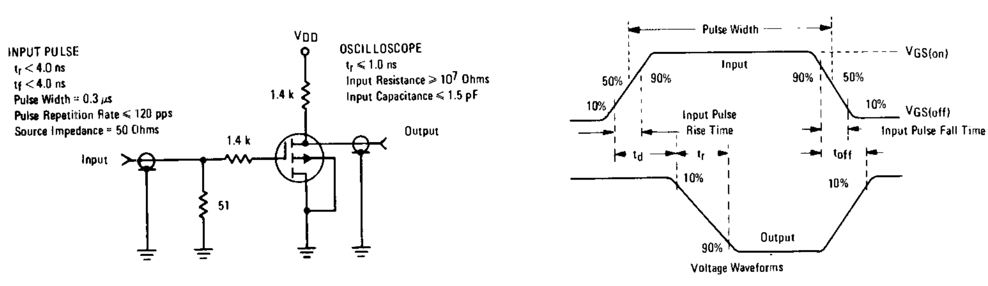
*ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Drain-Source Breakdown Voltage (I_D = 10 μAdc, V_{GS} = 0)	$V_{(BR)DSS}$	-30	–	Vdc
Source-Drain Breakdown Voltage (I_S = 10 μAdc, V_{GD} = 0)	$V_{(BR)SDS}$	-30	–	Vdc
Zero-Gate Voltage Source Current (V_{SD} = -15 Vdc, V_{GD} = 0)	I_{SDS}	–	1.0	nAdc
(V_{SD} = -15 Vdc, V_{GD} = 0, T_A = 150°C)		–	2.0	μAdc
Zero-Gate Voltage Drain Current (Note 1) (V_{DS} = -15 Vdc, V_{GS} = 0)	I_{DSS}	–	1.0	nAdc
(V_{DS} = -15 Vdc, V_{GS} = 0, T_A = 150°C)		–	2.0	μAdc
ON CHARACTERISTICS				
Gate-Source Threshold Voltage (V_{DS} = -15 Vdc, I_D = 10 μAdc)	$V_{GS(TH)}$	-3.0	-6.0	Vdc
Forward Gate Current (V_{GS} = -25 Vdc, V_{DS} = 0)	I_{GF}	–	2.5	pAdc
"ON" Drain Current (V_{DS} = -15 Vdc, V_{GS} = -15 Vdc)	$I_{D(on)}$	10	50	mAdc
SMALL-SIGNAL CHARACTERISTICS				
Static Drain-Source "ON" Resistance (V_{GS} = -15 Vdc, I_D = 0, f = 1.0 kHz) 2N4066	$r_{ds(on)}$	–	500	Ohms
2N4067		–	250	
Forward Transadmittance (Note 1) (V_{DS} = -15 Vdc, V_{GS} = -15 Vdc, f = 1.0 kHz) 2N4066	$\|y_{fs}\|$	1.5	–	mmhos
2N4067		2.5	–	
(V_{DS} = -15 Vdc, V_{GS} = -15 Vdc, f = 1.0 kHz, T_A = 100°C) 2N4066		1.0	–	
2N4067		1.75	–	
Output Admittance (V_{DS} = -15 Vdc, V_{GS} = -15 Vdc, f = 1.0 kHz)	$\|y_{os}\|$	–	300	μmhos
Input Capacitance (V_{DS} = -15 Vdc, V_{GS} = -15 Vdc, f = 1.0 MHz)	C_{iss}	–	7.0	pF
Reverse Transfer-Capacitance (V_{DS} = 0, V_{GS} = 0, f = 1.0 MHz)	C_{rss}	–	1.5	pF
Source-Substrate Capacitance (V_{DU} = -15 Vdc, V_{GS} = 0, I_S = 0, f = 1.0 MHz)	C_{SU}	–	5.0	pF
Drain-Substrate Capacitance (V_{SU} = -15 Vdc, V_{GS} = 0, I_S = 0, f = 1.0 MHz)	C_{DU}	–	5.0	pF
SWITCHING CHARACTERISTICS				
Delay Time (V_{DD} = -15 Vdc, $I_{D(on)}$ = 10 mAdc, $V_{GS(on)}$ = -15 Vdc, $V_{GS(off)}$ = 0)	t_d	–	20	ns
Rise Time	t_r	–	30	ns
Turn-Off Time	t_{off}	–	50	ns

*Indicates JEDEC Registered Data.

Note 1: Pulse Test: Pulse Width ≤ 630 ms, Duty Cycle ≤ 10%.

FIGURE 1 – SWITCHING TIMES TEST CIRCUIT



2N4360 (SILICON)

SILICON P-CHANNEL JUNCTION FIELD-EFFECT TRANSISTORS

Depletion Mode (Type A) Junction Field-Effect Transistors designed primarily for low-power audio frequency applications

- Forward Transadmittance –
  $|y_{fs}|$ = 2.0 mmhos (Min) @ V_{DS} = –10 Vdc
- Low Reverse Transfer Capacitance –
  C_{rss} = 5.0 pF (Max) @ V_{DS} = –10 Vdc

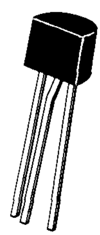
*MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain-Source Voltage	V_{DS}	-20	Vdc
Drain-Gate Voltage	V_{DG}	-20	Vdc
Reverse Gate-Source Voltage	V_{GSR}	20	Vdc
Gate Current	I_G	50	mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	200 2.0	mW mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	-55 to +125	°C

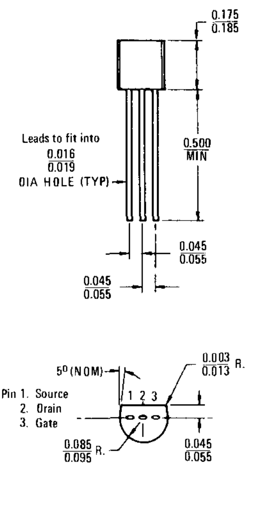
*Indicates JEDEC Registered Data.

P-CHANNEL JUNCTION FIELD-EFFECT TRANSISTORS

(Type A)



Case 29 with leads formed to a TO-18 configuration.



CASE 29(7)

TO-92

***ELECTRICAL CHARACTERISTICS** (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Gate-Source Breakdown Voltage (I_G = 10 μAdc, V_{DS} = 0)	$V_{(BR)GSS}$	20	–	Vdc
Gate-Source Cutoff Voltage (V_{DS} = –10 Vdc, I_D = 1.0 μAdc)	$V_{GS(off)}$	0.7	10	Vdc
Gate Reverse Current	I_{GSS}			
(V_{GS} = 15 Vdc, V_{DS} = 0)		–	10	nAdc
(V_{GS} = 15 Vdc, V_{DS} = 0, T_A = 65°C)		–	0.5	μAdc
ON CHARACTERISTICS				
Zero-Gate Voltage Drain Current (Note 1) (V_{DS} = –10 Vdc, V_{GS} = 0)	I_{DSS}	3.0	30	mAdc
Gate-Source Voltage (V_{DS} = –10 Vdc, I_D = 0.3 mAdc)	V_{GS}	0.4	9.0	Vdc
SMALL-SIGNAL CHARACTERISTICS				
Drain-Source "ON" Resistance (V_{GS} = 0, I_D = 0, f = 1.0 kHz)	$r_{ds(on)}$	–	700	Ohms
Forward Transadmittance (Note 1) (V_{DS} = –10 Vdc, V_{GS} = 0, f = 1.0 kHz)	$\|y_{fs}\|$	2000	8000	μmhos
Forward Transconductance (V_{DS} = –10 Vdc, V_{GS} = 0, f = 1.0 MHz)	$Re(y_{fs})$	1500	–	μmhos
Output Admittance (V_{DS} = –10 Vdc, V_{GS} = 0, f = 1.0 kHz)	$\|y_{os}\|$	–	100	μmhos
Input Capacitance (V_{DS} = –10 Vdc, V_{GS} = 0, f = 1.0 MHz)	C_{iss}	–	20	pF
Reverse Transfer Capacitance (V_{DS} = –10 Vdc, V_{GS} = 0, f = 1.0 MHz)	C_{rss}	–	5.0	pF
Common-Source Noise Figure (V_{DS} = –10 Vdc, I_D = 1.0 mAdc, R_G = 1.0 Megohm, f = 100 Hz)	NF	–	5.0	dB
Equivalent Short-Circuit Input Noise Voltage (V_{DS} = –10 Vdc, I_D = 1.0 mAdc, f = 100 Hz, BW = 15 Hz)	E_n	–	0.19	$\mu V/\sqrt{Hz}$

*Indicates JEDEC Registered Data.

Note 1: Pulse Test: Pulse Width ≤ 630 ms, Duty Cycle ≤ 10%.

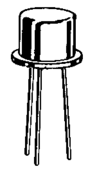
2N4427 (SILICON)

NPN SILICON RF POWER TRANSISTOR

. . . designed for amplifier, frequency multiplier, or oscillator applications in military and industrial equipment. Suitable for use as output driver or pre-driver stages in VHF and UHF equipment.

- Current-Gain—Bandwidth Product —
  f_T = 500 MHz (Min) @ I_C = 50 mAdc
- Power Gain —
  G_{pe} = 10 dB (Min) @ V_{CE} = 12 Vdc
- 1 Watt Minimum Power Output @ f = 175 MHz
- Multiple-Emitter Construction for Excellent High-Frequency Performance

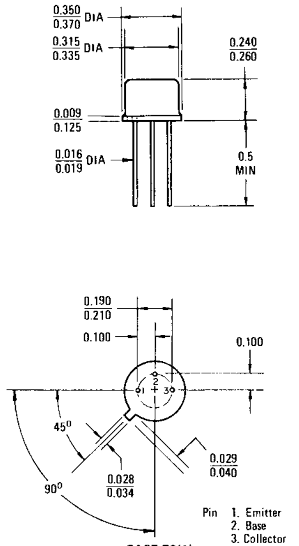
NPN SILICON
RF POWER
TRANSISTOR



*MAXIMUM RATINGS

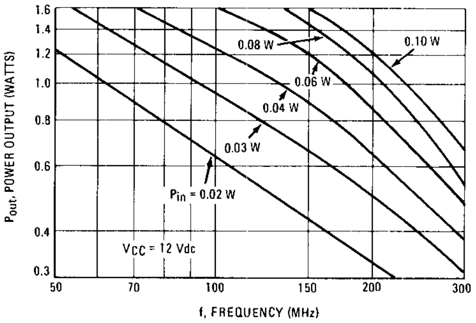
Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	20	Vdc
Collector-Base Voltage	V_{CB}	40	Vdc
Emitter-Base Voltage	V_{EB}	2.0	Vdc
Collector Current — Continuous	I_C	400	mAdc
Base Current — Continuous	I_B	400	mAdc
** Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	1.0 5.71	Watt mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	3.5 20	Watts mW/°C
Storage Temperature Range	T_{stg}	-65 to + 200	°C

*Indicates JEDEC Registered Data
**Motorola guarantees this data in additon to JEDEC registered Data



CASE 79(1)
(TO-39)

FIGURE 1 — POWER OUTPUT versus FREQUENCY

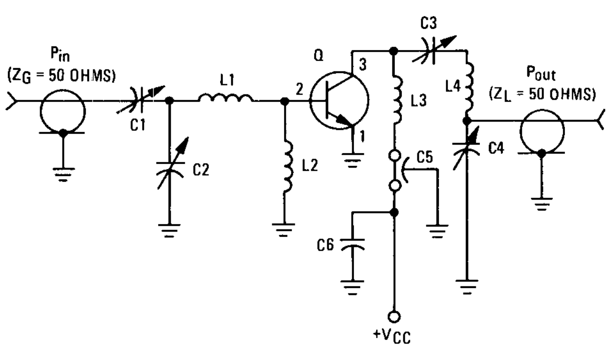


ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Max	Unit
***OFF CHARACTERISTICS**				
Collector-Emitter Sustaining Voltage (I_C = 5.0 mAdc, I_B = 0)	$V_{CEO(sus)}$	20	–	Vdc
Collector-Emitter Sustaining Voltage (I_C = 5.0 mAdc, R_{BE} = 10 ohms)	$V_{CER(sus)}$	40	–	Vdc
Collector Cutoff Current (V_{CE} = 12 Vdc, I_B = 0)	I_{CEO}	–	0.02	mAdc
Collector Cutoff Current (V_{CE} = 40 Vdc, V_{BE} = −1.5 Vdc) (V_{CE} = 12 Vdc, V_{BE} = −1.5 Vdc, T_C = +150°C)	I_{CEV}	– –	0.1 5.0	mAdc
Emitter Cutoff Current (V_{EB} = 2.0 Vdc, I_C = 0)	I_{EBO}	–	0.1	mAdc
***ON CHARACTERISTICS**				
DC Current Gain (I_C = 100 mAdc, V_{CE} = 5.0 Vdc) (I_C = 360 mAdc, V_{CE} = 5.0 Vdc)	h_{FE}	10 5.0	200 –	–
Collector-Emitter Saturation Voltage (I_C = 100 mAdc, I_B = 20 mAdc)	$V_{CE(sat)}$	–	0.5	Vdc
***DYNAMIC CHARACTERISTICS**				
Current-Gain — Bandwidth Product (I_C = 50 mAdc, V_{CE} = 15 Vdc, f = 200 MHz)	f_T	500	–	MHz
Output Capacitance (V_{CB} = 12 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	–	4.0	pF
FUNCTIONAL TEST				
*Power Input (Figure 1) (P_{out} = 1.0 W, Z_S = 50 Ohms, V_{CC} = 12 Vdc, f = 175 MHz)	P_{in}	–	100	mW
Common-Emitter Amplifier Power Gain (P_{in} = 100 mW, Z_S = 50 Ohms, V_{CC} = 12 Vdc, f = 175 MHz)	G_{pe}	10	–	dB
*Collector Efficiency (Figure 1) (P_{out} = 1.0 W, Z_S = 50 Ohms, V_{CC} = 12 Vdc, f = 175 MHz)	η	50	–	%

*Indicates JEDEC Registered Data

FIGURE 1 — 175 MHz RF AMPLIFIER CIRCUIT FOR POWER-OUTPUT TEST



C1, C2, C3, and C4: 3-30 pF
C5: 1,000 pF
C6: 0.01 μF
L1: 2 turns No. 16 wire, 3/16" ID, 1/4" long
L2: Ferrite choke, Z = 450 ohms
L3: 2 turns No. 16 wire, 1/4" ID, 1/4" long
L4: 4 turns No. 16 wire, 3/8" ID, 3/8" long
Q: 2N4427

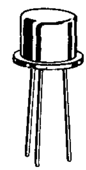
2N4428 (SILICON)

NPN SILICON RF POWER TRANSISTOR

. . . designed primarily for use in large signal VHF and UHF amplifier output stages in military and industrial communications applications.

- High Power Output – P_{out} = 0.75 Watt with 10 dB Gain @ f = 500 MHz
- High Current-Gain–Bandwidth Product – f_T = 1000 MHz (Typ) @ I_C = 50 mAdc
- Multiple Emitter Construction for Excellent High Frequency Performance

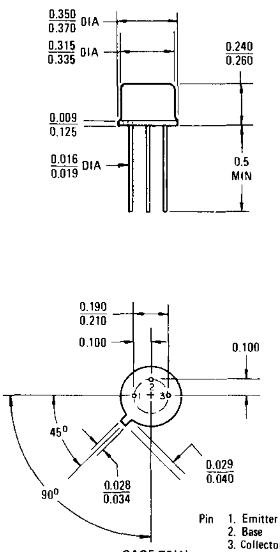
NPN SILICON RF POWER TRANSISTOR



*MAXIMUM RATINGS

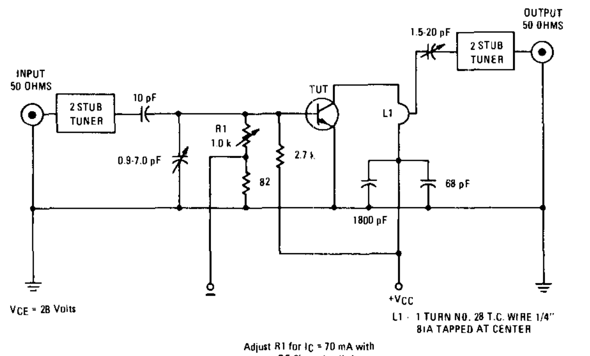
Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	35	Vdc
Collector-Base Voltage	V_{CB}	55	Vdc
Emitter-Base Voltage	V_{EB}	3.5	Vdc
Collector Current – Continuous	I_C	425	mAdc
Base Current – Continuous	I_B	150	mAdc
Total Device Dissipation @ $T_C = 25^oC$ Derate above 25^oC	P_D	3.5 20	Watts $mW/^oC$
Operating and Storage Junction Temperature Range	T_J, T_{stg}	-65 to +200	^oC

*Indicates JEDEC Registered Data.



CASE 79(1)
(TO-39)

FIGURE 1 – 500 MHz TEST CIRCUIT



*ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Sustaining Voltage (I_C = 20 mAdc, I_B = 0)	$V_{CEO(sus)}$	35	–	–	Vdc
Collector-Emitter Sustaining Voltage (I_C = 20 mAdc, R_{BE} = 10 ohms)	$V_{CER(sus)}$	55	–	–	Vdc
Collector Cutoff Current (V_{CE} = 55 Vdc, V_{BE} = −1.5 Vdc)	I_{CEX}	–	–	1.0	mAdc
Emitter Cutoff Current (V_{EB} = 3.5 Vdc, I_C = 0)	I_{EBO}	–	–	0.1	mAdc
ON CHARACTERISTICS					
DC Current Gain	h_{FE}				–
(I_C = 50 mAdc, V_{CE} = 5.0 Vdc)		20	–	200	
(I_C = 400 mAdc, V_{CE} = 5.0 Vdc)		5.0	–	–	
DYNAMIC CHARACTERISTICS					
Current-Gain—Bandwidth Product (I_C = 50 mAdc, V_{CE} = 20 Vdc, f = 200 MHz)	f_T	700	1000	–	MHz
Output Capacitance (V_{CB} = 28 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	–	1.2	3.5	pF
FUNCTIONAL TEST					
Power Input (Figure 1) (P_{out} = 750 mW, V_{CE} = 28 Vdc, R_S = 50 Ohms, f = 500 MHz)	P_{in}	–	–	75	mW
Collector Efficiency (Figure 1) (P_{out} = 750 mW, V_{CE} = 28 Vdc, R_S = 50 Ohms, f = 500 MHz)	η	35	–	–	%

*Indicates JEDEC Registered Data.

FIGURE 2 — CURRENT-GAIN—BANDWIDTH PRODUCT

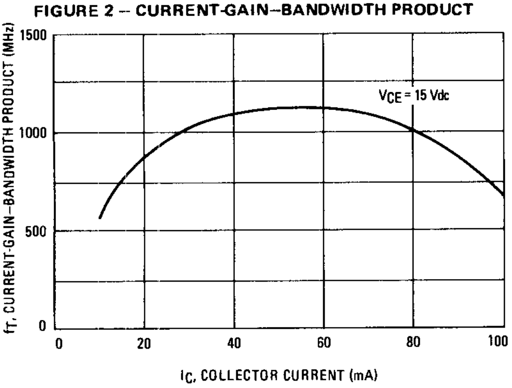
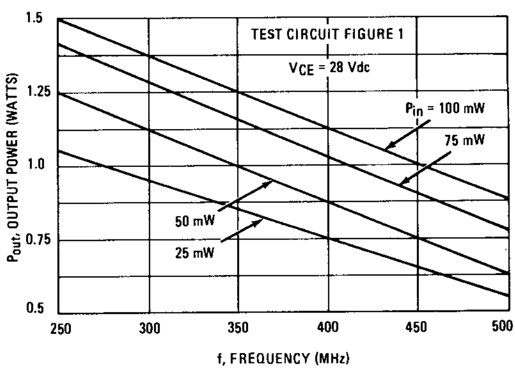


FIGURE 3 — OUTPUT POWER versus FREQUENCY



2N5031 (SILICON)
2N5032

NPN SILICON RF SMALL-SIGNAL TRANSISTORS

. . . designed primarily for use in high-gain, low-noise, small-signal amplifiers in military and industrial equipment. Suitable for use in video wideband and general high-frequency amplifier applications of 50 to 1000 MHz.

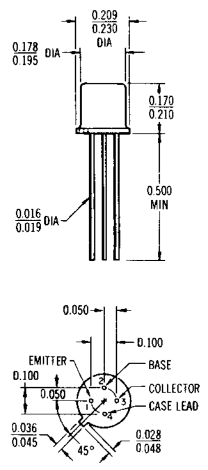
- Low Noise Figure —
  NF = 2.5 dB (Max) @ f = 450 MHz (2N5031)
- High Power Gain —
  G_{pe} = 17 dB (Typ) @ f = 450 MHz
- High Current-Gain—Bandwidth Product —
  f_T = 1000 MHz (Min) @ I_C = 5.0 mAdc

NPN SILICON
RF SMALL-SIGNAL
TRANSISTORS

*MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	10	Vdc
Collector-Base Voltage	V_{CB}	15	Vdc
Emitter-Base Voltage	V_{EB}	3.0	Vdc
Collector Current — Continuous	I_C	20	mAdc
Total Device Dissipation @ $T_A = 25^oC$ Derate above 25^oC	P_D	200 1.14	mW $mW/^oC$
Operating and Storage Junction Temperature Range	T_J, T_{stg}	-65 to +200	^oC

*Indicates JEDEC Registered Data.



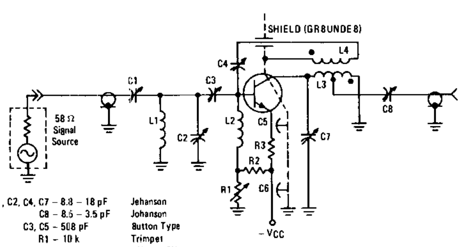
CASE 20(10)
TO-72

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
***OFF CHARACTERISTICS**					
Collector-Emitter Breakdown Voltage (I_C = 1.0 mAdc, I_B = 0)	BV_{CEO}	10	–	–	Vdc
Collector-Base Breakdown Voltage (I_C = 0.01 mAdc, I_E = 0)	BV_{CBO}	15	–	–	Vdc
Emitter-Base Breakdown Voltage (I_E = 0.01 mAdc, I_C = 0)	BV_{EBO}	3.0	–	–	Vdc
Collector Cutoff Current (V_{CB} = 6.0 Vdc, I_E = 0)	I_{CBO}	–	1.0	10	nAdc
***ON CHARACTERISTICS**					
DC Current Gain (I_C = 1.0 mAdc, V_{CE} = 6.0 Vdc)	h_{FE}	25	–	300	–
DYNAMIC CHARACTERISTICS					
*Current-Gain—Bandwidth Product (I_C = 5.0 mAdc, V_{CE} = 6.0 Vdc, f = 100 MHz)	f_T	1000	–	3500	MHz
*Output Capacitance (V_{CE} = 6.0 Vdc, I_E = 0, f = 0.1 MHz)	C_{ob}	–	1.3	1.5	pF
Collector-Base Time Constant (I_C = 10 mAdc, V_{CE} = 6.0 Vdc, f = 31.8 MHz)	$r_b'C_c$	–	5.0	10	ps
*Noise Figure† (Figure 1) (I_C = 1.0 mAdc, V_{CE} = 6.0 Vdc, f = 450 MHz) 2N5031	NF	–	–	2.5	dB
2N5032		–	–	3.0	
***FUNCTIONAL TEST**					
Common-Emitter Amplifier Power Gain† (Figure 1) (V_{CE} = 6.0 Vdc, I_C = 1.0 mAdc, f = 450 MHz)	G_{pe}	14	17	25	dB

*Indicates JEDEC Registered Data.
†Tuned for Minimum Noise.

FIGURE 1 – POWER GAIN AND NOISE FIGURE TEST CIRCUIT



C1, C2, C4, C7 – 8.8 – 18 pF Jehansan
C8 – 8.5 – 3.5 pF Johanson
C3, C5 – 508 pF 8utton Type
R1 – 10 k Trimpet
R2 – 2.7 k 1/4 watt 5%
R3 – 1.0 k 1/4 watt 5%
L1 – 1/4" 8rass Rod, Solder Pleted, 1-1/8" leng. Placed 5/8" from the socket and in parallol with the shield, which bisects the socket. The ungraunded side is seldered dirœctly te the ungreunded side of C2.
L2 – 8.22 μH
L3 – 1/4" 8rass Rod, Solder Plated, 1-1/2" long. Placed 1/2" from the socket and in parallal with shield, which bisects the socket. The ungrounded side is soldered directly to the ungrounded side ef C7. Output tap is 15/16" frem ground.
L4 – 1/2 Turn #16, 5/16" abeve L3 end 5/8" long, (ever L3).

FIGURE 2 – COLLECTOR-BASE CAPACITANCE versus VOLTAGE

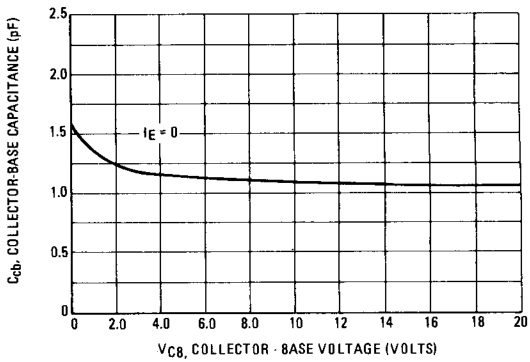


FIGURE 3 – CURRENT-GAIN–BANDWIDTH PRODUCT

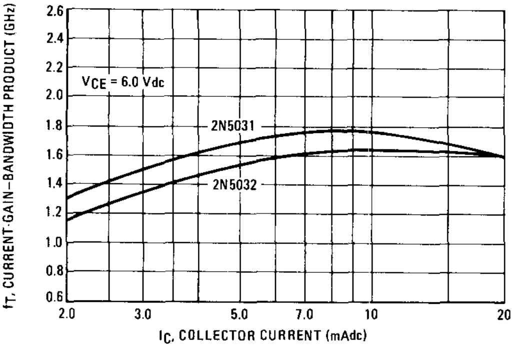


FIGURE 4 – S_{11} AND S_{22}

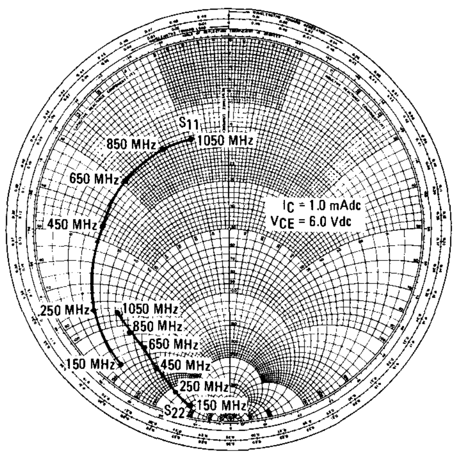


FIGURE 5 – S_{12}

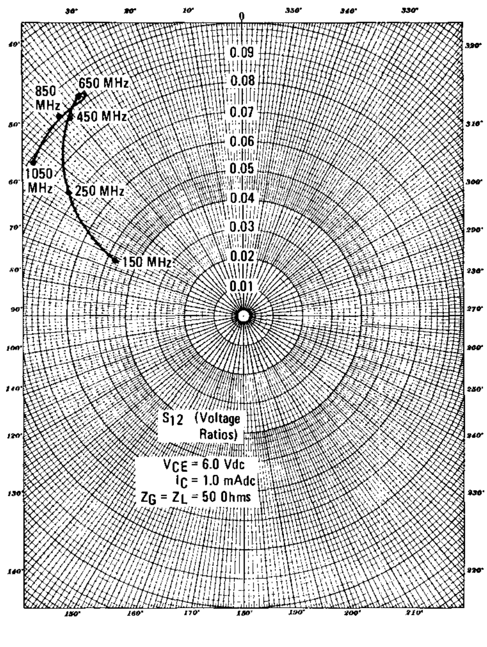


FIGURE 6 – S_{21}

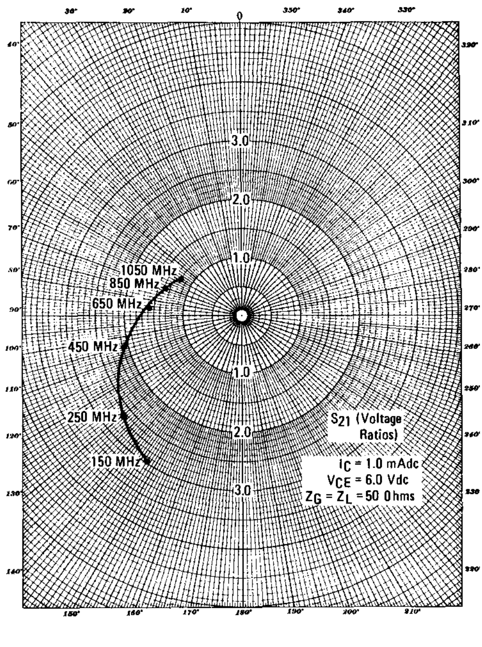


FIGURE 7 – NOISE FIGURE versus FREQUENCY

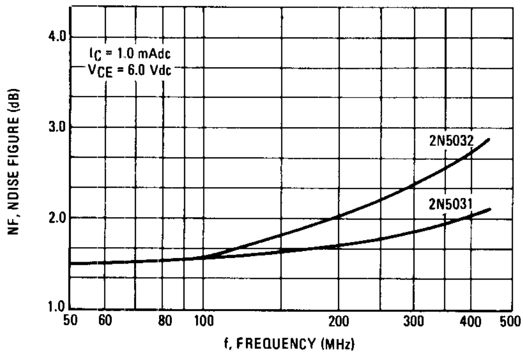


FIGURE 8 – POWER GAIN versus FREQUENCY

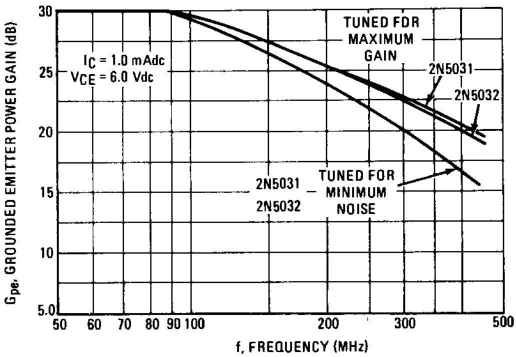


FIGURE 9 – INPUT ADMITTANCE versus FREQUENCY

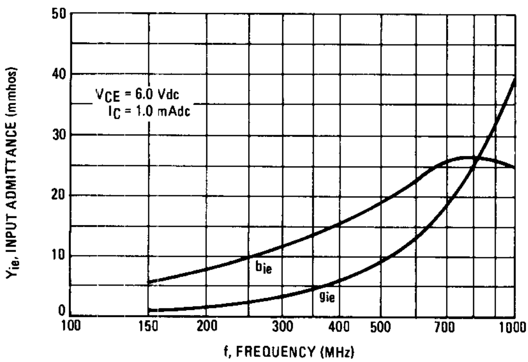


FIGURE 10 – OUTPUT ADMITTANCE versus FREQUENCY

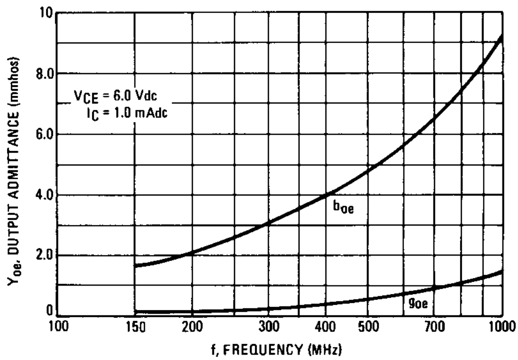


FIGURE 11 – FORWARD TRANSFER ADMITTANCE versus FREQUENCY

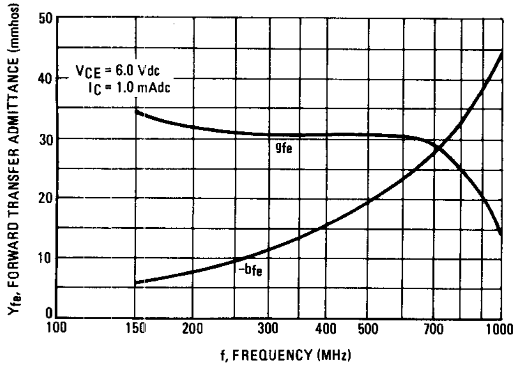
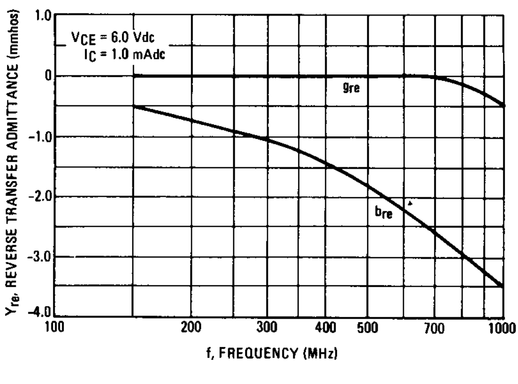


FIGURE 12 – REVERSE TRANSFER ADMITTANCE versus FREQUENCY



2N5050 (SILICON)
2N5051
2N5052

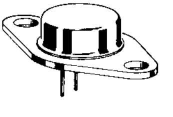
MEDIUM-POWER NPN SILICON TRANSISTORS

. . . designed for untuned amplifier and switching applications.

- High Voltage Ratings – V_{CEO} = 125, 150 and 200 Vdc
- Low Collector-Emitter Saturation Voltage – $V_{CE(sat)}$ = 1.0 Vdc (Max) @ I_C = 0.75 Adc
- Packaged in the Compact, High Efficiency TO-66 Case

2 AMPERE POWER TRANSISTORS NPN SILICON

125-200 VOLTS 40 WATTS



*MAXIMUM RATINGS

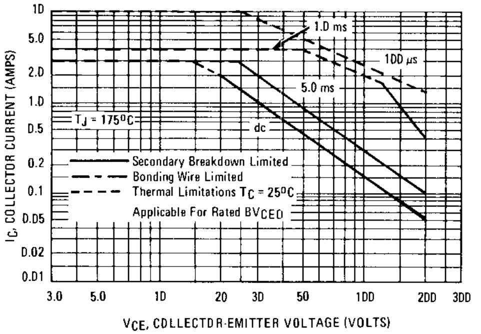
Rating	Symbol	2N5050	2N5051	2N5052	Unit
Collector-Emitter Voltage	V_{CEO}	125	150	200	Vdc
Collector-Base Voltage	V_{CB}	125	150	200	Vdc
Emitter-Base Voltage	V_{EB}	6.0			Vdc
Collector Current – Continuous	I_C	2.0			Adc
Base Current	I_B	1.0			Adc
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	40 0.266			Watts W/°C
Operating Junction Temperature Range	T_J	-65 to +175			°C
Storage Temperature Range	T_{stg}	-65 to +200			°C

*THERMAL CHARACTERISTICS

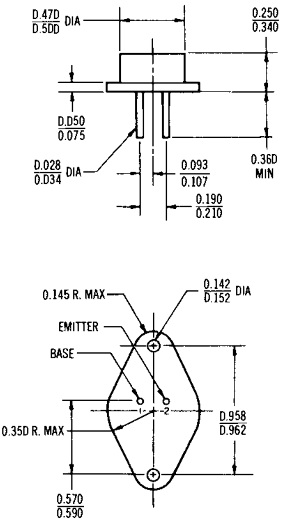
Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	θ_{JC}	3.76	°C/W

*Indicates JEDEC Registered Data.

FIGURE 1 – ACTIVE-REGION SAFE OPERATING AREA



The Safe Operating Area Curves indicate $I_C - V_{CE}$ limits below which the device will not enter secondary breakdown. Collector load lines for specific circuits must fall within the applicable Safe Area to avoid causing a catastrophic failure. To insure operation below the maximum T_J, power-temperature derating must be observed for both steady state and pulse power conditions.



CASE 80
TO-66

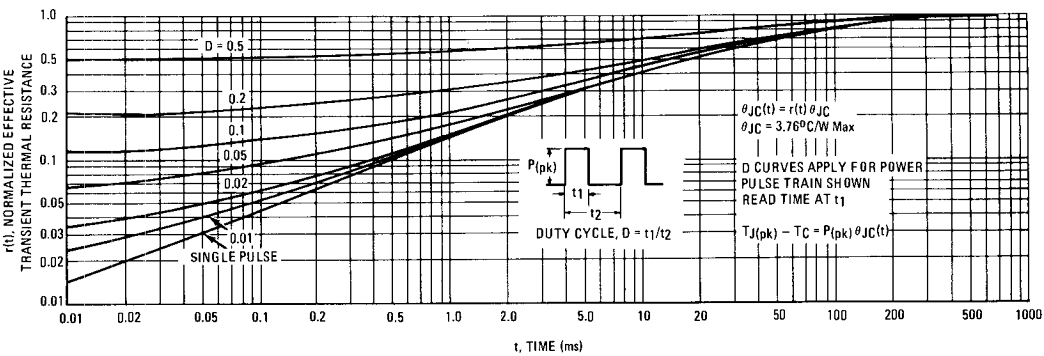
Collector Connected to Case

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristic		Symbol	Min	Max	Unit
***OFF CHARACTERISTICS**					
Collector-Emitter Sustaining Voltage (Note 1) (I_C = 200 mAdc, I_B = 0)	2N5050	$V_{CEO(sus)}$	125	–	Vdc
	2N5051		150	–	
	2N5052		200	–	
Collector-Emitter Cutoff Current (V_{CE} = 62.5 Vdc, I_B = 0)	2N5050	I_{CEO}	–	0.1	mAdc
(V_{CE} = 75 Vdc, I_B = 0)	2N5051		–	0.1	
(V_{CE} = 100 Vdc, I_B = 0)	2N5052		–	0.1	
Collector-Emitter Cutoff Current (V_{CE} = Rated V_{CEO}, $V_{EB(off)}$ = 1.5 Vdc)		I_{CEX}	–	0.5	mAdc
(V_{CE} = Rated V_{CEO}, $V_{EB(off)}$ = 1.5 Vdc, T_C = 150°C)			–	5.0	
Emitter-Base Cutoff Current (V_{BE} = 6.0 Vdc, I_C = 0)		I_{EBO}	–	0.1	mAdc
***ON CHARACTERISTICS**					
DC Current Gain (Note 1) (I_C = 0.75 Adc, V_{CE} = 5.0 Vdc)		h_{FE}	25	100	–
(I_C = 1.0 Adc, V_{CE} = 5.0 Vdc)			25	–	
(I_C = 2.0 Adc, V_{CE} = 5.0 Vdc)			5.0	–	
Collector-Emitter Saturation Voltage (Note 1) (I_C = 0.75 Adc, I_B = 0.1 Adc)		$V_{CE(sat)}$	–	1.0	Vdc
(I_C = 2.0 Adc, I_B = 0.4 Adc)			–	5.0	
Base-Emitter On Voltage (Note 1) (I_C = 0.75 Adc, V_{CE} = 5.0 Vdc)		$V_{BE(on)}$	–	1.2	Vdc
***DYNAMIC CHARACTERISTICS**					
Current-Gain—Bandwidth Product (I_C = 250 mAdc, V_{CE} = 10 Vdc, f = 5.0 MHz)		f_T	10	–	MHz
Small-Signal Current Gain (I_C = 250 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)		h_{fe}	25	–	–
Common Base Output Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 100 kHz)		C_{ob}	–	250	pF
***SWITCHING CHARACTERISTICS**					
Rise Time	(V_{CC} = 120 Vdc, I_C = 750 mAdc, R_L = 150 Ohms, I_{B1} = I_{B2} = 100 mAdc)	t_r	–	300	ns
Storage Time		t_s	–	3.5	µs
Fall Time		t_f	–	1.2	µs

*Indicates JEDEC Registered Data. Note 1: Pulse Test: Pulse Width ≤300 µs, Duty Cycle ≤2.0%.

FIGURE 2 – THERMAL RESPONSE



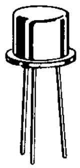
2N5108 (SILICON)

NPN SILICON HIGH-FREQUENCY TRANSISTOR

. . . designed for amplifier, frequency multiplier, or oscillator applications in military and industrial equipment. Suitable for use as output, driver, or pre-driver stages in UHF equipment and as a fundamental frequency oscillator at 1.68 GHz.

- High Power Output – P_{out} = 1.0 W (Min) @ f = 1.0 GHz
- High Current-Gain—Bandwidth Product –
  f_T = 1200 MHz (Min) @ I_C = 50 mAdc
- Ideal for Radio Sonde Applications –
  P_{out} (oscillator) = 300 mW (Typ) @ f = 1.68 GHz

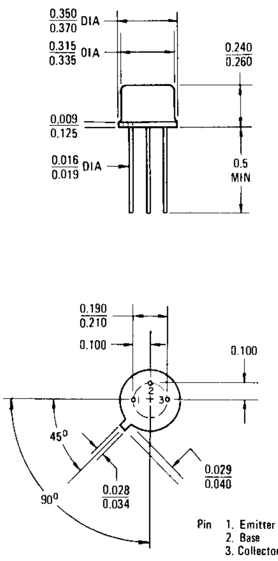
NPN SILICON AMPLIFIER TRANSISTOR



MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	30	Vdc
*Collector-Emitter Voltage (R_{BE} = 10 Ohms)	V_{CER}	55	Vdc
*Collector-Base Voltage	V_{CB}	55	Vdc
*Emitter-Base Voltage	V_{EB}	3.0	Vdc
*Collector Current – Continuous	I_C	0.4	Adc
*Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	3.5 0.02	Watts W/°C
*Storage Temperature Range	T_{stg}	-65 to +200	°C

*Indicates JEDEC Registered Data.



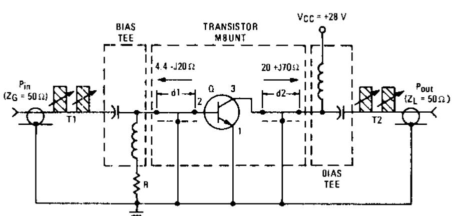
CASE 79(1)
(TO-39)

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
*Collector-Emitter Sustaining Voltage (I_C = 5.0 mAdc, R_{BE} = 10 ohms)	$V_{CER(sus)}$	55	–	–	Vdc
Collector-Base Breakdown Voltage (I_C = 0.1 mAdc, I_E = 0)	BV_{CBO}	55	–	–	Vdc
*Emitter-Base Breakdown Voltage (I_E = 0.1 mAdc, I_C = 0)	BV_{EBO}	3.0	–	–	Vdc
*Collector Cutoff Current (V_{CE} = 15 Vdc, I_B = 0)	I_{CEO}	–	–	20	μAdc
*Collector Cutoff Current	I_{CES}				
(V_{CE} = 50 Vdc, V_{BE} = 0)		–	–	1.0	μAdc
(V_{CE} = 15 Vdc, V_{BE} = 0, T_C = 150°C)		–	–	10	mAdc
ON CHARACTERISTICS					
Collector-Emitter Saturation Voltage (I_C = 100 mAdc, I_B = 10 mAdc)	$V_{CE(sat)}$	–	–	0.5	Vdc
DYNAMIC CHARACTERISTICS					
*Current-Gain–Bandwidth Product (I_C = 50 mAdc, V_{CE} = 15 Vdc, f = 200 MHz)	f_T	1200	–	–	MHz
*Output Capacitance (V_{CB} = 30 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	–	1.3	3.0	pF
FUNCTIONAL TEST					
*Common-Emitter Amplifier Power Gain (Figure 1) (P_{out} = 1.0 W, V_{CC} = 28 Vdc, I_C = 102 mAdc, f = 1.0 GHz)	G_{PE}	5.0	–	–	dB
Power Output (Figure 1) (P_{in} = 316 mW, V_{CE} = 28 Vdc, f = 1.0 GHz)	P_{out}	1.0	–	–	Watt
*Collector Efficiency (P_{in} = 316 mW, V_{CE} = 28 Vdc, f = 1.0 GHz)	η	35	–	–	%
Power Output (Oscillator) (Figure 2) (V_{CE} = 20 Vdc, V_{EB} = 1.5 Vdc, f = 1.68 GHz) (Minimum Efficiency = 15%)	P_{out}	–	0.3	–	Watt

*Indicates JEDEC Registered Data.

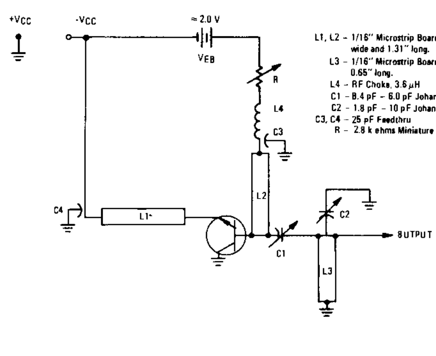
FIGURE 1 – 1 GHz RF AMPLIFIER POWER OUTPUT TEST CIRCUIT



d1: 1" Input line, center conductor width = 0.200"
d2: 1" Output line, center conductor width = 0.125"
Q: 2N5108
R: 3.9 ohms
T1, T2: Microlab Double Stub Tuner, or Equivalent
Bias Tee: Microlab 08N, or Equivalent
Transistor Mount: 1/32" Microstrip board

Note: Impedance measurements are made at transistor socket pins.

FIGURE 2 – 1.68 GHz RF OSCILLATOR POWER OUTPUT TEST CIRCUIT



L1, L2 – 1/16" Microstrip Board. Lines are 0.16" wide and 1.31" long.
L3 – 1/16" Microstrip Board. 0.16" wide and 0.65" long.
L4 – RF Choke, 3.6 μH
C1 – 0.4 pF – 6.0 pF Johanson 4640
C2 – 1.8 pF – 10 pF Johanson 4355
C3, C4 – 25 pF Feedthru
R – 2.8 k ohms Miniature Trim pot

FIGURE 3 – POWER OUTPUT versus POWER INPUT

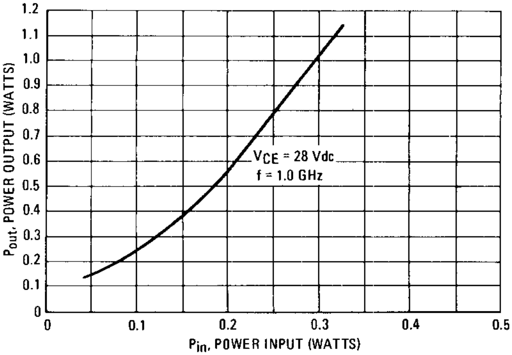


FIGURE 4 – POWER OUTPUT versus FREQUENCY

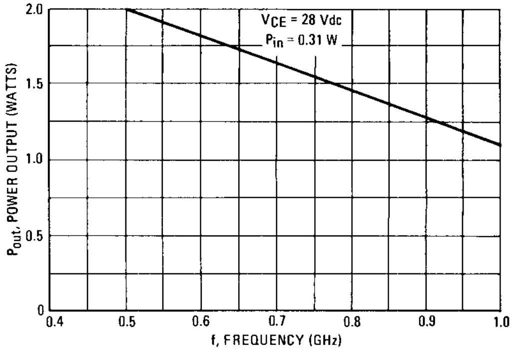


FIGURE 5 – POWER OUTPUT versus COLLECTOR-EMITTER VOLTAGE

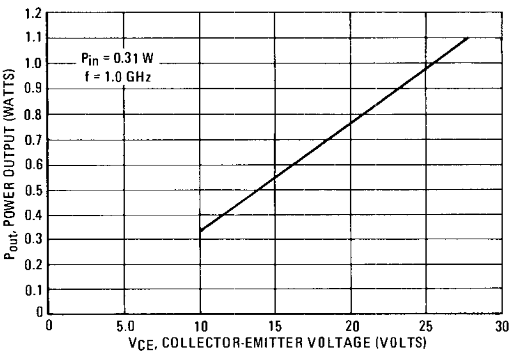


FIGURE 6 – OSCILLATOR POWER OUTPUT versus COLLECTOR CURRENT

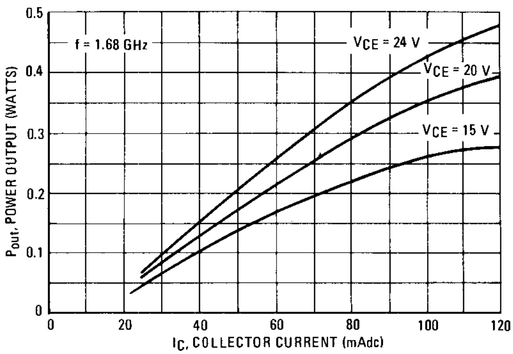


FIGURE 7 CURRENT-GAIN–BANDWIDTH PRODUCT versus CURRENT

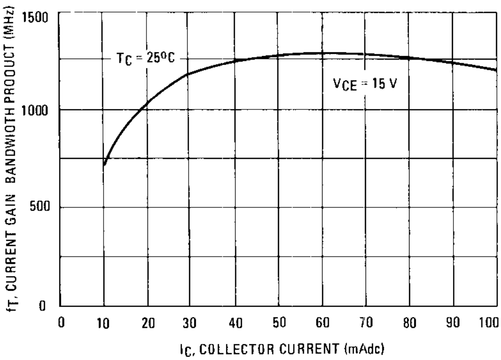
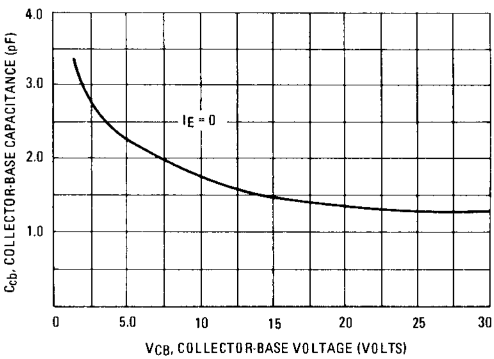


FIGURE 8 COLLECTOR BASE CAPACITANCE versus VOLTAGE



2N5155 (GERMANIUM)

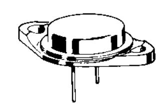
PNP GERMANIUM POWER TRANSISTORS

. . . designed for high-current switching applications requiring low saturation voltages, fast switching times and above average Collector-Emitter Sustaining capability.

- Alloy Diffused Epitaxial Construction
- Low Saturation Voltages —
  $V_{CE(sat)}$ = 0.9 Vdc (Max) @ I_C = 25 Adc
  $V_{BE(sat)}$ = 1.4 Vdc (Max) @ I_C = 25 Adc
- DC Current Gain —
  h_{FE} = 25 (Min) @ I_C = 8.0 Adc

25 AMPERE
PNP ADE GERMANIUM POWER TRANSISTOR

140 VOLTS
106 WATTS



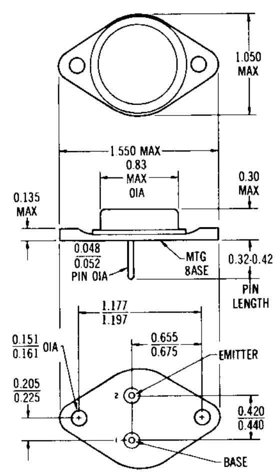
*MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	120	Vdc
Collector-Base Voltage	V_{CB}	140	Vdc
Emitter-Base Voltage	V_{EB}	1.5	Vdc
Collector Current - Continuous ** - Continuous - Peak	I_C	15 25 25	Adc
Base Current - Continuous	I_B	5.0	Adc
**Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	106 1.25	Watts W/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	-65 to +110	°C

THERMAL CHARACTERISTICS

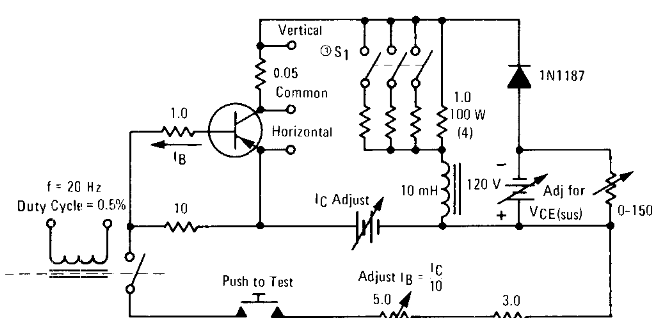
Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	θ_{JC}	0.8	°C/W

*Indicates JEDEC Registered Data.
**Motorola guarantees this data in addition to the JEDEC Registered data shown.



Collector Connected to Case
CASE 11A
(TO-3)
Except Pin Diameter

FIGURE 1 – SUSTAINING VOLTAGE TEST CIRCUIT



① Close Switch S_1 for I_C = 25A Test.

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
*Collector-Emitter Breakdown Voltage (I_C = 100 mAdc, I_B = 0)		BV_{CEO}	120	-	Vdc
*Collector-Emitter Sustaining Voltage (See Figure 1) (I_C = 8.0 Adc, R_{EB} = 10 Ohms) (I_C = 25 Adc, R_{EB} = 10 Ohms)		$V_{CE(sus)}$	120 80	- -	Vdc
*Collector Cutoff Current (V_{CE} = 140 Vdc, $V_{BE(off)}$ = 0.2 Vdc) (V_{CE} = 140 Vdc, $V_{BE(off)}$ = 0.2 Vdc, T_C = 85°C)		I_{CEX}	- -	10 25	mAdc
Collector Cutoff Current (V_{CB} = 2.0 Vdc, I_E = 0)		I_{CBO}	-	200	μAdc
*Emitter Cutoff Current (V_{EB} = 1.5 Vdc, I_C = 0)		I_{EBO}	-	500	mAdc
ON CHARACTERISTICS					
*DC Current Gain (I_C = 8.0 Adc, V_{CE} = 2.0 Vdc)		h_{FE}	25	100	-
*Collector-Emitter Saturation Voltage (I_C = 25 Adc, I_B = 2.5 Adc)		$V_{CE(sat)}$	-	0.9	Vdc
*Base-Emitter Saturation Voltage (I_C = 25 Adc, I_B = 2.5 Adc)		$V_{BE(sat)}$	-	1.4	Vdc
Pulse Energy Test (Note 1) (See Figure 2) (I_C = 4.2 Adc, V_{CE} = 30 Vdc)		PET	1.26	-	Joule
DYNAMIC CHARACTERISTICS					
Current-Gain-Bandwidth Product (I_C = 5.0 Adc, V_{CE} = 2.0 Vdc, f = 50 kHz)		f_T	100	-	kHz
SWITCHING CHARACTERISTICS					
Rise Time	(V_{CC} = -12 Vdc, I_C = 10 Adc,	t_r	-	18	μs
Storage Time	I_{B1} = 1.0 Adc, I_{B2} = 1.0 Adc)	t_s	-	12	μs
Fall Time	(See Figure 3)	t_f	-	18	μs

*Indicates JEDEC Registered Data.
Note 1: Pulse Test: Pulse Width = 10 ms, Duty Cycle = 2.5%.

FIGURE 2 – PULSE ENERGY TEST CIRCUIT

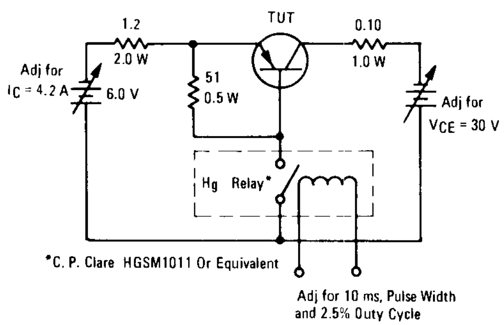
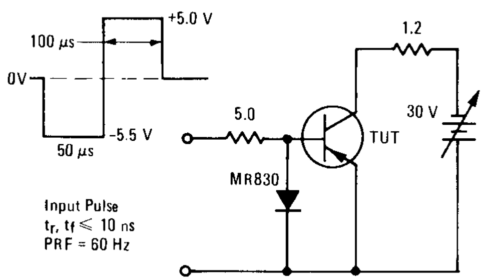


FIGURE 3 – SWITCHING TIME TEST CIRCUIT



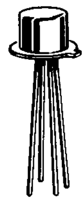
2N5179 (SILICON)

NPN SILICON RF AMPLIFIER TRANSISTOR

. . . designed primarily for use in high-gain, low-noise tuned-amplifier, oscillator, and mixer applications. Can also be used in UHF converter applications.

- High Current-Gain—Bandwidth Product —
  f_T = 900 MHz (Min) @ I_C = 5.0 mAdc
- High Power Gain —
  G_{pe} = 15 dB (Min) @ f = 200 MHz
- High Power Output (Oscillator) —
  P_{out} = 20 mW (Min) @ f = 500 MHz
- Low Noise Figure —
  NF = 4.5 dB (Max) @ f = 200 MHz

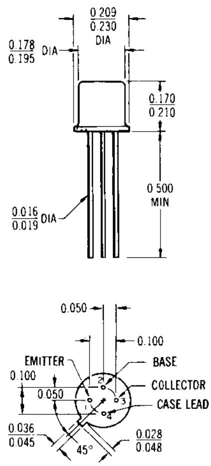
NPN SILICON RF AMPLIFIER TRANSISTOR



*MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage Applicable 1.0 to 20 mAdc	V_{CEO}	12	Vdc
Collector-Base Voltage	V_{CB}	20	Vdc
Emitter-Base Voltage	V_{EB}	2.5	Vdc
Collector Current	I_C	50	mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	200 1.14	mW mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	300 1.71	mW mW/°C
Storage Temperature Range	T_{stg}	-65 to +200	°C

*Indicates JEDEC Registered Data.



CASE 20(10)
TO-72 PACKAGE

*ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Sustaining Voltage (I_C = 3.0 mAdc, I_B = 0)	$V_{CEO(sus)}$	12	–	Vdc
Collector-Base Breakdown Voltage (I_C = 0.001 mAdc, I_E = 0)	BV_{CBO}	20	–	Vdc
Emitter-Base Breakdown Voltage (I_E = 0.01 mAdc, I_C = 0)	BV_{EBO}	2.5	–	Vdc
Collector Cutoff Current (V_{CB} = 15 Vdc, I_E = 0) (V_{CB} = 15 Vdc, I_E = 0, T_A = 150°C)	I_{CBO}	– –	0.02 1.0	μAdc
ON CHARACTERISTICS				
DC Current Gain (I_C = 3.0 mAdc, V_{CE} = 1.0 Vdc)	h_{FE}	25	250	–
Collector-Emitter Saturation Voltage (I_C = 10 mAdc, I_B = 1.0 mAdc)	$V_{CE(sat)}$	–	0.4	Vdc
Base-Emitter Saturation Voltage (I_C = 10 mAdc, I_B = 1.0 mAdc)	$V_{BE(sat)}$	–	1.0	Vdc
DYNAMIC CHARACTERISTICS				
Current-Gain – Bandwidth Product ① (I_C = 5.0 mAdc, V_{CE} = 6.0 Vdc, f = 100 MHz)	f_T	900	2000	MHz
Collector-Base Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 0.1 to 1.0 MHz)	C_{cb}	–	1.0	pF
Small-Signal Current Gain (I_C = 2.0 mAdc, V_{CE} = 6.0 Vdc, f = 1.0 kHz)	h_{fe}	25	300	–
Collector-Base Time Constant (I_E = 2.0 mAdc, V_{CB} = 6.0 Vdc, f = 31.9 MHz)	$r_b'C_c$	3.0	14	ps
Noise Figure (See Figure 1) (I_C = 1.5 mAdc, V_{CE} = 6.0 Vdc, R_S = 50 ohms, f = 200 MHz)	NF	–	4.5	dB
FUNCTIONAL TEST				
Common-Emitter Amplifier Power Gain (See Figure 1) (V_{CE} = 6.0 Vdc, I_C = 5.0 mAdc, f = 200 MHz)	G_{pe}	15	–	dB
Power Output (See Figure 2) (V_{CB} = 10 Vdc, I_E = -12 mAdc, f ≥ 500 MHz)	P_{out}	20	–	mW

*Indicates JEDEC Registered Values.

① f_T is defined as the frequency at which $|h_{fe}|$ extrapolates to unity.

FIGURE 1 – 200 MHz AMPLIFIER POWER GAIN AND NOISE FIGURE CIRCUIT

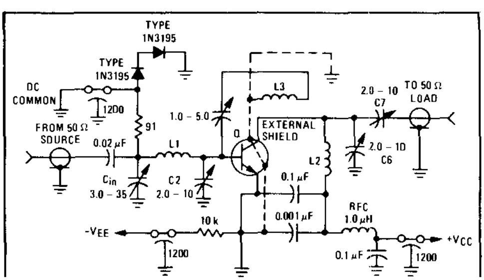
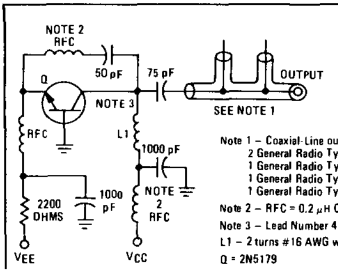


FIGURE 2 – 500 MHz OSCILLATOR CIRCUIT



Note 1 – Coaxial-Line output network consisting of:
2 General Radio Type 874-TEE or equivalent
1 General Radio Type 874-D20 Adjustable Stub or equivalent
1 General Radio Type 874-LA Adjustable Line or equivalent
1 General Radio Type 874-WN3 Short-circuit termination or equivalent

Note 2 – RFC = 0.2 μH Ohmite #2-460 or equivalent

Note 3 – Lead Number 4 (case) floating

L1 – 2 turns #16 AWG wire, 3/8 inch OD, 1-1/4 inch long

Q = 2N5179

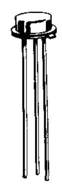
2N5229 (SILICON)
2N5230
2N5231

PNP SILICON ANNULAR TRANSISTORS

. . . designed for low-level, chopper applications requiring high speed operation. This series of devices offers excellent characteristics for use in servo-loop, sensing instrumentation and control amplifier for motor drive systems. These transistors can also be used as replacement devices for alloy-type transistors where high BV_{EBO} is required.

- Low Offset Voltage – $V_{EC(off)}$ = 0.5 mVdc (Max) @ I_B = 100 μAdc
- Low Dynamic "ON" Series Resistance – r_{ec} (ON) = 6.0 Ohms (Max) @ I_B = 1.0 mAdc
- Space Saving TO-46 Package

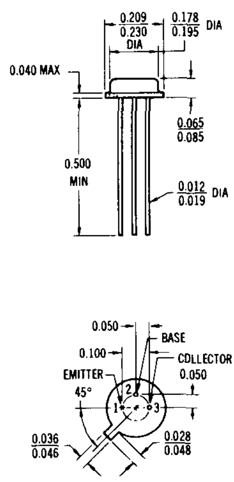
PNP SILICON CHOPPER TRANSISTORS



MAXIMUM RATINGS

Rating	Symbol	2N5229	2N5230	2N5231	Unit
*Collector-Emitter Voltage	V_{CEO}	10	20	30	Vdc
*Collector-Base Voltage	V_{CB}	15	30	50	Vdc
*Emitter-Base Voltage	V_{EB}	15	30	50	Vdc
*Collector Current	I_C	← 50 →			mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	← 0.5 → ← 2.86 →			Watt mW/°C
*Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	← 2.0 → ← 12 →			Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	← -65 to +200 →			°C

*Indicates JEDEC Registered Data.



CASE 26
TO–46 PACKAGE

*ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Emitter-Collector Breakdown Voltage		BV_{ECO}			Vdc
(I_E = 10 μAdc, I_B = 0)	2N5229		10	–	
	2N5230		20	–	
	2N5231		30	–	
Collector-Base Breakdown Voltage		BV_{CBO}			Vdc
(I_C = 10 μAdc, I_E = 0)	2N5229		15	–	
	2N5230		30	–	
	2N5231		50	–	
Emitter-Base Breakdown Voltage		BV_{EBO}			Vdc
(I_E = 10 μAdc, I_C = 0)	2N5229		15	–	
	2N5230		30	–	
	2N5231		50	–	
Collector Cutoff Current		I_{CBO}			nAdc
(V_{CB} = 12 Vdc, I_E = 0)	2N5229		–	1.0	
(V_{CB} = 25 Vdc, I_E = 0)	2N5230		–	1.0	
(V_{CB} = 40 Vdc, I_E = 0)	2N5231		–	1.0	
Emitter Cutoff Current		I_{EBO}			nAdc
(V_{EB} = 12 Vdc, I_C = 0)	2N5229		–	1.0	
(V_{EB} = 25 Vdc, I_C = 0)	2N5230		–	1.0	
(V_{EB} = 40 Vdc, I_C = 0)	2N5231		–	1.0	
ON CHARACTERISTICS					
DC Current Gain		h_{FE}			–
(I_C = 100 μAdc, V_{CE} = 1.0 Vdc)			50	–	
(I_C = 200 μAdc, V_{CE} = 0.5 Vdc) (Inverted Connection)			15	–	
Offset Voltage		$V_{EC(off)}$			mVdc
(I_B = 100 μAdc, I_E = 0)	2N5229,2N5230		–	0.5	
	2N5231		–	0.8	
(I_B = 1.0 mAdc, I_E = 0)	2N5229		–	0.8	
	2N5230,2N5231		–	1.0	
DYNAMIC CHARACTERISTICS					
Collector-Base Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 140 kHz)		C_{cb}	–	5.0	pF
Emitter-Base Capecitance (V_{EB} = 10 Vdc, I_C = 0, f = 140 kHz)		C_{eb}	–	4.0	pF
Small-Signal Current Gain (I_C = 1.0 mAdc, V_{CE} = 5.0 Vdc, f = 4.0 MHz)		h_{fe}	2.0	–	–
"ON" Series Resistance		$r_{ec\,(ON)}$			Ohms
(I_B = 1.0 mAdc, I_E = 0, I_e = 100 μAdc, f = 1.0 kHz)	2N5229		1.0	6.0	
	2N5230		2.0	8.0	
	2N5231		2.0	10	

*Indicates JEDEC Registered Data.

TYPICAL CHARACTERISTICS

FIGURE 1 – EMITTER-COLLECTOR VOLTAGE versus BASE CURRENT

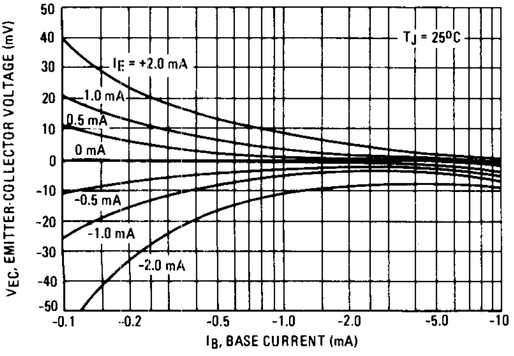


FIGURE 2 – EMITTER-COLLECTOR VOLTAGE versus JUNCTION TEMPERATURE

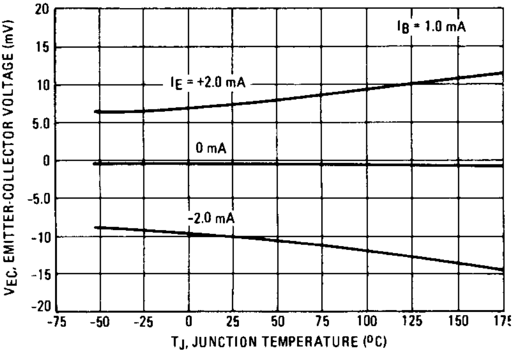


FIGURE 3 – EMITTER-COLLECTOR "ON" RESISTANCE versus BASE CURRENT

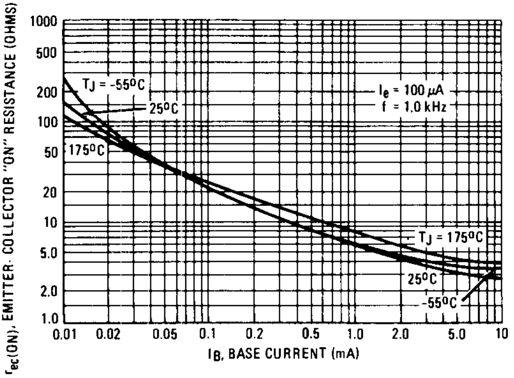


FIGURE 4 – EMITTER-COLLECTOR "ON" RESISTANCE TEMPERATURE COEFFICIENT versus BASE CURRENT

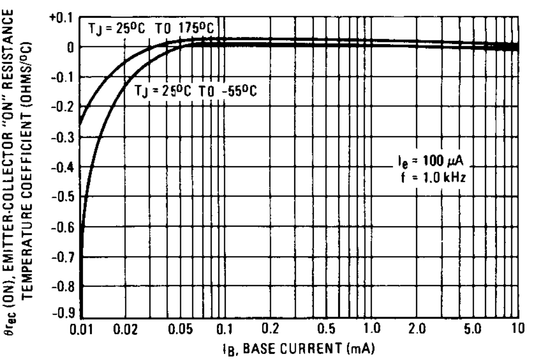


FIGURE 5 – CURRENT GAIN versus COLLECTOR CURRENT

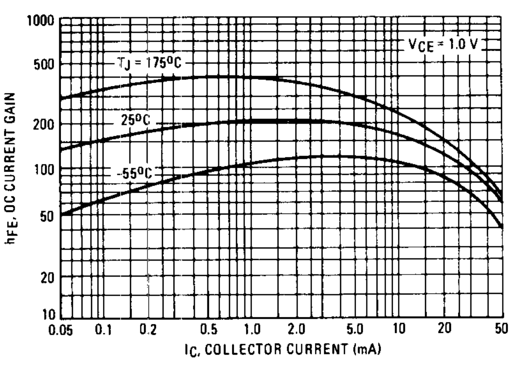


FIGURE 6 – CURRENT GAIN (Inverted Connection) versus EMITTER CURRENT

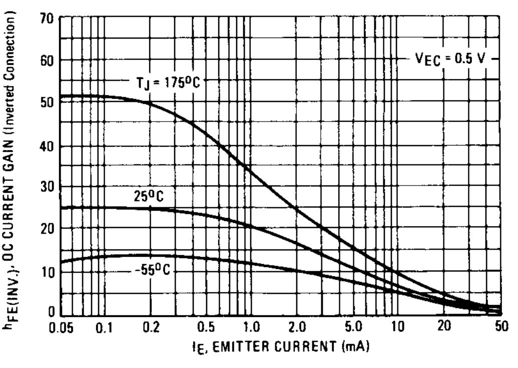


FIGURE 7 – COLLECTOR CUTOFF CURRENT versus JUNCTION TEMPERATURE

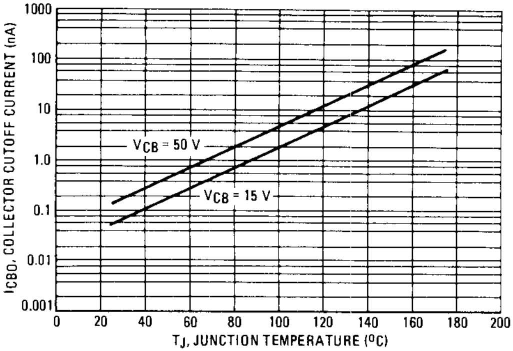


FIGURE 8 – EMITTER CUTOFF CURRENT versus JUNCTION TEMPERATURE

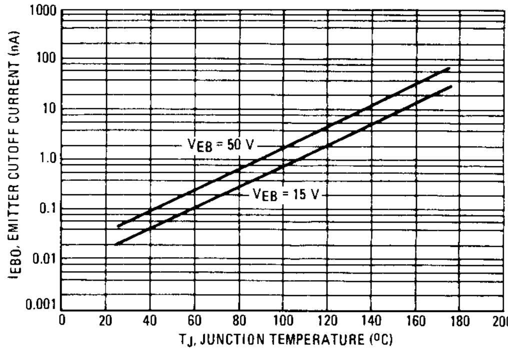


FIGURE 9 – COLLECTOR-EMITTER SATURATION VOLTAGE versus COLLECTOR CURRENT

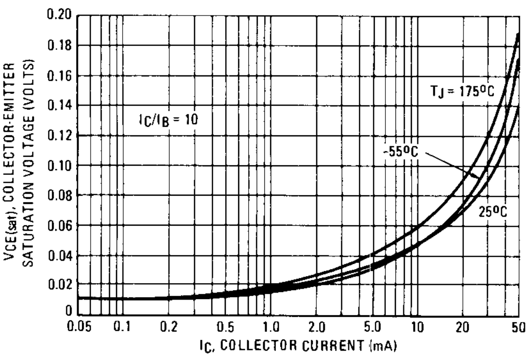
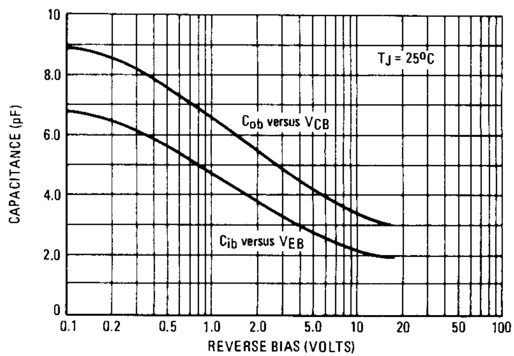


FIGURE 10 – JUNCTION CAPACITANCE versus REVERSE BIAS VOLTAGE



2N5324 (GERMANIUM)
2N5325

PNP GERMANIUM POWER TRANSISTORS

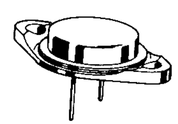
. . . designed primarily for switching, inverter, and industrial power supply applications.

- Low Collector Cutoff Current –
  I_{CEX} = 7.0 mAdc (Max) @ V_{CEX} = 250 Vdc (2N5324)
  7.0 mAdc (Max) @ V_{CEX} = 325 Vdc (2N5325)
- Low Collector-Emitter Saturation Voltage –
  $V_{CE(sat)}$ = 0.5 Vdc (Max) @ I_C = 10 Adc
- Low Base-Emitter Saturation Voltage –
  $V_{BE(sat)}$ = 0.75 Vdc (Max) @ I_C = 10 Adc
- Guaranteed Excellent Safe Operating Area ($V_{CER(sus)}$)
  Specified at 3.0 Amps and 10 Amps
- 100% Stabilization Bake at 125°C for 100 Hours

10 AMPERE
POWER TRANSISTORS
PNP GERMANIUM

EPITAXIAL BASE

250-325 VOLTS
56 WATTS



*MAXIMUM RATINGS

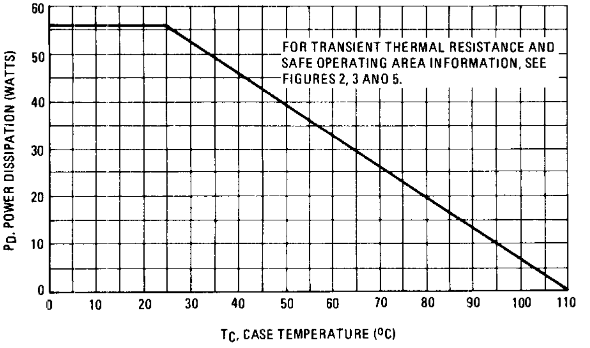
Rating	Symbol	2N5324	2N5325	Unit
Collector-Emitter Voltage	V_{CEO}	150	200	Vdc
Collector-Base Voltage	V_{CB}	250	325	Vdc
Emitter-Base Voltage	V_{EB}	4.0		Vdc
Collector Current – Continuous	I_C	10		Adc
Base Current – Continuous	I_B	3.0		Adc
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	56 0.67		Watts W/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	-65 to +110		°C

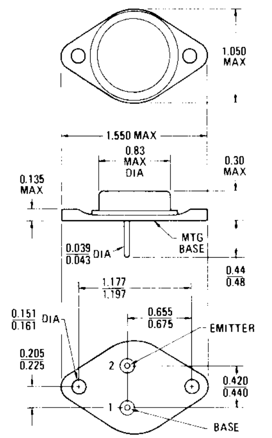
*Indicates JEDEC Registered Data.

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	θ_{JC}	1.5	°C/W

FIGURE 1 – POWER-TEMPERATURE DERATING CURVE





CASE 11
TO-3
Collector Connected to case

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
†Collector-Emitter Breakdown Voltage		BV_{CEO}			Vdc
(I_C = 0.1 Adc, I_B = 0)	2N5324		150	–	
	2N5325		200	–	
Collector-Emitter Sustaining Voltage		$V_{CER(sus)}$			Vdc
(I_C = 3.0 Adc, R_{BE} = 10 Ohms) (Figure 4, Test Condition 1)	2N5324		165	–	
	2N5325		200	–	
(I_C = 10 Adc, R_{BE} = 10 Ohms) (Figure 4, Test Condition 2)	2N5324		100	–	
	2N5325		115	–	
*Collector Cutoff Current (See Note 1)		I_{CEV}			mAdc
(V_{CE} = 250 Vdc, V_{BE} (off) = 0.2 Vdc)	2N5324		–	7.0	
(V_{CE} = 250 Vdc, V_{BE} (off) = 0.2 Vdc, T_C = 85°C)			–	35	
(V_{CE} = 325 Vdc, V_{BE} (off) = 0.2 Vdc)	2N5325		–	7.0	
(V_{CE} = 325 Vdc, V_{BE} (off) = 0.2 Vdc, T_C = 85°C)			–	35	
*Emitter Cutoff Current (V_{BE} = 4.0 Vdc, I_C = 0)		I_{EBO}	–	100	mAdc
ON CHARACTERISTICS					
*DC Current Gain (I_C = 5.0 Adc, V_{CE} = 2.0 Vdc)		h_{FE}	20	60	–
*Collector-Emitter Saturation Voltage (I_C = 10 Adc, I_B = 1.0 Adc)		$V_{CE(sat)}$	–	0.5	Vdc
*Base-Emitter Saturation Voltage (I_C = 10 Adc, I_B = 1.0 Adc)		$V_{BE(sat)}$	–	0.75	Vdc
DYNAMIC CHARACTERISTICS					
Current-Gain--Bandwidth Product (I_C = 0.5 Adc, V_{CE} = 5.0 Vdc, f = 0.5 MHz)		f_T	2.0	–	MHz
SWITCHING CHARACTERISTICS					
*Rise Time	(I_C = 5.0 Adc, I_{B1} = I_{B2} = 0.5 Adc) (See Figure 6)	t_r	–	15	μs
*Storage Time	(I_C = 5.0 Adc, I_{B1} = I_{B2} = 0.5 Adc) (See Figure 6)	t_s	–	10	μs
*Fall Time	(I_C = 5.0 Adc, I_{B1} = I_{B2} = 0.5 Adc) (See Figure 6)	t_f	–	7.0	μs

Note 1. Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

*Indicates JEDEC Registered Data.

†JEDEC Registration Defined as $V_{(BR)CEO}$

FIGURE 2 – TRANSIENT THERMAL RESPONSE

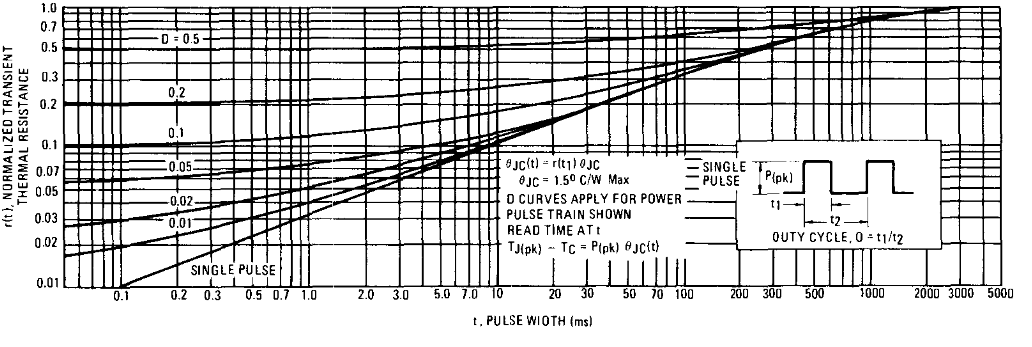


FIGURE 3 – COLLECTOR-EMITTER SUSTAINING VOLTAGE

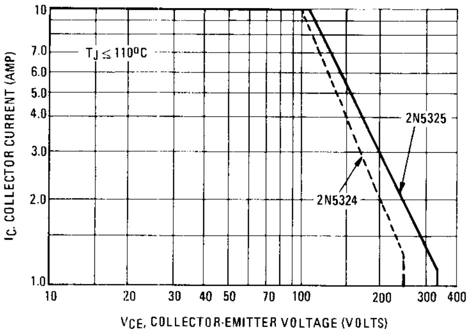


FIGURE 4 – COLLECTOR-EMITTER SUSTAINING VOLTAGE TEST CIRCUIT

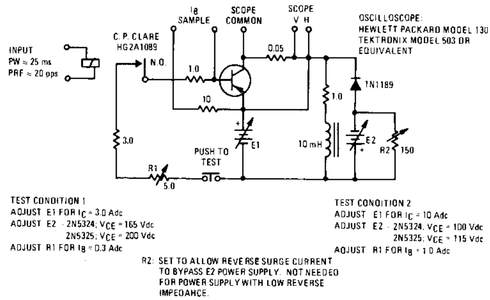


FIGURE 5 – ACTIVE REGION SAFE OPERATING AREA

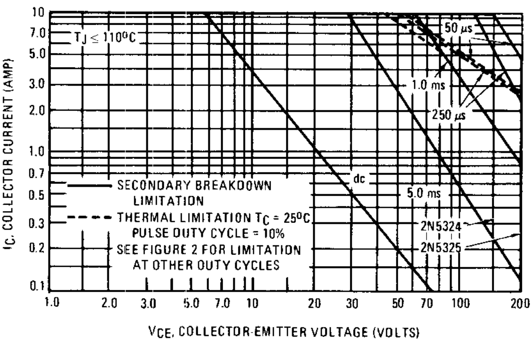


FIGURE 6 – SWITCHING TIME TEST CIRCUIT

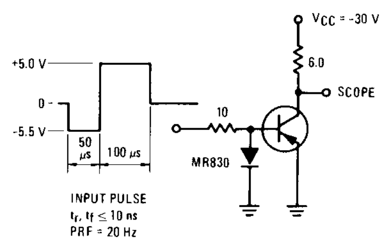


FIGURE 7 – SWITCHING TIMES

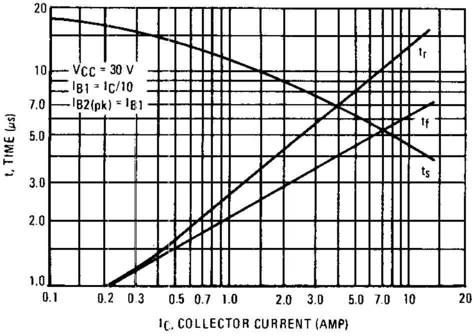


FIGURE 8 - CURRENT GAIN BANDWITH PRODUCT

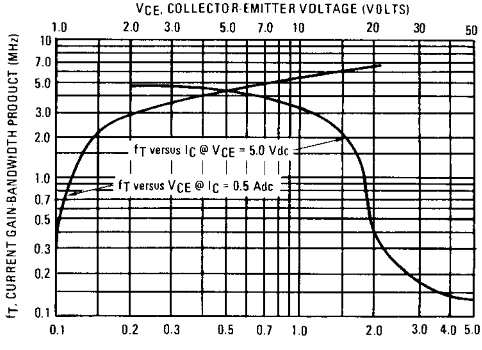


FIGURE 9 – DC CURRENT GAIN

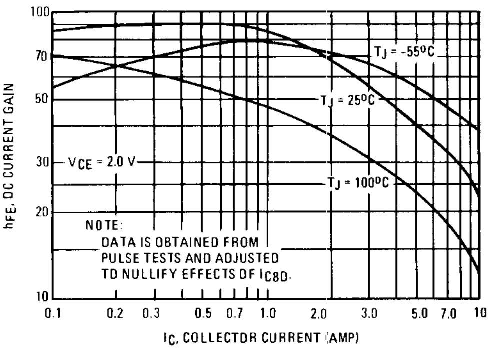


FIGURE 10 – COLLECTOR SATURATION REGION

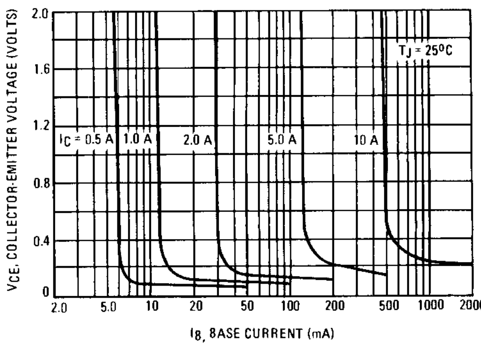


FIGURE 11 – EFFECTS OF EMITTER-BASE RESISTANCE

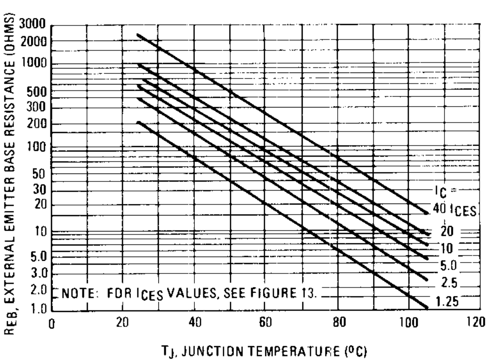


FIGURE 12 – "ON" VOLTAGES

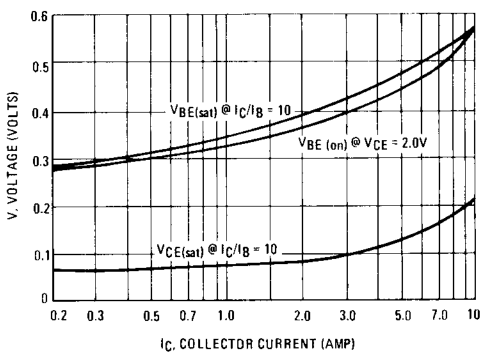


FIGURE 13 – COLLECTOR CUTOFF REGION

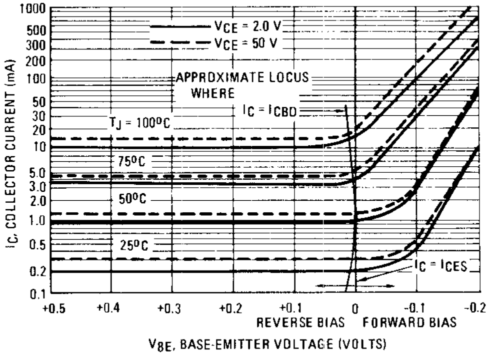
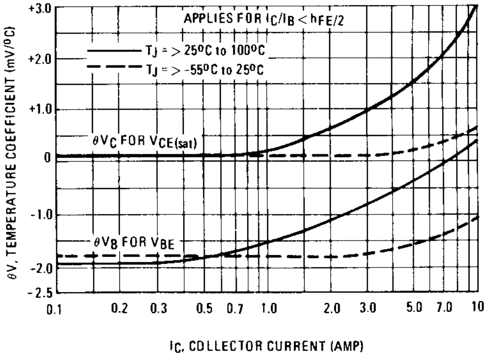


FIGURE 14 – TEMPERATURE COEFFICIENTS



2N5400 (SILICON)
2N5401

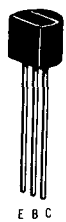
PNP SILICON ANNULAR TRANSISTORS

. . . designed for general-purpose, high-voltage amplifier applications.

- High Voltage Ratings — BV_{CEO} = 120 and 150 Vdc (Min)
- Low Saturation Voltage
  ($V_{CE(sat)}$ = 0.25 V (max) @ I_C = 50 mA
- Current Gain Specified from 1.0 mAdc to 50 mAdc
- One-Piece, Injection-Molded Unibloc Package for High Reliability
- Excellent for Nixie Driver Applications

HIGH VOLTAGE

PNP SILICON AMPLIFIER TRANSISTORS

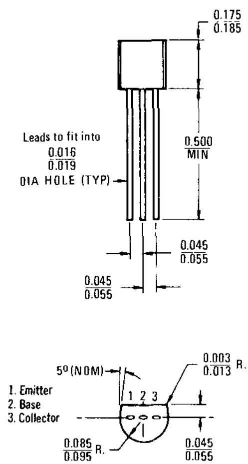


*MAXIMUM RATINGS

Rating	Symbol	2N5400	2N5401	Unit
Collector-Emitter Voltage	V_{CEO}	120	150	Vdc
Collector-Base Voltage	V_{CB}	130	160	Vdc
Emitter-Base Voltage	V_{EB}	5.0		Vdc
Collector Current - Continuous	I_C	600		mAdc
Total Device Dissipation @ $T_A = 25^oC$ Derate above 25°C	P_D	310 2.81		mW mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +135		°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	θ_{JA}	0.357	°C/mW



CASE 29 (1)
TO-92

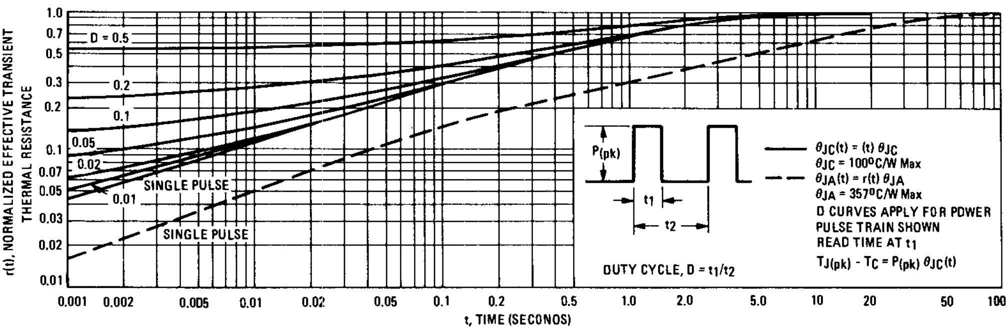
*Indicates JEDEC Registered Data

* ELECTRICAL CHARACTERISTICS ($T_A = 25^oC$ unless otherwise noted)

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (Note 1)		BV_{CEO}			Vdc
(I_C = 1.0 mAdc, I_B = 0)	2N5400		120	–	
	2N5401		150	–	
Collector-Base Breakdown Voltage		BV_{CBO}			Vdc
(I_C = 100 μAdc, I_E = 0)	2N5400		130	–	
	2N5401		160	–	
Emitter-Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)		BV_{EBO}	5.0	–	Vdc
Collector Cutoff Current		I_{CBO}			
(V_{CB} = 100 Vdc, I_E = 0)	2N5400		–	100	nAdc
(V_{CB} = 120 Vdc, I_E = 0)	2N5401		–	50	
(V_{CB} = 100 Vdc, I_E = 0, $T_A = 100^oC$)	2N5400		–	100	μAdc
(V_{CB} = 120 Vdc, I_E = 0, $T_A = 100^oC$)	2N5401		–	50	
Emitter Cutoff Current (V_{EB} = 3.0 Vdc, I_C = 0)		I_{EBO}	–	50	nAdc
ON CHARACTERISTICS					
DC Current Gain (Note 1)		h_{FE}			–
(I_C = 1.0 mAdc, V_{CE} = 5.0 Vdc)	2N5400		30	–	
	2N5401		50	–	
(I_C = 10 mAdc, V_{CE} = 5.0 Vdc)	2N5400		40	180	
	2N5401		60	240	
(I_C = 50 mAdc, V_{CE} = 5.0 Vdc)	2N5400		40	–	
	2N5401		50	–	
Collector-Emitter Saturation Voltage (Note 1)		$V_{CE(sat)}$			Vdc
(I_C = 10 mAdc, I_B = 1.0 mAdc)			–	0.20	
(I_C = 50 mAdc, I_B = 5.0 mAdc)			–	0.25	
Base-Emitter Saturation Voltage (Note 1)		$V_{BE(sat)}$			Vdc
(I_C = 10 mAdc, I_B = 1.0 mAdc)			–	1.0	
(I_C = 50 mAdc, I_B = 5.0 mAdc)			–	1.0	
DYNAMIC CHARACTERISTICS					
Current-Gain—Bandwidth Product		f_T			MHz
(I_C = 10 mAdc, V_{CE} = 10 Vdc, f = 100 MHz)	2N5400		100	400	
	2N5401		100	300	
Output Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 1.0 MHz)		C_{ob}	–	6.0	pF
Small-Signal Current Gain		h_{fe}			–
(I_C = 1.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)	2N5400		30	200	
	2N5401		40	200	
Noise Figure (I_C = 250 μAdc, V_{CE} = 5.0 Vdc, R_S = 1.0 k ohm, f = 10 Hz to 15.7 kHz)		NF	–	8.0	dB

*Indicates JEDEC Registered Data
Note 1: Pulse Test: Pulse Width = 300 μs, Duty Cycle = 2.0%

FIGURE 1 – THERMAL RESPONSE



h PARAMETERS

(V_{CE} = 10 Vdc, f = 1.0 kHz, T_A = 25°C)

FIGURE 2 – CURRENT GAIN

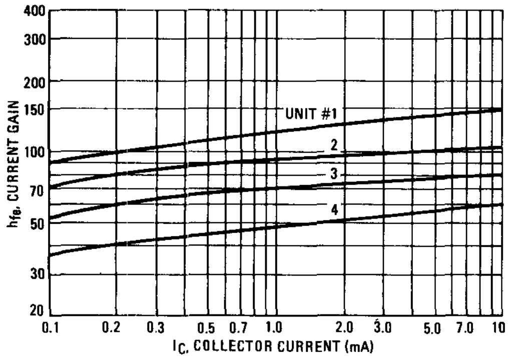


FIGURE 3 – OUTPUT ADMITTANCE

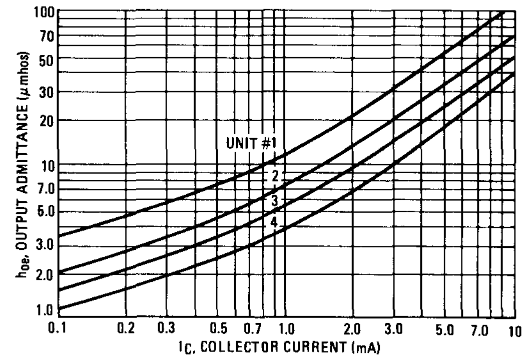


FIGURE 4 – INPUT IMPEDANCE

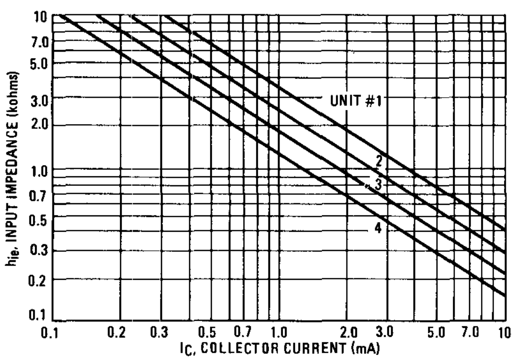


FIGURE 5 – VOLTAGE FEEDBACK RATIO

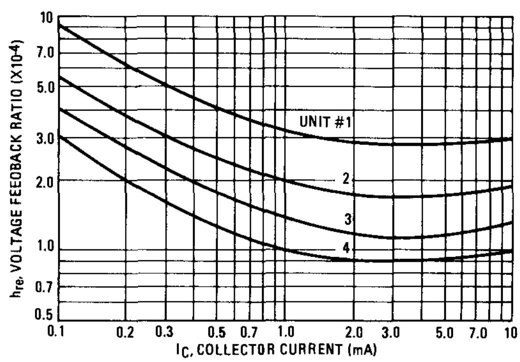
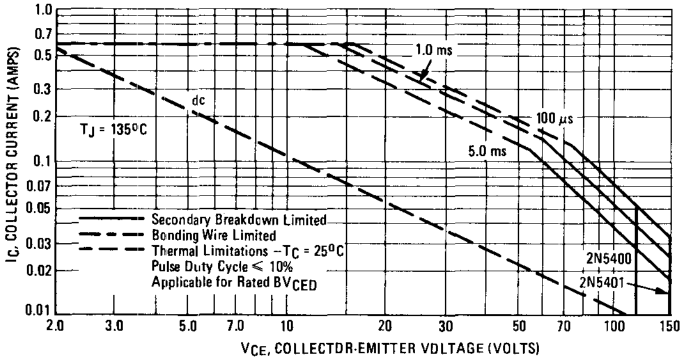


FIGURE 6 – ACTIVE REGION SAFE OPERATING AREA



There are two limitations on the power handling ability of a transistor: junction temperature and secondary breakdown. Safe operating area curves indicate I_C–V_{CE} limits of the transistor that must be observed for reliable operation; i.e., the transistor must not be subjected to greater dissipation than the curves indicate.

The data of Figure 6 is based on $T_{J(pk)}$ = 135°C; T_C is variable depending on conditions. Pulse curves are valid for duty cycles of 10% provided $T_{J(pk)} \leqslant$ 135°C. $T_{J(pk)}$ may be calculated from the data in Figure 1. At high case temperatures, thermal limitations will reduce the power that can be handled to values less than the limitations imposed by secondary breakdown.

FIGURE 7 – DC CURRENT GAIN

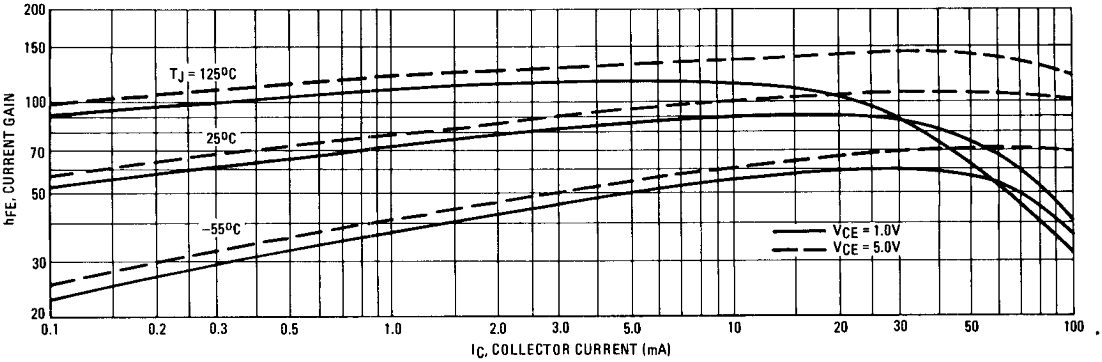


FIGURE 8 – COLLECTOR SATURATION REGION

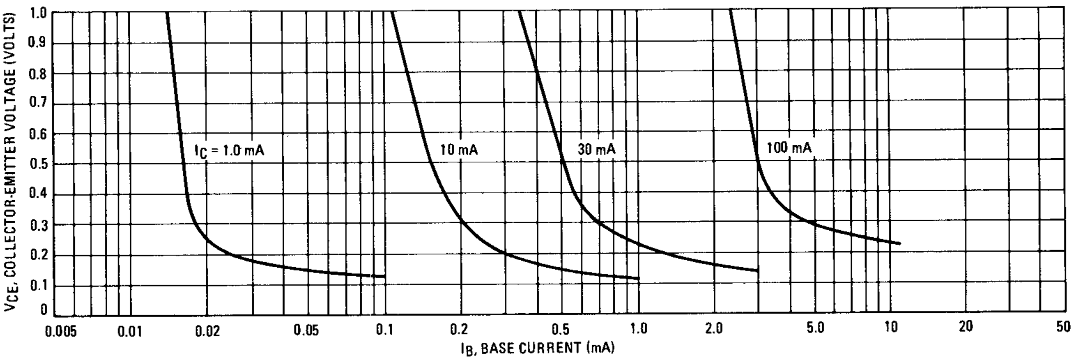


FIGURE 9 – COLLECTOR CUT-OFF REGION

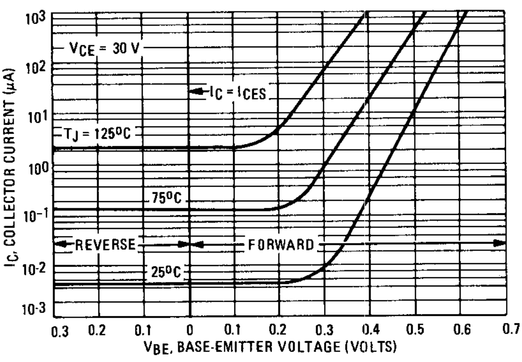


FIGURE 10 – EFFECTS OF BASE-EMITTER RESISTANCE

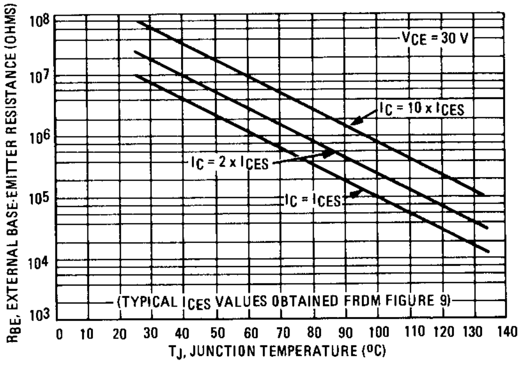


FIGURE 11 – "ON" VOLTAGES

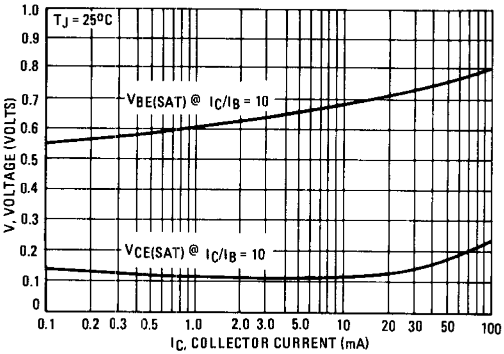


FIGURE 12 – TEMPERATURE COEFFICIENTS

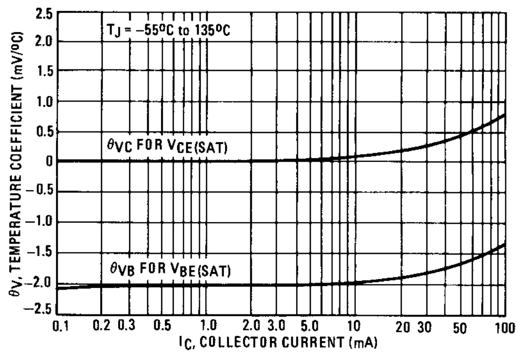


FIGURE 13 – SWITCHING TIME TEST CIRCUIT

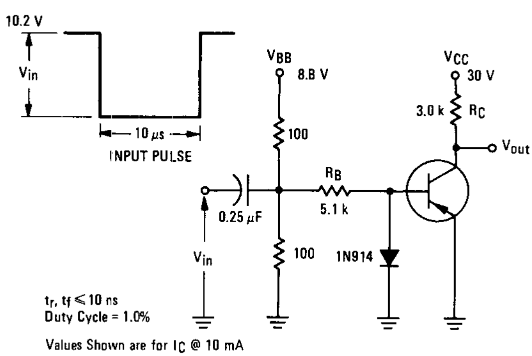


FIGURE 14 – CAPACITANCES

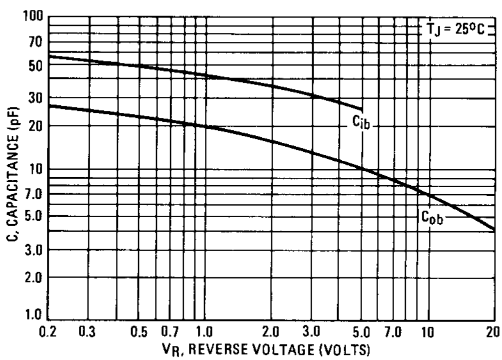


FIGURE 15 – TURN-ON TIME

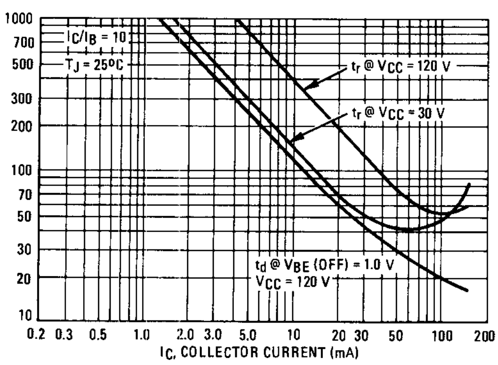
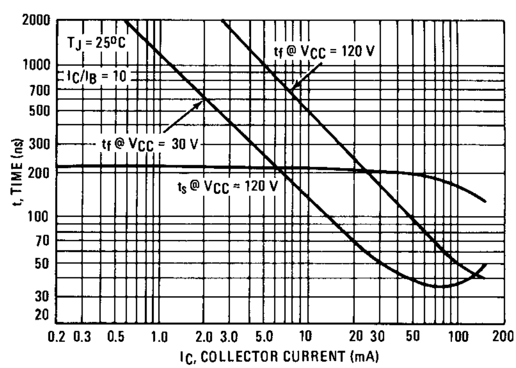


FIGURE 16 – TURN-OFF TIME



2N5550 (SILICON)
2N5551

NPN SILICON ANNULAR TRANSISTORS

. . . designed for general-purpose, high-voltage amplifier applications.

- High Voltage Ratings – BV_{CEO} = 140 and 160 Vdc (Min)
- Low Saturation Voltage
  $V_{CE(sat)}$ = 0.25 V (max) @ I_C = 50 mA, 2N5550
  = 0.20 V (max) @ I_C = 50 mA, 2N5551
- Current Gain Specified from 1.0 mAdc to 50 mAdc
- One-Piece, Injection Molded Unibloc Package for High Reliability
- Excellent for Nixie Driver Applications

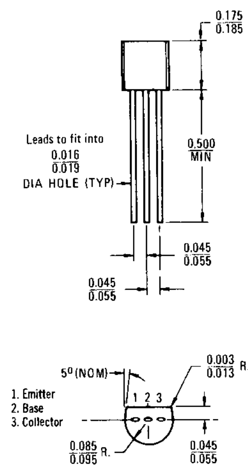
HIGH VOLTAGE
NPN SILICON
AMPLIFIER TRANSISTORS

*MAXIMUM RATINGS

Rating	Symbol	2N5550	2N5551	Unit
Collector-Emitter Voltage	V_{CEO}	140	160	Vdc
Collector-Base Voltage	V_{CB}	160	180	Vdc
Emitter-Base Voltage	V_{EB}	6.0		Vdc
Collector Current – Continuous	I_C	600		mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	310 2.81		mW mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	-55 to +135		°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	θ_{JA}	0.357	°C/mW



CASE 29 (1)
TO-92

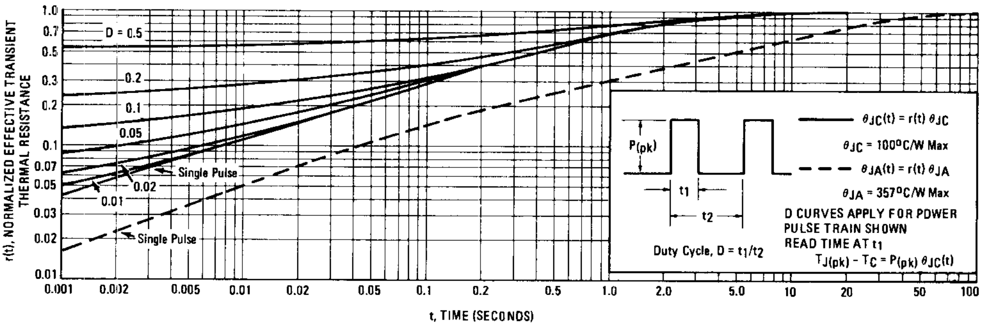
* Indicates JEDEC Registered Data

*ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (Note 1) (I_C = 1.0 mAdc, I_B = 0)	2N5550	BV_{CEO}	140	–	Vdc
	2N5551		160	–	
Collector-Base Breakdown Voltage (I_C = 100 μAdc, I_E = 0)	2N5550	BV_{CBO}	160	–	Vdc
	2N5551		180	–	
Emitter-Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)		BV_{EBO}	6.0	–	Vdc
Collector Cutoff Current (V_{CB} = 100 Vdc, I_E = 0)	2N5550	I_{CBO}	–	100	nAdc
(V_{CB} = 120 Vdc, I_E = 0)	2N5551		–	50	
(V_{CB} = 100 Vdc, I_E = 0, T_A = 100°C)	2N5550		–	100	μAdc
(V_{CB} = 120 Vdc, I_E = 0, T_A = 100°C)	2N5551		–	50	
Emitter Cutoff Current (V_{EB} = 4.0 Vdc, I_C = 0)		I_{EBO}	–	50	nAdc
ON CHARACTERISTICS					
DC Current Gain (Note 1) (I_C = 1.0 mAdc, V_{CE} = 5.0 Vdc)	2N5550	h_{FE}	60	–	–
	2N5551		80	–	
(I_C = 10 mAdc, V_{CE} = 5.0 Vdc)	2N5550		60	250	
	2N5551		80	250	
(I_C = 50 mAdc, V_{CE} = 5.0 Vdc)	2N5550		20	–	
	2N5551		30	–	
Collector-Emitter Saturation Voltage (Note 1) (I_C = 10 mAdc, I_B = 1.0 mAdc)	Both Types	$V_{CE(sat)}$	–	0.15	Vdc
(I_C = 50 mAdc, I_B = 5.0 mAdc)	2N5550		–	0.25	
	2N5551		–	0.20	
Base-Emitter Saturation Voltage (Note 1) (I_C = 10 mAdc, I_B = 1.0 mAdc)	Both Types	$V_{BE(sat)}$	–	1.0	Vdc
(I_C = 50 mAdc, I_B = 5.0 mAdc)	2N5550		–	1.2	
	2N5551		–	1.0	
DYNAMIC CHARACTERISTICS					
Current-Gain–Bandwidth Product (I_C = 10 mAdc, V_{CE} = 10 Vdc, f = 100 MHz)		f_T	100	300	MHz
Output Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 1.0 MHz)		C_{ob}	–	6.0	pF
Input Capacitance (V_{BE} = 0.5 Vdc, I_C = 0, f = 1.0 MHz)	2N5550	C_{ib}	–	30	pF
	2N5551		–	20	
Small-Signal Current Gain (I_C = 1.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)		h_{fe}	50	200	–
Noise Figure (I_C = 250 μAdc, V_{CE} = 5.0 Vdc, R_S = 1.0 k ohm, f = 10 Hz to 15.7 kHz)	2N5550	NF	–	10	dB
	2N5551		–	8.0	

*Indicates JEDEC Registered Data
Note 1: Pulse Test: Pulse Width = 300 μs, Duty Cycle = 2.0%

FIGURE 1 – THERMAL RESPONSE



h PARAMETERS

(V_{CE} = 10 Vdc, f = 1.0 kHz, T_A = 25°C)

FIGURE 2 – CURRENT GAIN

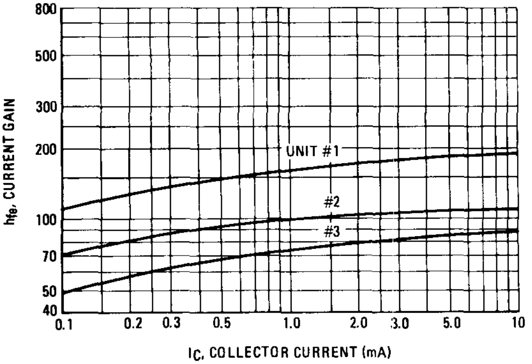


FIGURE 3 – OUTPUT ADMITTANCE

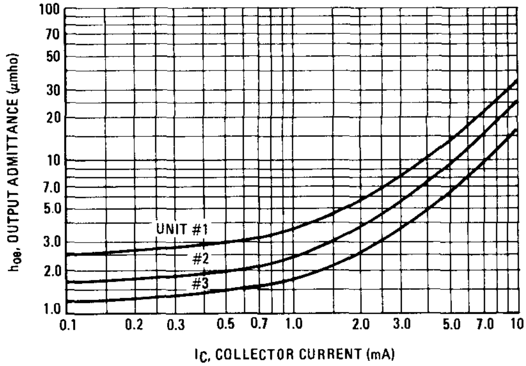


FIGURE 4 – INPUT IMPEDANCE

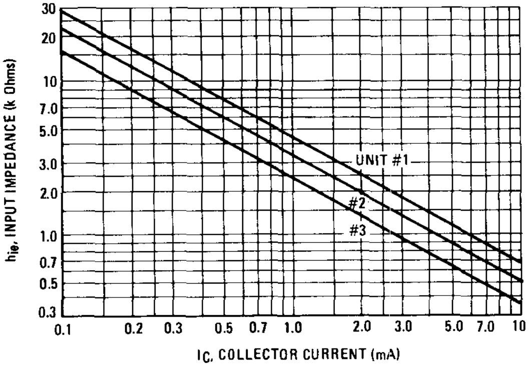


FIGURE 5 – VOLTAGE FEEDBACK RATIO

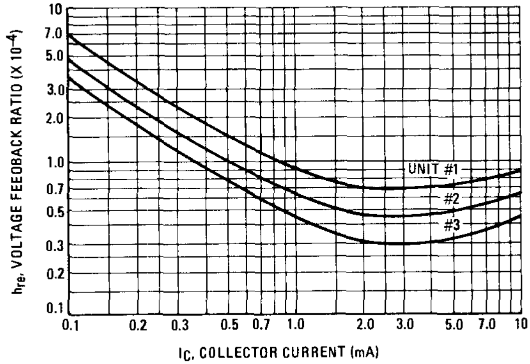
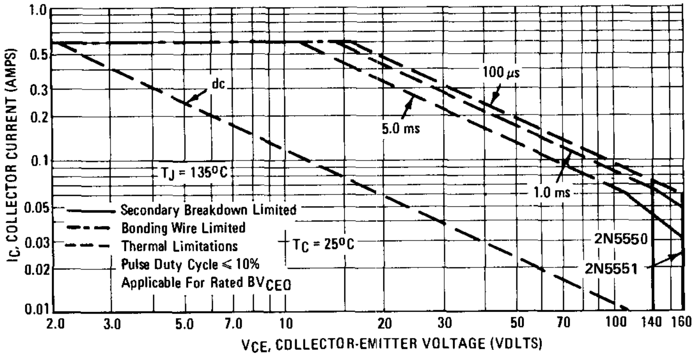


FIGURE 6 – ACTIVE REGION SAFE OPERATING AREA



There are two limitations on the power handling ability of a transistor: junction temperature and secondary breakdown. Safe operating area curves indicate I_C–V_{CE} limits of the transistor that must be observed for reliable operation; i.e., the transistor must not be subjected to greater dissipation than the curves indicate.

The data of Figure 6 is based on $T_{J(pk)}$ = 135°C; T_C is variable depending on conditions. Pulse curves are valid for duty cycles of 10% provided $T_{J(pk)} \leq$ 135°C. $T_{J(pk)}$ may be calculated from the data in Figure 1. At high case temperatures, thermal limitations will reduce the power that can be handled to values less than the limitations imposed by secondary breakdown.

FIGURE 7 – DC CURRENT GAIN

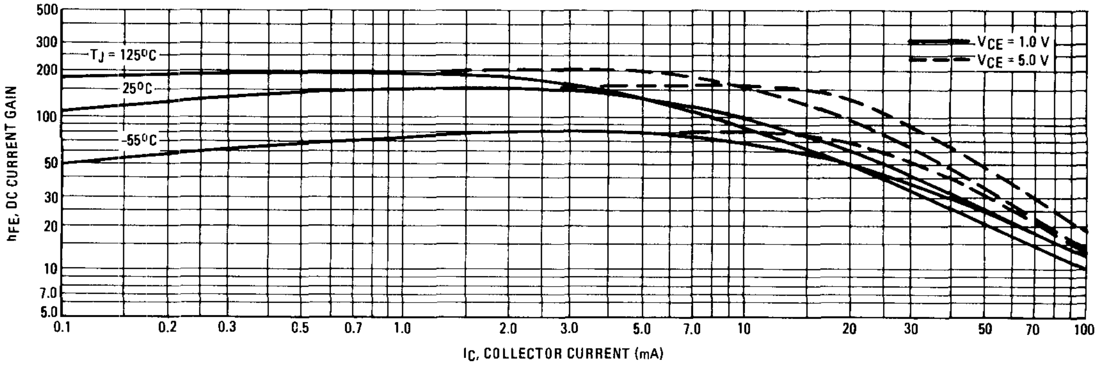


FIGURE 8 – COLLECTOR SATURATION REGION

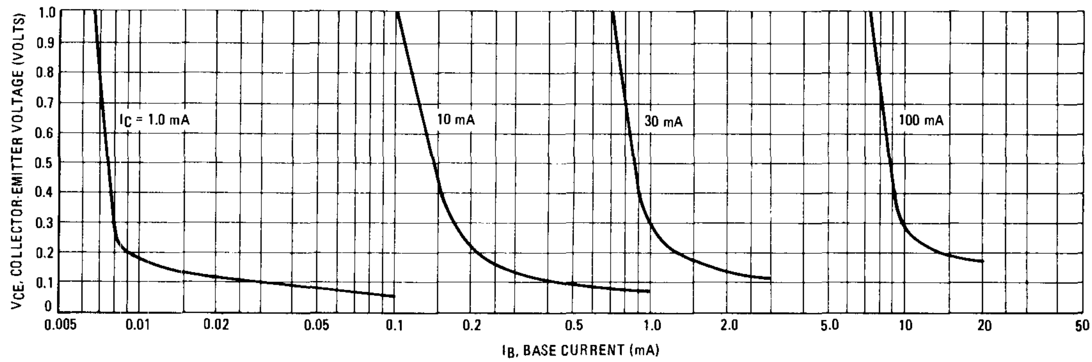


FIGURE 9 – COLLECTOR CUT-OFF REGION

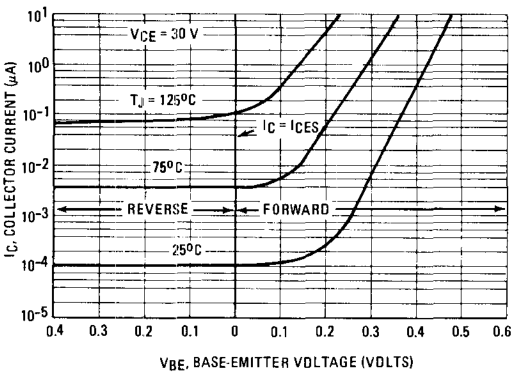


FIGURE 10 – EFFECTS OF BASE-EMITTER RESISTANCE

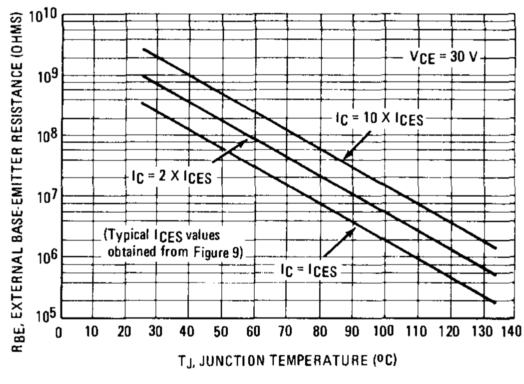


FIGURE 11 – "ON" VOLTAGES

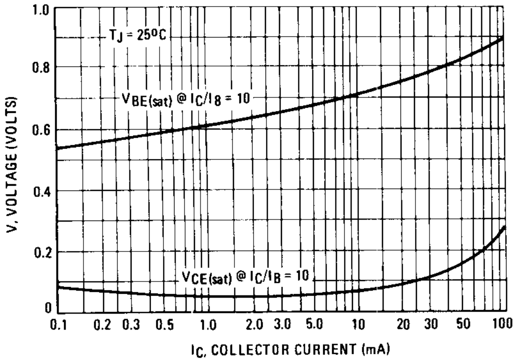


FIGURE 12 – TEMPERATURE COEFFICIENTS

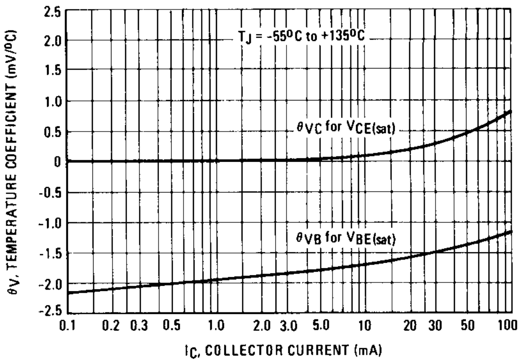


FIGURE 13 – SWITCHING TIME TEST CIRCUIT

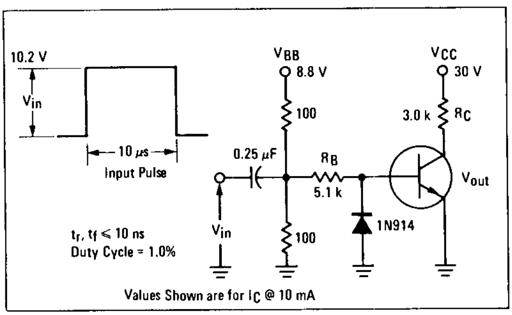


FIGURE 14 – CAPACITANCES

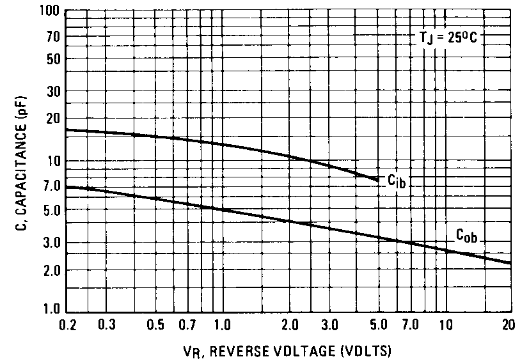


FIGURE 15 – TURN-ON TIME

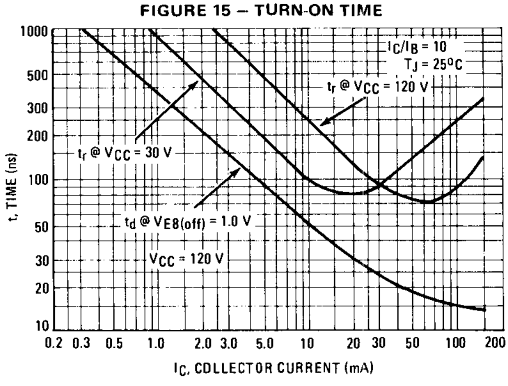
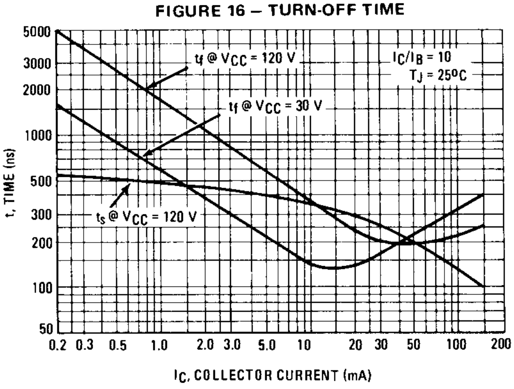


FIGURE 16 – TURN-OFF TIME



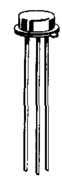
2N5581 (SILICON)
2N5582

NPN SILICON ANNULAR STAR SWITCHING TRANSISTORS

. . . designed for high-speed switching circuits and dc to VHF amplifier applications.

- TO-46 Equivalents to the 2N2221A and 2N2222A
- Low Leakage Current —
  I_{CBO} = 1.0 nAdc (Typ) @ V_{CB} = 60 Vdc
- DC Current Gain Specified over a Wide Current Range —
  h_{FE} from 0.1 to 500 mAdc
- Low Saturation Voltage —
  $V_{CE(sat)}$ = 0.3 Vdc (Max) @ I_C = 150 mAdc
- High Current-Gain Bandwidth Product —
  f_T = 300 MHz (Min) @ I_C = 20 mAdc — 2N5582
- High Voltage Ratings —
  BV_{CEO} = 40 Vdc (Min) @ I_C = 10 mAdc
  BV_{CBO} = 75 Vdc (Min) @ I_C = 10 μAdc

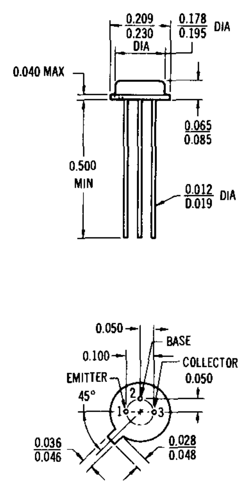
NPN SILICON ANNULAR STAR SWITCHING TRANSISTORS



MAXIMUM RATINGS

Rating	Symbol	Value	Unit
*Collector-Emitter Voltage	V_{CEO}	40	Vdc
*Collector-Base Voltage	V_{CB}	75	Vdc
*Emitter-Base Voltage	V_{EB}	6.0	Vdc
*Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	0.5 3.33	Watts mW/°C
*Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	2.0 11.43	Watts mW/°C
*Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +200	°C

*Indicates JEDEC Registered Data.



CASE 26

TO-46 PACKAGE

ELECTRICAL CHARACTERISTICS ($T_A = 25^oC$ unless otherwise noted)

Characteristic		Fig. No.	Symbol	Min	Max	Unit
OFF CHARACTERISTICS						
*Collector-Emitter Breakdown Voltage (I_C = 10 mAdc, I_B = 0)		–	BV_{CEO}	40	–	Vdc
*Collector-Base Breakdown Voltage (I_C = 10 μAdc, I_E = 0)		–	BV_{CBO}	75	–	Vdc
*Emitter-Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)		–	BV_{EBO}	6.0	–	Vdc
Collector Cutoff Current (V_{CE} = 60 Vdc, $V_{EB(off)}$ = 3.0 Vdc)		–	I_{CEX}	–	10	nAdc
Collector Cutoff Current		–	I_{CBO}			μAdc
*(V_{CB} = 60 Vdc, I_E = 0)				–	0.01	
(V_{CB} = 60 Vdc, I_E = 0, $T_A = 150^oC$)				–	10	
*Emitter Cutoff Current (V_{BE} = 3.0 Vdc, I_C = 0)		–	I_{EBO}	–	10	nAdc
ON CHARACTERISTICS						
* DC Current Gain (Note 1)			h_{FE}			–
(I_C = 0.1 mAdc, V_{CE} = 10 Vdc)	2N5581	–		20	–	
	2N5582			35	–	
(I_C = 1.0 mAdc, V_{CE} = 10 Vdc)	2N5581	–		25	–	
	2N5582			50	–	
(I_C = 10 mAdc, V_{CE} = 10 Vdc)	2N5581	–		35	–	
	2N5582			75	–	
(I_C = 10 mAdc, V_{CE} = 10 Vdc, $T_A = -55^oC$)	2N5581	–		15	–	
	2N5582			35	–	
(I_C = 150 mAdc, V_{CE} = 1.0 Vdc)	2N5581	3		20	–	
	2N5582			50	–	
(I_C = 150 mAdc, V_{CE} = 10 Vdc)	2N5581	–		40	120	
	2N5582			100	300	
(I_C = 500 mAdc, V_{CE} = 10 Vdc)	2N5581	–		25	–	
	2N5582			40	–	
* Collector-Emitter Saturation Voltage (Note 1)		4	$V_{CE(sat)}$			Vdc
(I_C = 150 mAdc, I_B = 15 mAdc)				–	0.3	
(I_C = 500 mAdc, I_B = 50 mAdc)				–	1.0	
* Base-Emitter Saturation Voltage (Note 1)		5	$V_{BE(sat)}$			Vdc
(I_C = 150 mAdc, I_B = 15 mAdc)				0.6	1.2	
(I_C = 500 mAdc, I_B = 50 mAdc)				–	2.0	
DYNAMIC CHARACTERISTICS/SMALL-SIGNAL CHARACTERISTICS						
* Current-Gain—Bandwidth Product		7	f_T			MHz
(I_C = 20 mAdc, V_{CE} = 20 Vdc, f = 100 MHz)	2N5581			250	–	
	2N5582			300	–	
*Collector-Base Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 100 kHz)		15	C_{cb}	–	8.0	pF
*Emitter-Base Capacitance (V_{BE} = 0.5 Vdc, I_C = 0, f = 100 kHz)		15	C_{eb}	–	25	pF
Input Impedance		11, 12	h_{ie}			k ohms
(I_C = 1.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)	2N5581			1.0	3.5	
	2N5582			2.0	8.0	
(I_C = 10 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)	2N5581			0.2	1.0	
	2N5582			0.25	1.25	
Voltage Feedback Ratio		9, 10	h_{re}			–
(I_C = 1.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)	2N5581			–	5×10^{-4}	
	2N5582			–	8×10^{-4}	
(I_C = 10 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)	2N5581			–	2.5×10^{-4}	
	2N5582			–	4×10^{-4}	
Small-Signal Current Gain		9, 10	h_{fe}			–
(I_C = 1.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)	2N5581			30	150	
	2N5582			50	300	
(I_C = 10 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)	2N5581			50	300	
	2N5582			75	375	

*Indicates JEDEC Registered Data.

Note 1: Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

ELECTRICAL CHARACTERISTICS (Continued)

Output Admittance (I_C = 1.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz) 2N5581	11, 12	h_{oe}	3.0	15	µmhos
2N5582			5.0	35	
(I_C = 10 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz) 2N5581			10	100	
2N5582			25	200	
Collector-Base Time Constant (I_C = 20 mAdc, V_{CE} = 20 Vdc, f = 31.8 MHz)	7	$r_b'C_c$	–	150	ps

SWITCHING CHARACTERISTICS

* Delay Time	(V_{CC} = 30 Vdc, $V_{BE(off)}$ = 0.5 Vdc, I_C = 150 mAdc, I_{B1} = 15 mAdc)	1	t_d	–	10	ns
* Rise Time			t_r	–	25	ns
* Storage Time	(V_{CC} = 30 Vdc, I_C = 150 mAdc, I_{B1} = I_{B2} = 15 mAdc)	2, 16	t_s	–	225	ns
* Fall Time			t_f	–	60	ns
Active Region Time Constant (I_C = 150 mAdc, V_{CE} = 30 Vdc)		17	τ_A	–	2.5	ns

*Indicates JEDEC Registered Data.

FIGURE 1 – DELAY TIME AND RISE TIME EQUIVALENT TEST CIRCUIT

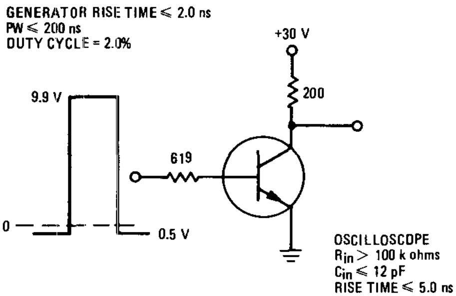
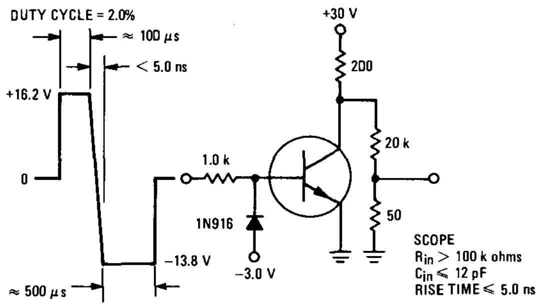


FIGURE 2 – STORAGE TIME AND FALL TIME EQUIVALENT TEST CIRCUIT



STATIC CHARACTERISTICS

FIGURE 3 – TYPICAL CURRENT GAIN CHARACTERISTICS

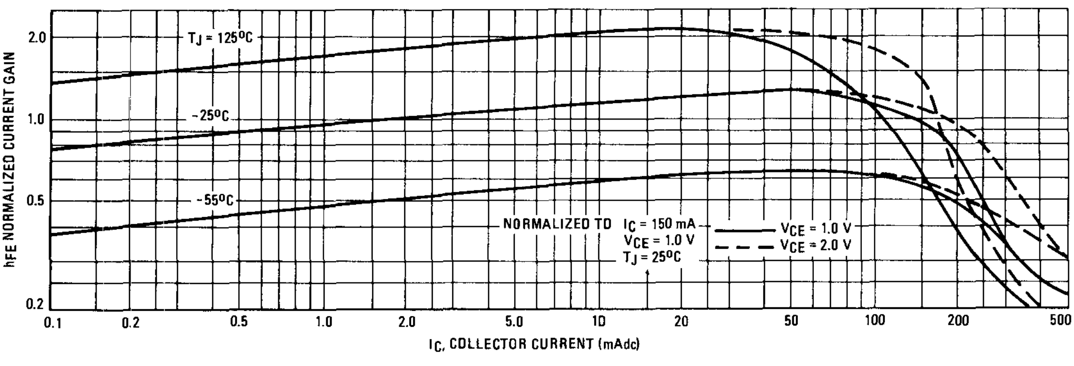
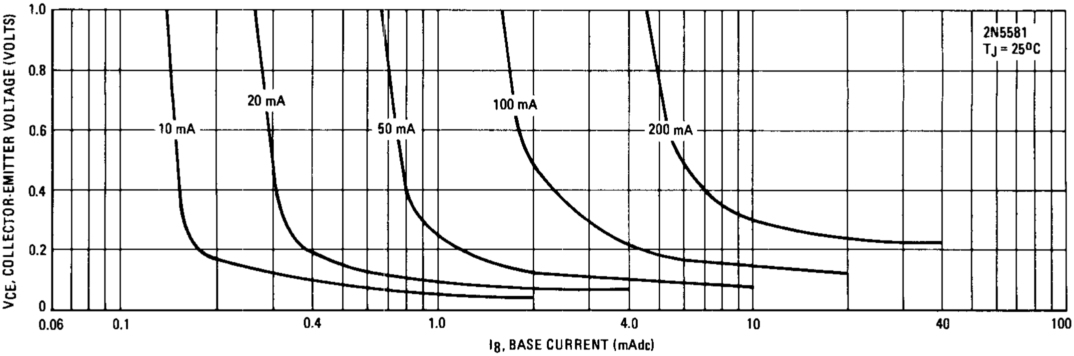


FIGURE 4 – COLLECTOR SATURATION VOLTAGE CHARACTERISTICS



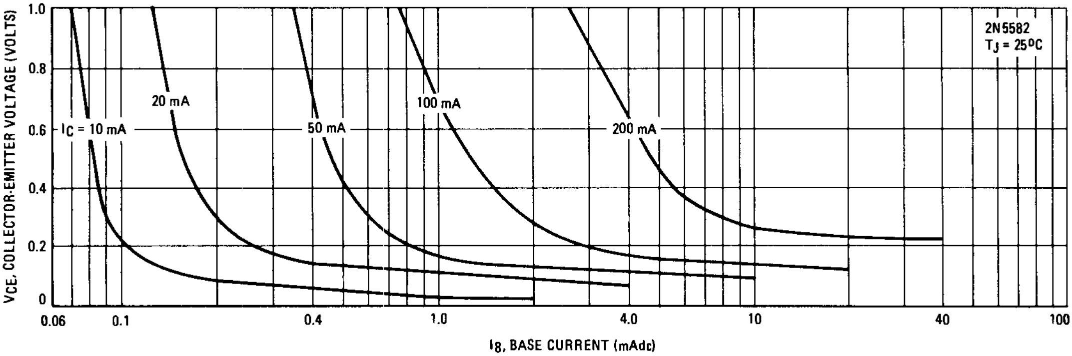


FIGURE 5 – BASE SATURATION VOLTAGE versus COLLECTOR CURRENT

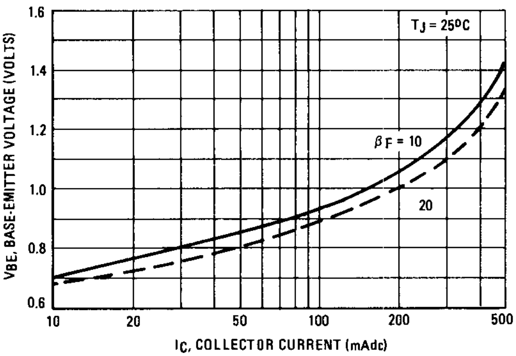


FIGURE 6 – TEMPERATURE COEFFICIENTS

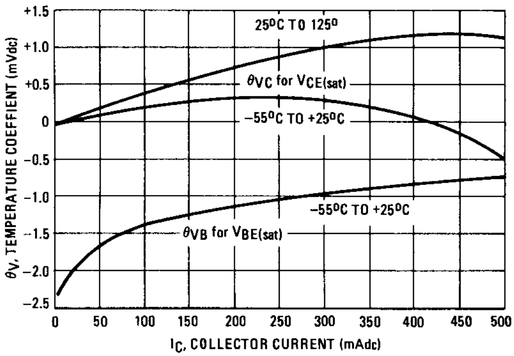


FIGURE 7 – CURRENT GAIN–BANDWIDTH PRODUCT AND COLLECTOR BASE TIME CONSTANT versus COLLECTOR CURRENT

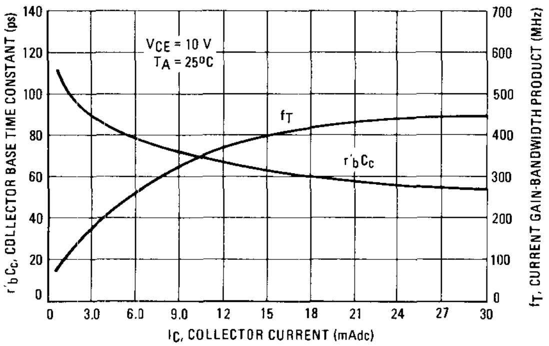
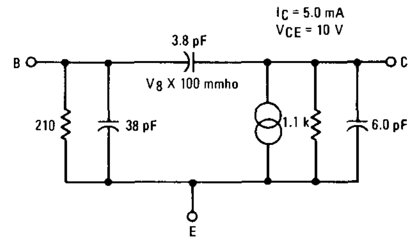


FIGURE 8 – EQUIVALENT CIRCUIT AT 30 MHz



SMALL SIGNAL FORWARD CURRENT GAIN AND VOLTAGE FEEDBACK RATIO versus COLLECTOR CURRENT

(V_{CE} = 10 Vdc, f = 1.0 kHz, T_A = 25°C)

FIGURE 9 – 2N5581

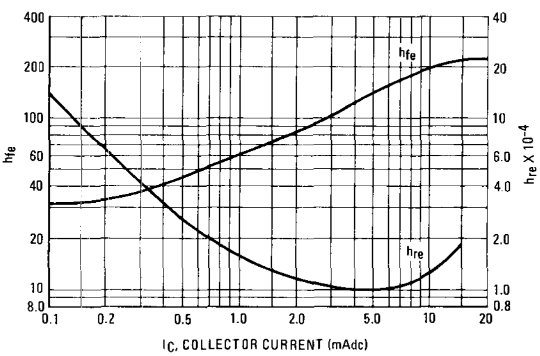
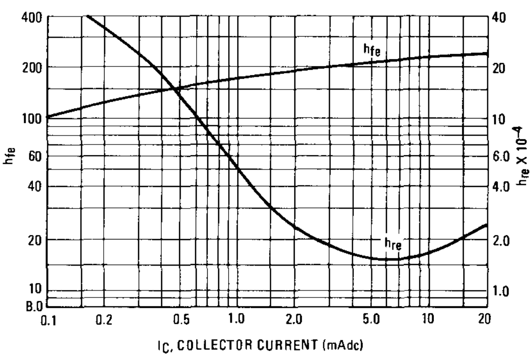


FIGURE 10 – 2N5582



SMALL SIGNAL INPUT IMPEDANCE AND OUTPUT CONDUCTANCE versus COLLECTOR CURRENT

(V_{CE} = 10 Vdc, f = 1.0 kHz, T_A = 25°C)

FIGURE 11 – 2N5581

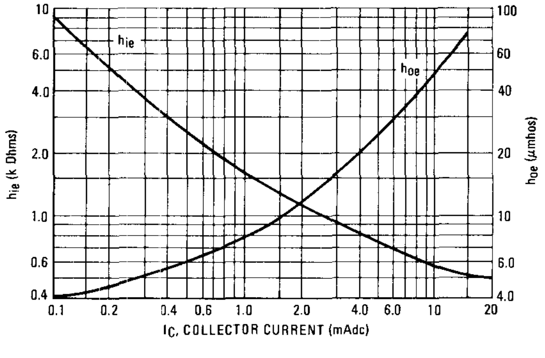


FIGURE 12 – 2N5582

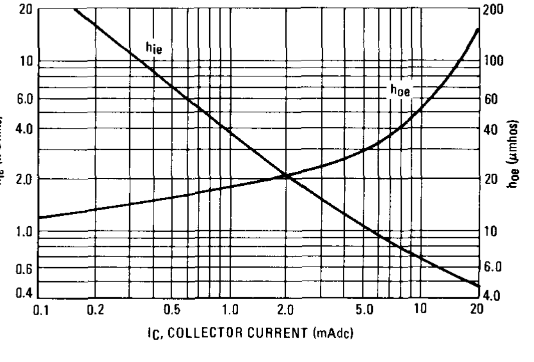


FIGURE 13 – 1.0 kHz NOISE FIGURE versus SOURCE IMPEDANCE

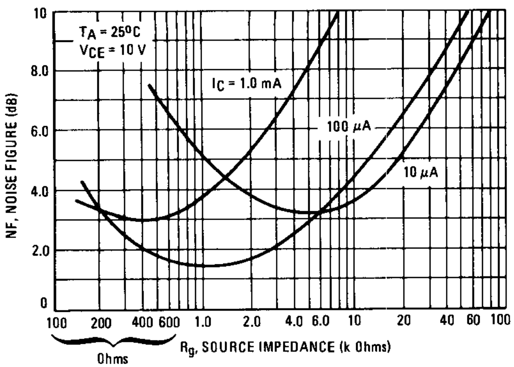


FIGURE 14 – NOISE FIGURE versus FREQUENCY

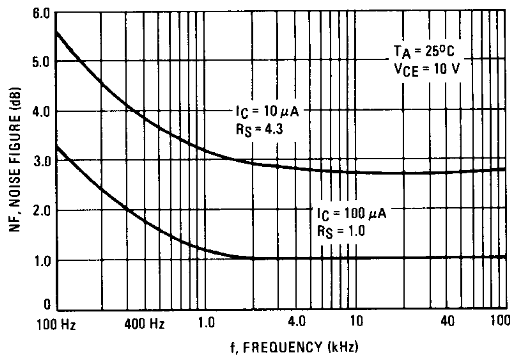


FIGURE 15 – CAPACITANCE VARIATIONS versus VOLTAGE

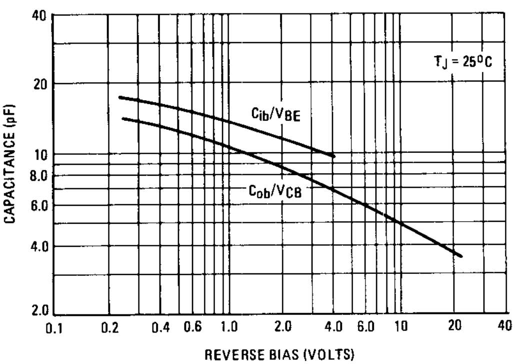


FIGURE 16 – STORAGE AND FALL TIME versus COLLECTOR CURRENT

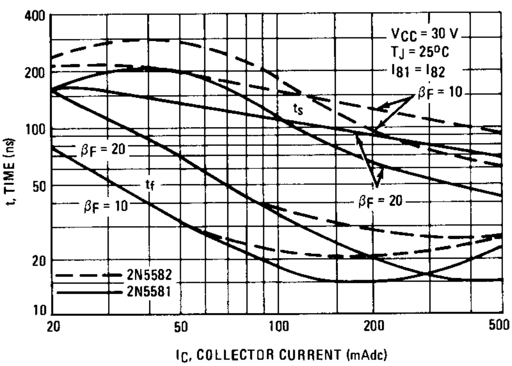


FIGURE 17 – ACTIVE REGION TIME CONSTANT versus COLLECTOR CURRENT

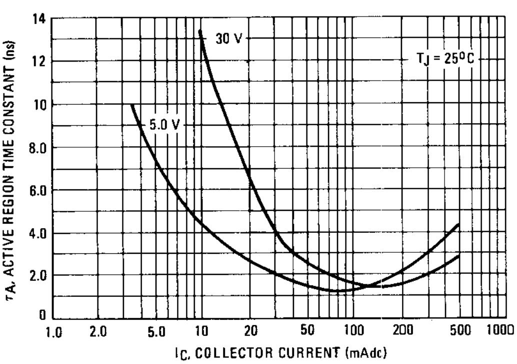
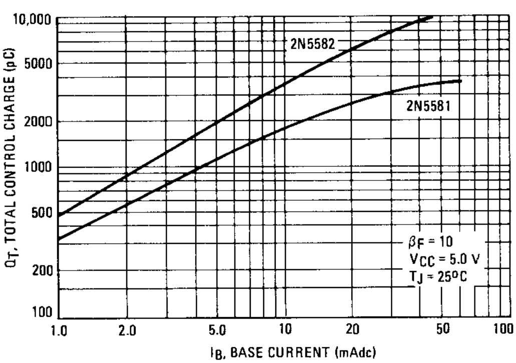


FIGURE 18 – TOTAL CONTROL CHARGE versus BASE CURRENT



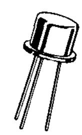
2N5583 (SILICON)

PNP SILICON ANNULAR TRANSISTOR

. . . designed for applications in high frequency amplifiers and non-saturated switching circuits. Large signal capabilities, low-noise and high gain-bandwidth product characteristics of the 2N5583 provide excellent performance in a variety of small signal and linear amplifier applications. Ideal for C A T V circuits.

- High Current-Gain—Bandwidth Product — f_T = 1300 (Min) @ I_C = 100 mAdc
- Low Collector-Base Time Constant — $r_b'C_c$ = 8.0 ps (Typ) @ I_C = 50 mAdc

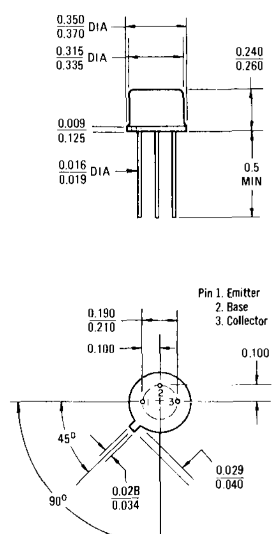
PNP SILICON AMPLIFIER TRANSISTOR



MAXIMUM RATINGS

Rating	Symbol	Value	Unit
*Collector-Emitter Voltage	V_{CEO}	30	Vdc
*Collector-Base Voltage	V_{CB}	30	Vdc
*Emitter-Base Voltage	V_{EB}	3.0	Vdc
*Collector Current — Continuous	I_C	500	mAdc
Total Device Dissipation @ $T_A = 25^oC$ Derate above 25^oC	P_D	1.0 5.71	Watt mW/^oC
*Total Device Dissipation @ $T_C = 25^oC$ Derate above 25^oC	P_D	5.0 28.6	Watts mW/^oC
*Operating and Storage Junction Temperature Range	T_J, T_{stg}	-65 to +200	^oC

*Indicates JEDEC Registered Data.



CASE 79(1)
(TO-39)

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Figure No.	Symbol	Min	Typ	Max	Unit
***OFF CHARACTERISTICS**						
Collector-Emitter Breakdown Voltage (Note 1) (I_C = 10 mAdc, I_B = 0)	–	BV_{CEO}	30	–	–	Vdc
Collector-Base Breakdown Voltage (I_C = 10 μAdc, I_E = 0)	–	BV_{CBO}	30	–	–	Vdc
Emitter-Base Breakdown Voltage (I_E = 100 μAdc, I_C = 0)	–	BV_{EBO}	3.0	–	–	Vdc
Collector Cutoff Current (V_{CB} = 20 Vdc, I_E = 0)	4	I_{CBO}	–	–	50	nAdc
Emitter Cutoff Current (V_{EB} = 2.0 Vdc, I_C = 0)	–	I_{EBO}	–	–	0.5	μAdc
***ON CHARACTERISTICS**						
DC Current Gain (Note 1)	1	h_{FE}				–
(I_C = 40 mAdc, V_{CE} = 2.0 Vdc)			20	40	–	
(I_C = 100 mAdc, V_{CE} = 2.0 Vdc)			25	40	100	
(I_C = 300 mAdc, V_{CE} = 5.0 Vdc)			15	22	–	
Collector-Emitter Saturation Voltage (Note 1) (I_C = 100 mAdc, I_B = 10 mAdc)	2,3	$V_{CE(sat)}$	–	0.6	0.8	Vdc
Base-Emitter On Voltage (Note 1) (I_C = 100 mAdc, V_{CE} = 2.0 Vdc)	3	$V_{BE(on)}$	–	0.84	1.8	Vdc
SMALL-SIGNAL CHARACTERISTICS						
*Current-Gain—Bandwidth Product	7	f_T				MHz
(I_C = 40 mAdc, V_{CE} = 10 Vdc, f = 100 MHz)			1000	1300	–	
(I_C = 100 mAdc, V_{CE} = 10 Vdc, f = 100 MHz)			1300	1500	–	
*Collector-Base Capacitance (V_{CB} = 15 Vdc, I_E = 0, f = 100 kHz)	5	C_{cb}	–	2.5	5.0	pF
*Emitter-Base Capacitance (V_{EB} = 0.5 Vdc, I_C = 0, f = 100 kHz)	5	C_{eb}	–	18	35	pF
Collector-Base Time Constant (I_C = 50 mAdc, V_{CB} = 10 Vdc, f = 63.6 MHz)	8	$r_b'C_c$	–	8.0	–	ps
SWITCHING CHARACTERISTICS						
Delay Time (V_{CC} = 31.4 Vdc, I_C = 150 mAdc, R_C = 160 Ohms, R_E = 26.6 Ohms) (See Figure 10 for more detail)	9	t_d	–	1.0	–	ns
Rise Time	9	t_r	–	2.1	–	ns
Fall Time	9	t_f	–	1.8	–	ns

*Indicates JEDEC Registered Data.
Note 1: Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle = 2.0%.

FIGURE 1 – DC CURRENT GAIN

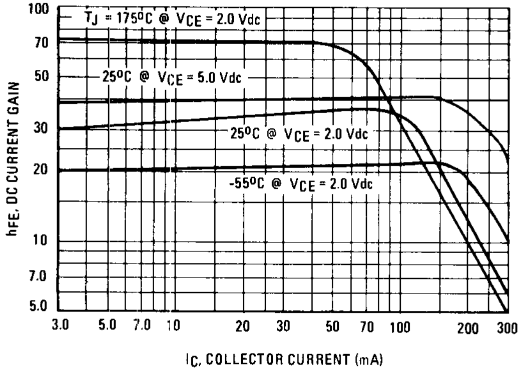


FIGURE 2 – COLLECTOR SATURATION REGION

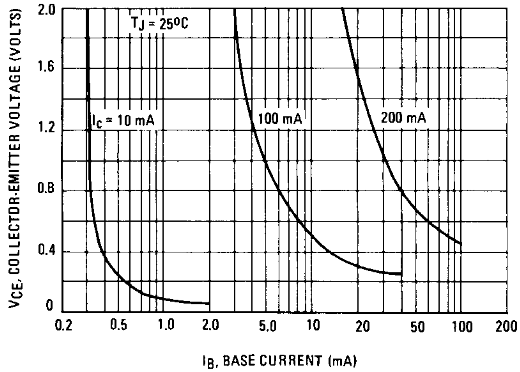


FIGURE 3 – "ON" VOLTAGES

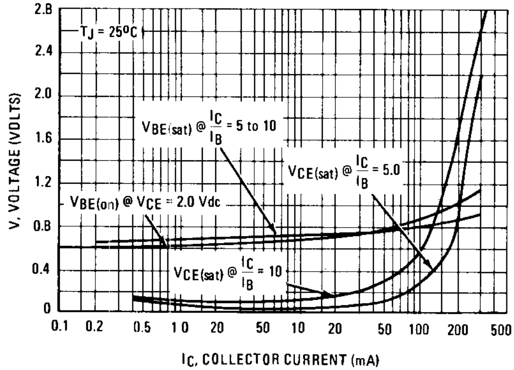


FIGURE 4 – COLLECTOR CURRENT versus BASE VOLTAGE

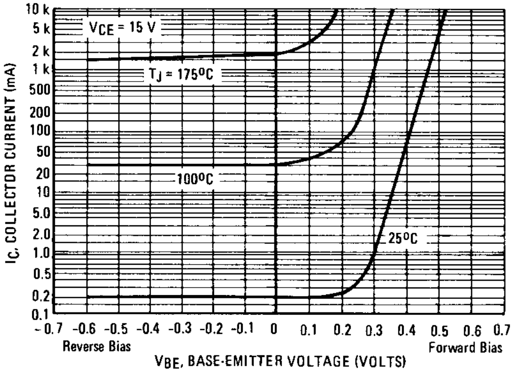


FIGURE 5 – CAPACITANCES

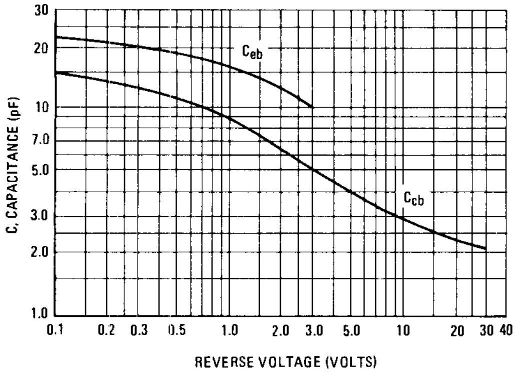


FIGURE 6 – TEMPERATURE COEFFICIENTS

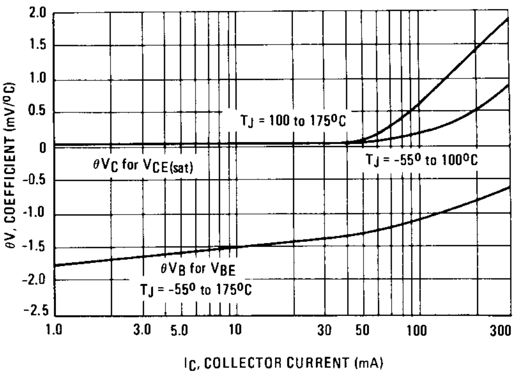


FIGURE 7 – CURRENT-GAIN–BANOWIOTH PRODUCT

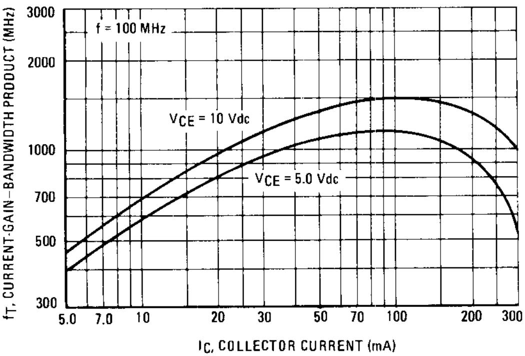


FIGURE 8 – COLLECTOR-BASE TIME CONSTANT

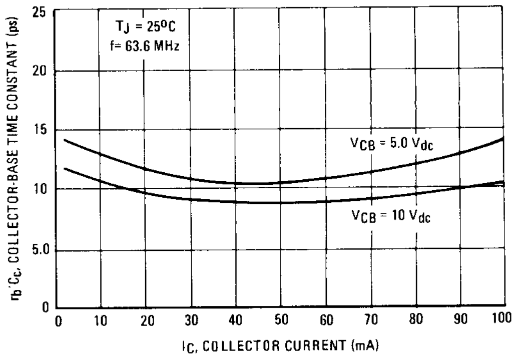


FIGURE 9 – SWITCHING TIMES

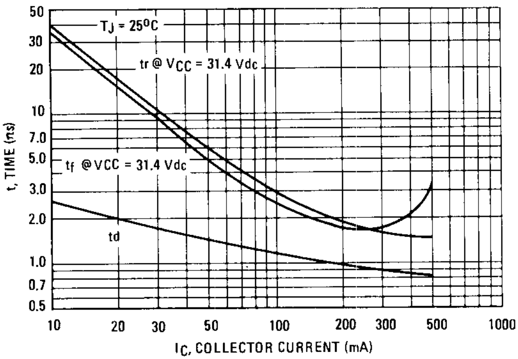
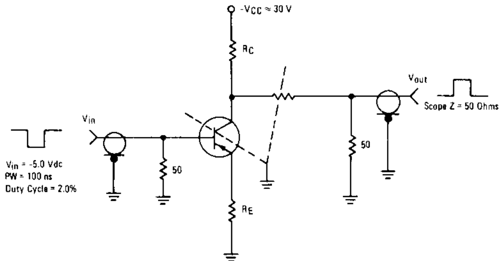


FIGURE 10 – SWITCHING TIMES TEST CIRCUIT



I_C mA	R_C Ohms	R_E Ohms	V_{CC} Volts
50	526	80	34.4
150	160	26.6	31.4
300	78	13.3	30.6
500	46.5	8.0	30.3

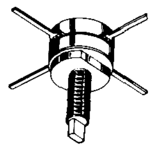
2N5589 (SILICON)

NPN SILICON RF POWER TRANSISTOR

. . . designed for 13.6 volt, VHF large signal power amplifier applications required in military and industrial equipment operating to 240 MHz.

- Low lead inductance stripline package for easier design and increased broadband capability.
- Balanced Emitter Construction for increased Safe Operating Area. The 2N5589 is designed to withstand an Open or Shorted Load at rated Output Power.
- Specified 13.6 Volt, 175 MHz Characteristics –
  Output Power = 3.0 Watts
  Minimum Gain = 8.2 dB
  Efficiency = 50%

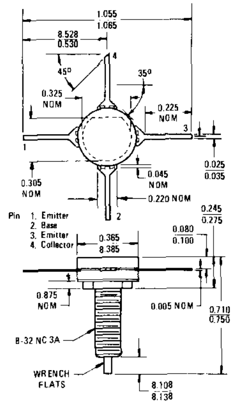
NPN SILICON RF POWER TRANSISTOR



*MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	18	Vdc
Collector-Base Voltage	V_{CB}	36	Vdc
Emitter-Base Voltage	V_{EB}	4.0	Vdc
Collector Current – Continuous	I_C	0.6	Adc
Total Device Dissipation @ $T_A = 25^oC$ Derate above 25^oC	P_D	15 86	Watts $mW/^oC$
Operating and Storage Junction Temperature Range	T_J, T_{stg}	-65 to +200	^oC

*Indicates JEDEC Registered Data.



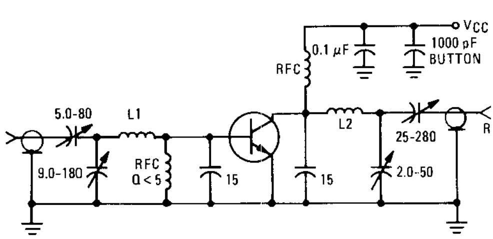
CASE 144B-02

*ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (Note 1) (I_C = 200 mAdc, I_B = 0)	BV_{CEO}	18	–	–	Vdc
Collector-Emitter Breakdown Voltage (Note 1) (I_C = 200 mAdc, V_{BE} = 0)	BV_{CES}	36	–	–	Vdc
Emitter-Base Breakdown Voltage (I_E = 1.0 mAdc, I_C = 0)	BV_{EBO}	4.0	–	–	Vdc
Collector Cutoff Current (V_{CB} = 15 Vdc, I_E = 0)	I_{CBO}	–	–	1.0	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 100 mAdc, V_{CE} = 5.0 Vdc)	h_{FE}	5.0	–	–	–
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 15 Vdc, I_E = 0, f = 0.1 to 1.0 MHz)	C_{ob}	–	15	30	pF
FUNCTIONAL TEST					
Power Input (Figure 1) (P_{out} = 3.0 W, V_{CE} = 13.6 Vdc, f = 175 MHz)	P_{in}	–	0.35	0.45	Watt
Common-Emitter Amplifier Power Gain (Figure 1) (P_{out} = 3.0 W, V_{CE} = 13.6 Vdc, f = 175 MHz)	G_{PE}	8.2	–	–	dB
Collector Efficiency (Figure 1) (P_{out} = 3.0 W, V_{CE} = 13.6 Vdc, f = 175 MHz)	η	50	–	–	%

*Indicates JEDEC Registered Data.
Note 1: Pulsed through 25 mH inductor.

FIGURE 1 – 175 MHz TEST CIRCUIT



All capacitance values in pF unless otherwise indicated
L1 – 1-3/8" length of #14 AWG Wire
L2 – 2 Turns #16 AWG Wire, 1/4" Dia. 1-1/2" Long

POWER OUTPUT versus FREQUENCY

FIGURE 2

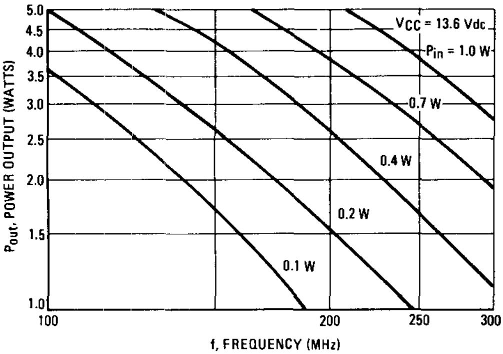


FIGURE 3

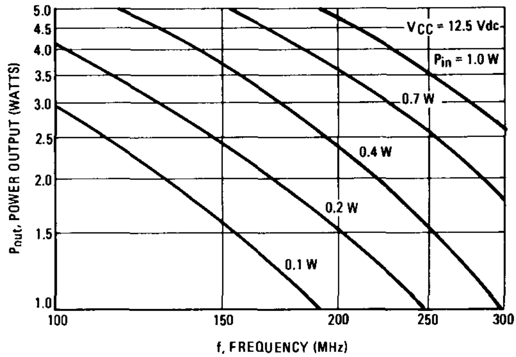


FIGURE 4 — POWER OUTPUT versus POWER INPUT

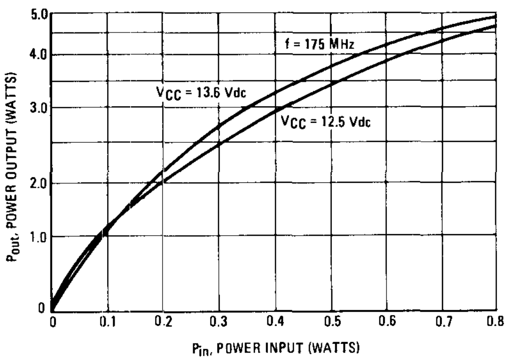
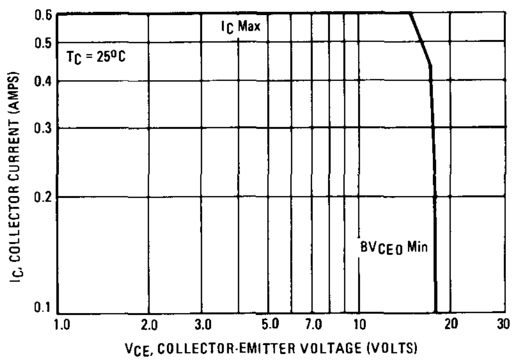


FIGURE 5 — DC SAFE OPERATING AREA



PARALLEL EQUIVALENT INPUT RESISTANCE versus FREQUENCY

FIGURE 6

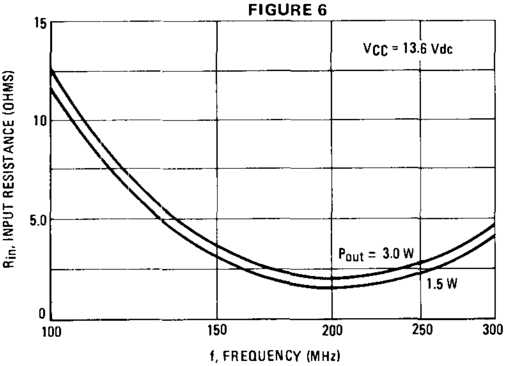
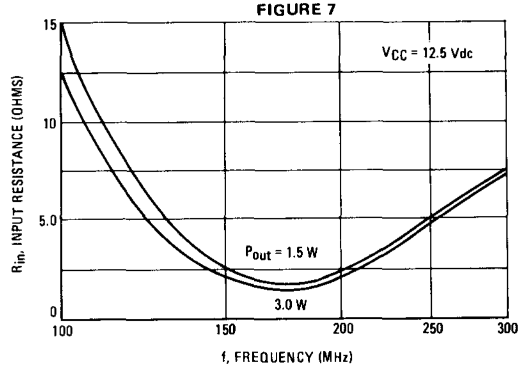


FIGURE 7



PARALLEL EQUIVALENT INPUT CAPACITANCE versus FREQUENCY

FIGURE 8

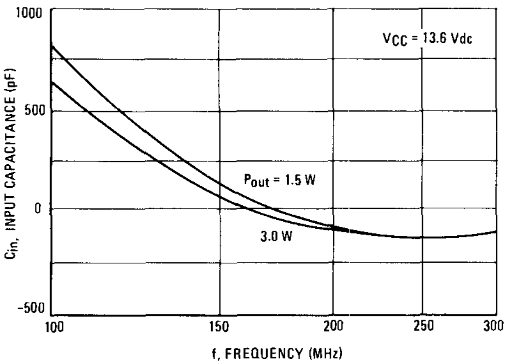
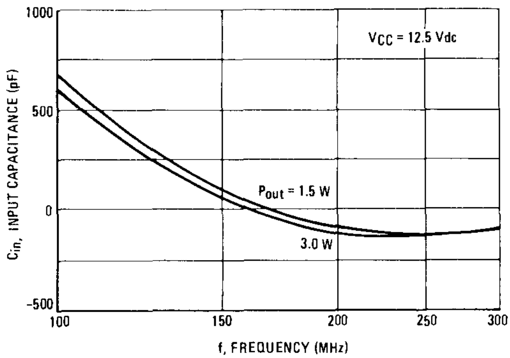


FIGURE 9



PARALLEL EQUIVALENT OUTPUT CAPACITANCE versus FREQUENCY

FIGURE 10

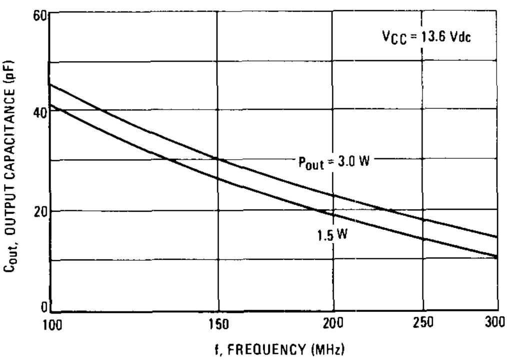
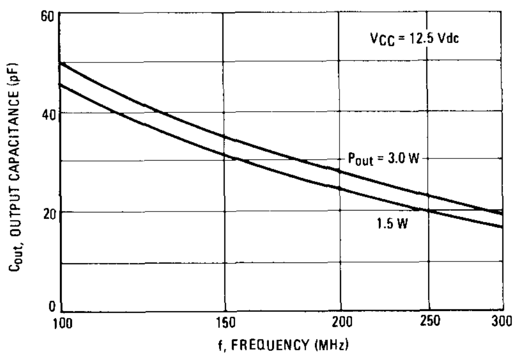


FIGURE 11



SERIES INPUT IMPEDANCE versus FREQUENCY

FIGURE 12

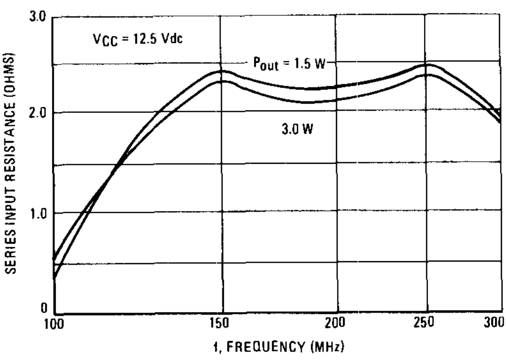
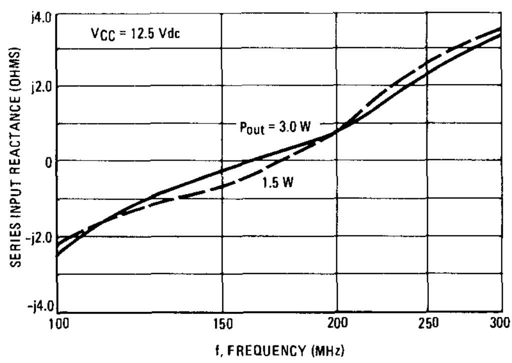


FIGURE 13



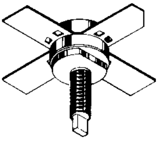
2N5590 (SILICON)

NPN SILICON RF POWER TRANSISTOR

. . . designed for 13.6 volt, VHF large signal power amplifier applications required in military and industrial equipment operating to 240 MHz.

- Low lead inductance stripline package for easier design and increased broadband capability.
- Balanced Emitter Construction for increased Safe Operating Area. The 2N5590 is designed to withstand an Open or Shorted Load at rated Output Power.
- Specified 13.6 Volt, 175 MHz Characteristics –
  Output Power = 10 Watts
  Minimum Gain = 5.2 dB
  Efficiency = 50%

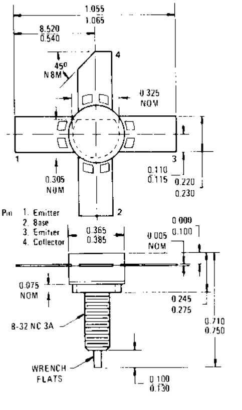
NPN SILICON RF POWER TRANSISTOR



*MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	18	Vdc
Collector-Base Voltage	V_{CB}	36	Vdc
Emitter-Base Voltage	V_{EB}	4.0	Vdc
Collector Current – Continuous	I_C	2.0	Adc
Total Device Dissipation @ $T_A = 25^oC$ Derate above 25^oC	P_D	30 171	Watts $mW/^oC$
Operating and Storage Junction Temperature Range	T_J, T_{stg}	-65 to +200	^oC

*Indicates JEDEC Registered Data.



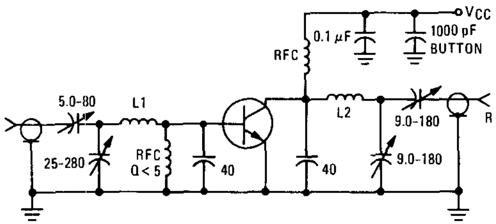
CASE 145A-01

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
*Collector-Emitter Sustaining Voltage (Note 1) (I_C = 200 mAdc, I_B = 0)	$V_{CEO(sus)}$	18	–	–	Vdc
*Collector-Emitter Sustaining Voltage (Note 1) (I_C = 200 mAdc, R_{BE} = 0)	$V_{CES(sus)}$	36	–	–	Vdc
*Emitter-Base Breakdown Voltage (I_E = 2.5 mAdc, I_C = 0)	BV_{EBO}	4.0	–	–	Vdc
Collector Cutoff Current (V_{CB} = 15 Vdc, I_E = 0)	I_{CBO}	–	–	1.0	mAdc
ON CHARACTERISTICS					
*DC Current Gain (I_C = 250 mAdc, V_{CE} = 5.0 Vdc)	h_{FE}	5.0	–	–	–
DYNAMIC CHARACTERISTICS					
*Output Capacitance (V_{CB} = 15 Vdc, I_E = 0, f = 0.1 to 1.0 MHz)	C_{ob}	–	35	70	pF
FUNCTIONAL TEST					
*Power Input (Figure 1) (P_{out} = 10 W, V_{CE} = 13.6 Vdc, f = 175 MHz)	P_{in}	–	–	3.0	Watts
*Common-Emitter Amplifier Power Gain (Figure 1) (P_{out} = 10 W, V_{CE} = 13.6 Vdc, f = 175 MHz)	G_{PE}	5.2	–	–	dB
Collector Efficiency (Figure 1) (P_{out} = 10 W, V_{CE} = 13.6 Vdc, f = 175 MHz)	η	50	–	–	%

*Indicates JEDEC Registered Data.
Note 1: Pulsed through 25 mH inductor.

FIGURE 1 – 175 MHz TEST CIRCUIT



All capacitance values in pF unless otherwise indicated
L1 – 1-3/8" length of #14 AWG Wire
L2 – 1 Turn #14 AWG Wire, 3/8" Dia. 1-1/2" Long

POWER OUTPUT versus FREQUENCY

FIGURE 2

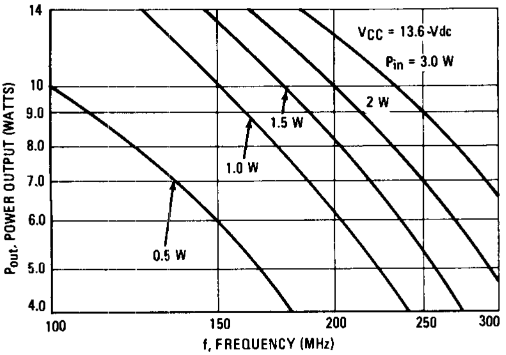


FIGURE 3

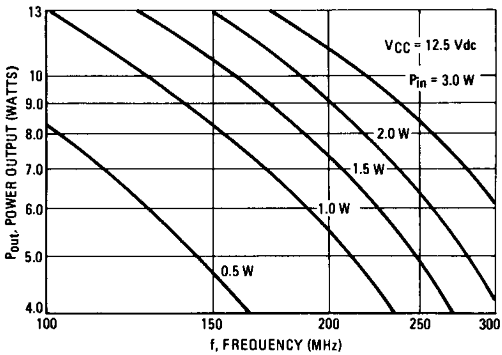


FIGURE 4 – POWER OUTPUT versus POWER INPUT

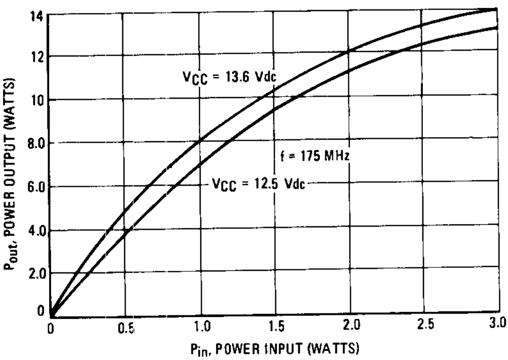
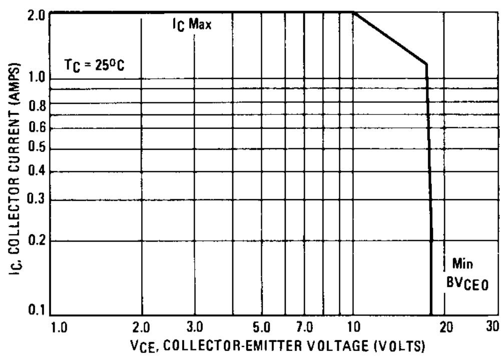


FIGURE 5 – DC SAFE OPERATING AREA



PARALLEL EQUIVALENT INPUT RESISTANCE versus FREQUENCY

FIGURE 6

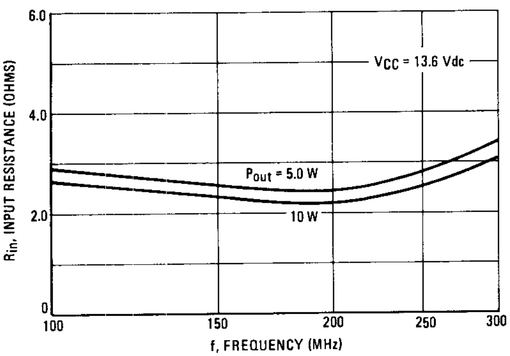
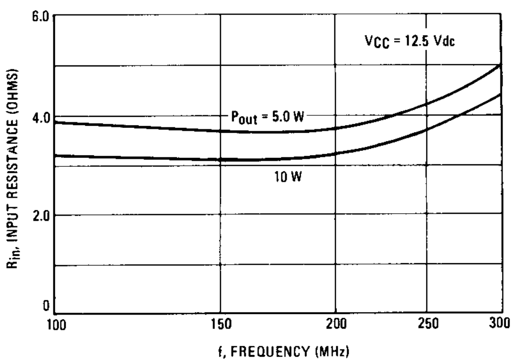


FIGURE 7



PARALLEL EQUIVALENT INPUT CAPACITANCE versus FREQUENCY

FIGURE 8

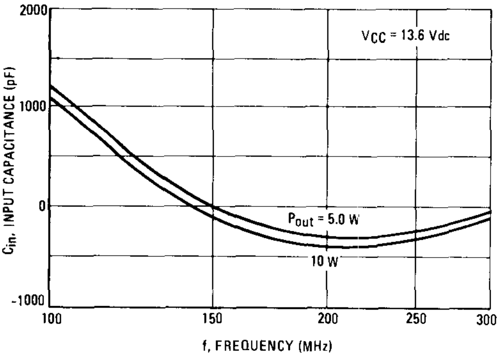
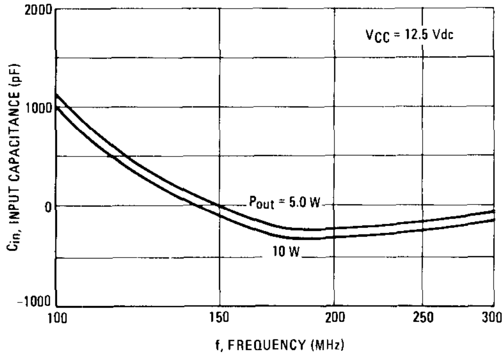


FIGURE 9



PARALLEL EQUIVALENT OUTPUT CAPACITANCE versus FREQUENCY

FIGURE 10

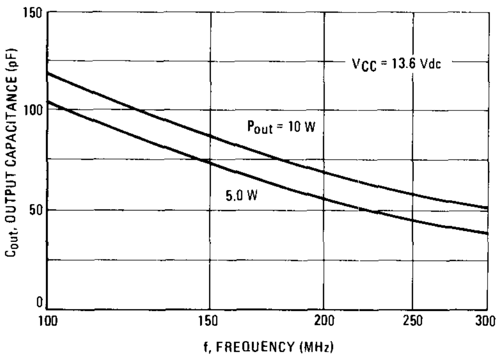
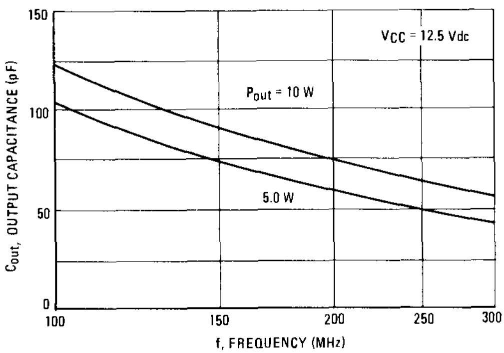


FIGURE 11



SERIES INPUT IMPEDANCE versus FREQUENCY

FIGURE 12

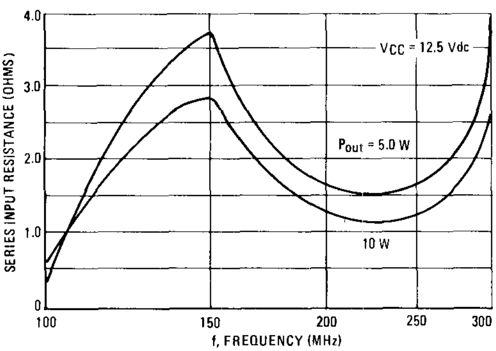
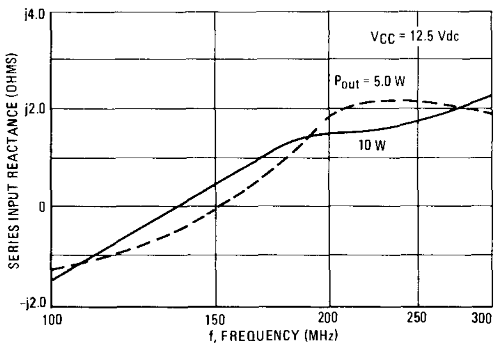


FIGURE 13



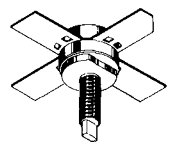
2N5591 (SILICON)

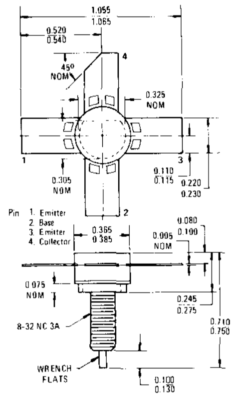
NPN SILICON RF POWER TRANSISTOR

. . . designed for 13.6 volt, VHF large signal power amplifier applications required in military and industrial equipment operating to 240 MHz.

- Low lead inductance stripline package for easier design and increased broadband capability.
- Balanced Emitter Construction for increased Safe Operating Area. The 2N5591 is designed to withstand an Open or Shorted Load at rated Output Power.
- Specified 13.6 Volt, 175 MHz Characteristics –
  Output Power = 25 Watts
  Minimum Gain = 4.4 dB
  Efficiency = 50%

NPN SILICON RF POWER TRANSISTOR





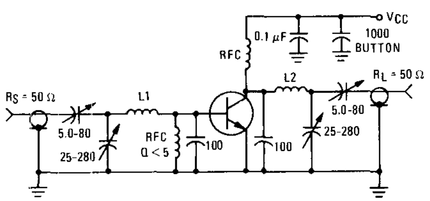
CASE 145A-01

*MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	18	Vdc
Collector-Base Voltage	V_{CB}	36	Vdc
Emitter-Base Voltage	V_{EB}	4.0	Vdc
Collector Current – Continuous	I_C	4.0	Adc
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	70 400	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	-65 to +200	°C

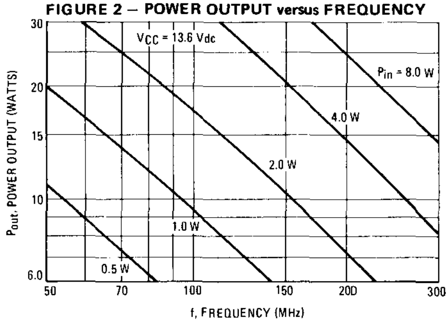
*Indicates JEDEC Registered Data.

FIGURE 1 – 175 MHz TEST CIRCUIT



ALL CAPACITORS IN pF UNLESS OTHERWISE INDICATED
L1 – #14 AWG STRAIGHT WIRE, 1-3/8" LONG
L2 – 1 TURN #14 AWG WIRE, 3/8" DIA. 1-1/2" LONG

FIGURE 2 – POWER OUTPUT versus FREQUENCY



ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
*Collector-Emitter Sustaining Voltage (Note 1) (I_C = 200 mAdc, I_B = 0)	$V_{CEO(sus)}$	18	–	–	Vdc
*Collector-Emitter Sustaining Voltage (Note 1) (I_C = 200 mAdc, V_{BE} = 0)	$V_{CES(sus)}$	36	–	–	Vdc
*Emitter-Base Breakdown Voltage (I_E = 5.0 mAdc, I_C = 0)	BV_{EBO}	4.0	–	–	Vdc
Collector Cutoff Current (V_{CB} = 15 Vdc, I_E = 0)	I_{CBO}	–	–	1.0	mAdc
***ON CHARACTERISTICS**					
DC Current Gain (I_C = 0.5 Adc, V_{CE} = 5.0 Vdc)	h_{FE}	5.0	–	–	–
***DYNAMIC CHARACTERISTICS**					
Output Capacitance (V_{CB} = 15 Vdc, I_E = 0, f = 0.1 to 1.0 MHz)	C_{ob}	–	90	120	pF
***FUNCTIONAL TEST**					
Power Input (Figure 1) (P_{out} = 25 W, V_{CE} = 13.6 Vdc, f = 175 MHz)	P_{in}	–	–	9.0	Watts
Common-Emitter Amplifier Power Gain (Figure 1) (P_{out} = 25 W, V_{CE} = 13.6 Vdc, f = 175 MHz)	G_{PE}	4.4	–	–	dB
Collector Efficiency (Figure 1) (P_{out} = 25 W, V_{CE} = 13.6 Vdc, f = 175 MHz)	η	50	–	–	%

*Indicates JEDEC Registered Data.
Note 1: Pulsed through 25 mH inductor.

FIGURE 3 – PARALLEL EQUIVALENT INPUT CAPACITANCE versus FREQUENCY

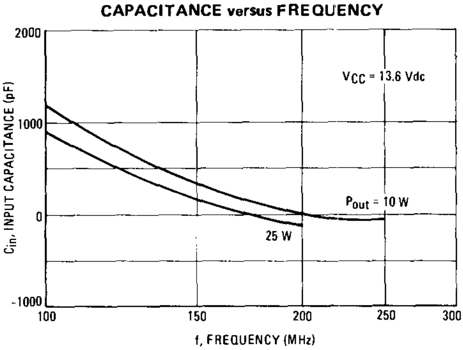


FIGURE 4 – PARALLEL EQUIVALENT INPUT RESISTANCE versus FREQUENCY

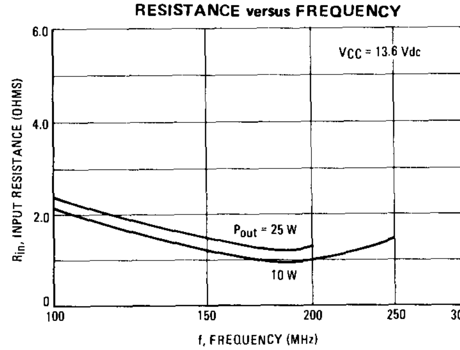


FIGURE 5 – PARALLEL EQUIVALENT OUTPUT CAPACITANCE versus FREQUENCY

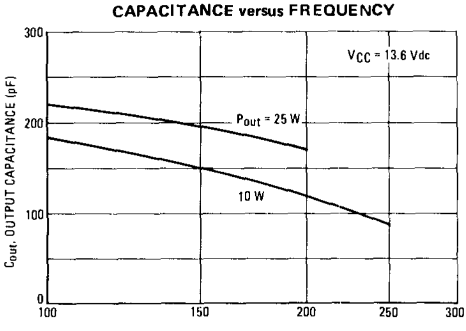
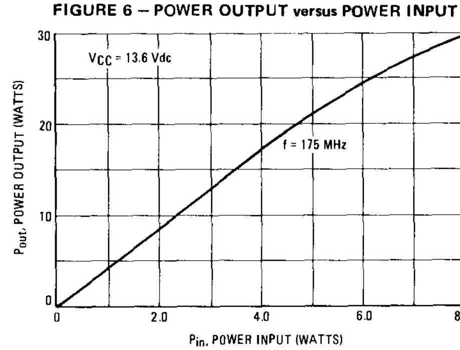


FIGURE 6 – POWER OUTPUT versus POWER INPUT



2N5629 (SILICON)
2N5630
2N5631

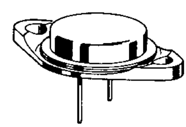
HIGH-POWER NPN SILICON TRANSISTORS

. . . for use in untuned amplifiers and switching circuit applications.

- High Collector-Emitter Sustaining Voltage –
  $V_{CEO(sus)}$ = 140 Vdc – 2N5631
- High DC Current Gain –
  h_{FE} = 25 (Min) @ I_C = 8.0 Adc – 2N5629
- Low Collector-Emitter Saturation Voltage –
  $V_{CE(sat)}$ = 1.0 Vdc (Max) @ I_C = 10 Adc

16 AMPERE POWER TRANSISTORS NPN SILICON

100-120-140 VOLTS 200 WATTS



*MAXIMUM RATINGS

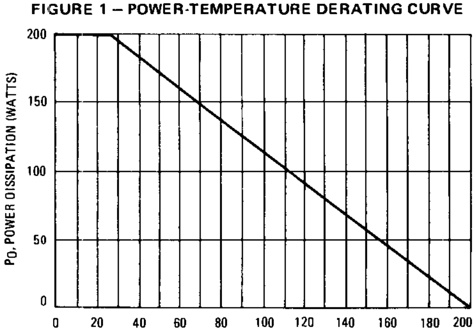
Rating	Symbol	2N5629	2N5630	2N5631	Unit
Collector-Emitter Voltage	V_{CEO}	100	120	140	Vdc
Collector-Base Voltage	V_{CB}	100	120	140	Vdc
Emitter-Base Voltage	V_{EB}	7.0			Vdc
Collector Current – Continuous Peak	I_C	16 20			Adc
Base Current – Continuous	I_B	5.0			Adc
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	200 1.14			Watts W/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	-65 to +200			°C

*THERMAL CHARACTERISTICS

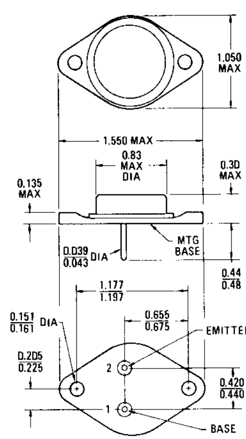
Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	θ_{JC}	0.875	°C/W

*Indicates JEDEC Registered Data.

FIGURE 1 – POWER-TEMPERATURE DERATING CURVE



Safe Area Curves are indicated by Figure 2. All Limits are applicable and must be observed.



CASE 11
TO-3
Collector Connected to Case

***ELECTRICAL CHARACTERISTICS** ($T_C = 25^oC$ unless otherwise noted)

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Sustaining Voltage (Note 1) (I_C = 200 mAdc, I_B = 0)	2N5629	$V_{CEO(sus)}$	100	–	Vdc
	2N5630		120	–	
	2N5631		140	–	
Collector-Emitter Cutoff Current (V_{CE} = 50 Vdc, I_B = 0)	2N5629	I_{CEO}	–	5.0	mAdc
(V_{CE} = 60 Vdc, I_B = 0)	2N5630		–	5.0	
(V_{CE} = 70 Vdc, I_B = 0)	2N5631		–	5.0	
Collector-Emitter Cutoff Current (V_{CE} = Rated V_{CB}, $V_{EB(off)}$ = 1.5 Vdc)		I_{CEX}	–	1.0	mAdc
(V_{CE} = Rated V_{CB}, $V_{EB(off)}$ = 1.5 Vdc, T_C = 150°C)			–	5.0	
Collector-Base Cutoff Current (V_{CB} = Rated V_{CB}, I_E = 0)		I_{CBO}	–	1.0	mAdc
Emitter-Base Cutoff Current (V_{BE} = 7.0 Vdc, I_C = 0)		I_{EBO}	–	1.0	mAdc
ON CHARACTERISTICS					
DC Current Gain (Note 1) (I_C = 8.0 Adc, V_{CE} = 2.0 Vdc)	2N5629	h_{FE}	25	100	–
	2N5630		20	80	
	2N5631		15	60	
(I_C = 16 Adc, V_{CE} = 2.0 Vdc)	All Types		4.0	–	
Collector-Emitter Saturation Voltage (Note 1) (I_C = 10 Adc, I_B = 1.0 Adc)	All Types	$V_{CE(sat)}$	–	1.0	Vdc
(I_C = 16 Adc, I_B = 4.0 Adc)			–	2.0	
Base-Emitter Saturation Voltage (Note 1) (I_C = 10 Adc, I_B = 1.0 Adc)		$V_{BE(sat)}$	–	1.8	Vdc
Base-Emitter On Voltage (Note 1) (I_C = 8.0 Adc, V_{CE} = 2.0 Vdc)		$V_{BE(on)}$	–	1.5	Vdc
DYNAMIC CHARACTERISTICS					
Current-Gain—Bandwidth Product (I_C = 1.0 Adc, V_{CE} = 20 Vdc, f = 0.5 MHz)		f_T	1.0	–	MHz
Output Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 0.1 MHz)		C_{ob}	–	500	pF
Small-Signal Current Gain (I_C = 4.0 Adc, V_{CE} = 10 Vdc, f = 1.0 kHz)		h_{fe}	15	–	–

*Indicates JEDEC Registered Data.

Note 1: Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

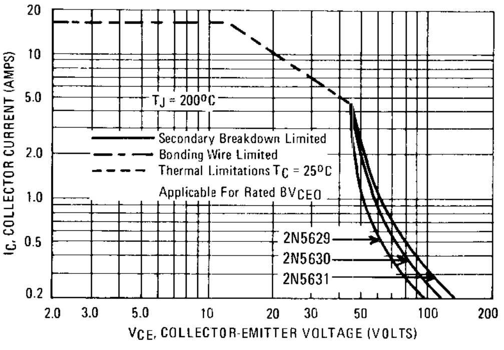


FIGURE 2 — DC SAFE OPERATING AREA

The Safe Operating Area Curves indicate I_C—V_{CE} limits below which the device will not enter secondary breakdown. Collector load lines for specific circuits must fall within the applicable Safe Area to avoid causing a catastrophic failure. To insure operation below the maximum T_J, power-temperature derating must be observed for both steady state and pulse power conditions.

2N5632 (SILICON)
2N5633
2N5634

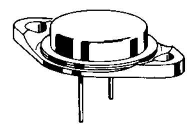
HIGH-POWER NPN SILICON TRANSISTORS

. . . for use in untuned amplifiers and switching circuit applications.

- High Collector-Emitter Voltage –
  V_{CEO} = 140 Vdc – 2N5634
- High DC Current Gain –
  h_{FE} = 25 (Min) @ I_C = 5.0 Adc – 2N5632
- Low Collector-Emitter Saturation Voltage –
  $V_{CE(sat)}$ = 1.0 Vdc (Max) @ I_C = 7.5 Adc

10 AMPERE
POWER TRANSISTORS
NPN SILICON

100-120-140 VOLTS
150 WATTS



*MAXIMUM RATINGS

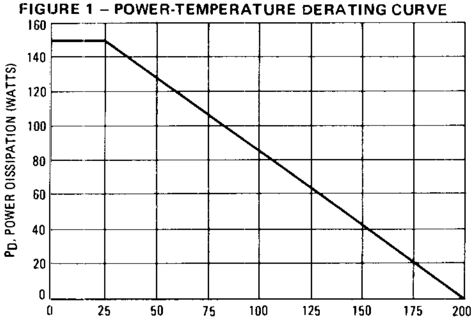
Rating	Symbol	2N5632	2N5633	2N5634	Unit
Collector-Emitter Voltage	V_{CEO}	100	120	140	Vdc
Collector-Base Voltage	V_{CB}	100	120	140	Vdc
Emitter-Base Voltage	V_{EB}	←	7.0	→	Vdc
Collector Current – Continuous – Peak	I_C	← ←	10 15	→ →	Adc
Base Current – Continuous	I_B	←	5.0	→	Adc
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	←	150 0.857	→	Watts W/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	←	–65 to +200	→	°C

*THERMAL CHARACTERISTICS

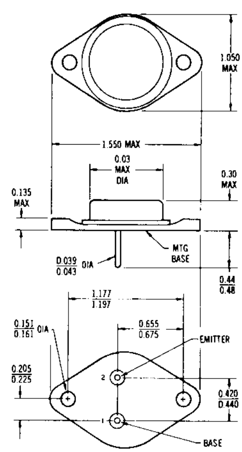
Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	θ_{JC}	1.17	°C/W

*Indicates JEDEC Registered Data.

FIGURE 1 – POWER-TEMPERATURE DERATING CURVE



Safe area limits are indicated by Figure 2.
Both limits are applicable and must be observed.



CASE 11
TO-3

Collector Connected to Case

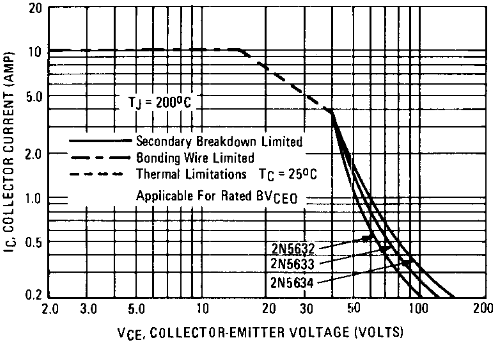
*ELECTRICAL CHARACTERISTICS ($T_C = 25^oC$ unless otherwise noted)

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Sustaining Voltage (Note 1)		$V_{CEO(sus)}$			Vdc
(I_C = 200 mAdc, I_B = 0)	2N5632		100	–	
	2N5633		120	–	
	2N5634		140	–	
Collector-Emitter Cutoff Current		I_{CEO}			mAdc
(V_{CE} = 50 Vdc, I_B = 0)	2N5632		–	5.0	
(V_{CE} = 60 Vdc, I_B = 0)	2N5633		–	5.0	
(V_{CE} = 70 Vdc, I_B = 0)	2N5634		–	5.0	
Collector-Emitter Cutoff Current		I_{CEX}			mAdc
(V_{CE} = Rated V_{CB}, V_{BE} = –1.5 Vdc)			–	1.0	
(V_{CE} = Rated V_{CB}, V_{BE} = –1.5 Vdc, T_C = 150°C)			–	5.0	
Collector Base Cutoff Current (V_{CB} = Rated V_{CB}, I_E = 0)		I_{CBO}	–	1.0	mAdc
Emitter-Base Cutoff Current (V_{BE} = 7.0 Vdc, I_C = 0)		I_{EBO}	–	1.0	mAdc
ON CHARACTERISTICS					
DC Current Gain (Note 1)		h_{FE}			–
(I_C = 5.0 Adc, V_{CE} = 2.0 Vdc)	2N5632		25	100	
	2N5633		20	80	
	2N5634		15	60	
(I_C = 10 Adc, V_{CE} = 2.0 Vdc)	All Types		5.0	–	
Collector-Emitter Saturation Voltage (Note 1)		$V_{CE(sat)}$			Vdc
(I_C = 7.5 Adc, I_B = 0.75 Adc)			–	1.0	
(I_C = 10 Adc, I_B = 2.0 Adc)			–	2.0	
Base-Emitter Saturation Voltage (Note 1) (I_C = 7.5 Adc, I_B = 0.75 Adc)		$V_{BE(sat)}$	–	2.0	Vdc
Base-Emitter On Voltage (Note 1) (I_C = 5.0 Adc, V_{CE} = 2.0 Vdc)		$V_{BE(on)}$	–	1.5	Vdc
DYNAMIC CHARACTERISTICS					
Current-Gain—Bandwidth Product (I_C = 1.0 Adc, V_{CE} = 20 Vdc, f = 0.5 MHz)		f_T	1.0	–	MHz
Output Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 0.1 MHz)		C_{ob}	–	300	pF
Small Signal Current Gain (V_{CE} = 10 Vdc, I_C = 2.0 Adc, f = 1.0 kHz)		h_{fe}	15	–	–

*Indicates JEDEC Registered Data.

Note 1: Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

FIGURE 2 — DC SAFE OPERATING AREA



The Safe Operating Area Curves indicate I_C-V_{CE} limits below which the device will not enter secondary breakdown. Collector load lines for specific circuits must fall within the applicable Safe Area to avoid causing a catastrophic failure. To insure operation below the maximum T_J, power-temperature derating must be observed for both steady state and pulse power conditions.

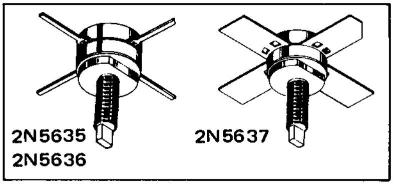
2N5635 (SILICON)
2N5636
2N5637

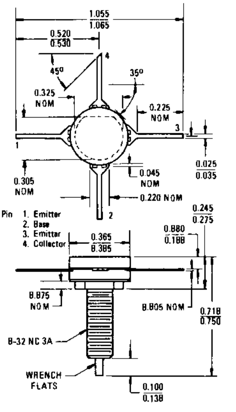
NPN SILICON RF POWER TRANSISTORS

. . . designed for VHF/UHF amplifier applications. These devices are suitable for use in 28 volt systems to 470 MHz. These transistors are ideal for 225-400 MHz communications equipment.

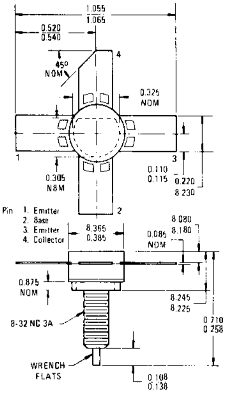
- Balanced Emitter Construction to provide the designer with the device technology that assures ruggedness and resists transistor damage caused by load mismatch.
- Low inductance strip line packaging for easier and better broad-band designs.
- Ceramic Package
- Choice of Power Levels at 400 MHz, 28 Vdc –
  2N5635 – 2.5 Watts – 6.2 dB (Min) Gain
  2N5636 – 7.5 Watts – 5.7 dB (Min) Gain
  2N5637 – 20 Watts – 4.6 dB (Min) Gain

NPN SILICON
RF POWER
TRANSISTORS





CASE 144B-02
2N5635, 2N5636



2N5637 CASE 145A-01

*MAXIMUM RATINGS

Rating	Symbol	2N5635	2N5636	2N5637	Unit
Collector-Emitter Voltage	V_{CEO}	←	35	→	Vdc
Collector-Base Voltage	V_{CB}	←	60	→	Vdc
Emitter-Base Voltage	V_{EB}	←	4.0	→	Vdc
Collector Current	I_C	1.0	1.5	3.0	Adc
Total Device Dissipation @ $T_A = 25^{\circ}C$ Derate above 25°C	P_D	7.5 43	15 86	30 171	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}		-65 to +200		°C

*Indicates JEDEC Registered Data.

*ELECTRICAL CHARACTERISTICS ($T_A = 25^oC$ unless otherwise noted)

Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Collector-Emitter Breakdown Voltage (Note 1)		BV_{CEO}				Vdc
(I_C = 100 mAdc, I_B = 0)	2N5635		35	–	–	
(I_C = 200 mAdc, I_B = 0)	2N5636,2N5637		35	–	–	
Collector-Emitter Breakdown Voltage (Note 1)		BV_{CES}				Vdc
(I_C = 100 mAdc, V_{BE} = 0)	2N5635		60	–	–	
(I_C = 200 mAdc, V_{BE} = 0)	2N5636,2N5637		60	–	–	
Emitter-Base Breakdown Voltage		BV_{EBO}				Vdc
(I_E = 1.0 mAdc, I_C = 0)	2N5635		4.0	–	–	
(I_E = 5.0 mAdc, I_C = 0)	2N5636		4.0	–	–	
(I_E = 10 mAdc, I_C = 0)	2N5637		4.0	–	–	
Collector Cutoff Current		I_{CBO}				mAdc
(V_{CB} = 30 Vdc, I_E = 0)	2N5635		–	–	0.1	
	2N5636		–	–	1.0	
	2N5637		–	–	1.0	
ON CHARACTERISTICS						
DC Current Gain		h_{FE}				–
(I_C = 100 mAdc, V_{CE} = 5.0 Vdc)	2N5635		5.0	–	–	
(I_C = 200 mAdc, V_{CE} = 5.0 Vdc)	2N5636		5.0	–	–	
(I_C = 500 mAdc, V_{CE} = 5.0 Vdc)	2N5637		5.0	–	–	
DYNAMIC CHARACTERISTICS						
Output Capacitance		C_{ob}				pF
(V_{CB} = 30 Vdc, I_E = 0, f = 0.1 to 1.0 MHz)	2N5635		–	5.0	10	
	2N5636		–	10	20	
	2N5637		–	20	30	
FUNCTIONAL TEST						
Common-Emitter Amplifier Power Gain		G_{PE}				dB
(P_{out} = 2.5 Watts, V_{CE} = 28 Vdc, f = 400 MHz)	2N5635		6.2	9.2	–	
(P_{out} = 7.5 Watts, V_{CE} = 28 Vdc, f = 400 MHz)	2N5636		5.7	7.0	–	
(P_{out} = 20 Watts, V_{CE} = 28 Vdc, f = 400 MHz)	2N5637		4.6	5.8	–	
Power Output		P_{out}				Watts
(P_{in} = 0.6 Watt, V_{CE} = 28 Vdc, f = 400 MHz)	2N5635		2.5	3.2	–	
(P_{in} = 2.0 Watts, V_{CE} = 28 Vdc, f = 400 MHz)	2N5636		7.5	8.4	–	
(P_{in} = 7.0 Watts, V_{CE} = 28 Vdc, f = 400 MHz)	2N5637		20	22	–	
Collector Efficiency		η				%
(P_{out} = 2.5 Watts, V_{CE} = 28 Vdc, f = 400 MHz)	2N5635		50	–	–	
(P_{out} = 7.5 Watts, V_{CE} = 28 Vdc, f = 400 MHz)	2N5636		50	–	–	
(P_{out} = 20 Watts, V_{CE} = 28 Vdc, f = 400 MHz)	2N5637		60	–	–	

*Indicates JEDEC Registered Data.
Note 1: Pulsed through 25 mH inductor.

FIGURE 1 – 400 MHz TEST CIRCUIT (2N5635,2N5636)

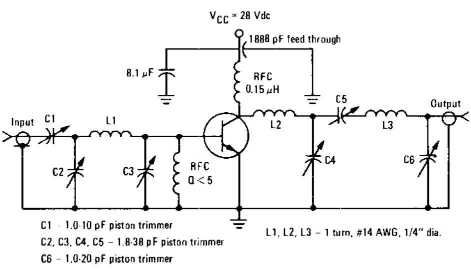
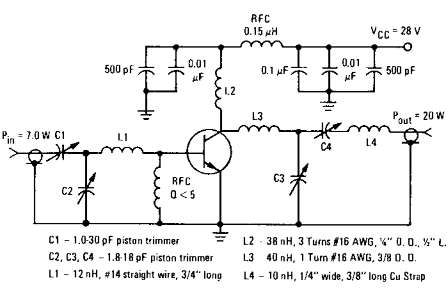


FIGURE 2 – 400 MHz TEST CIRCUIT (2N5637)



TYPICAL PERFORMANCE DATA

POWER OUTPUT versus FREQUENCY

FIGURE 3

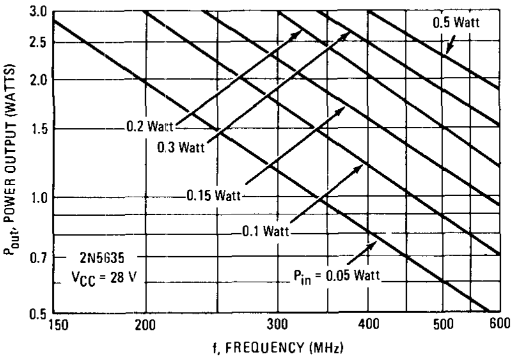


FIGURE 4

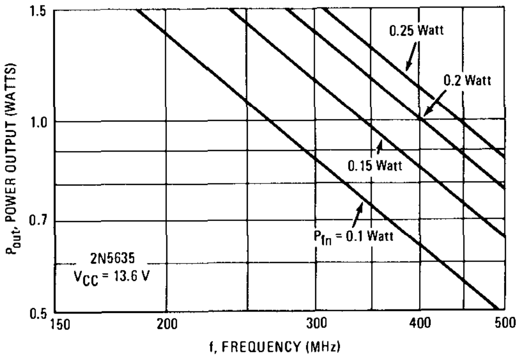


FIGURE 5

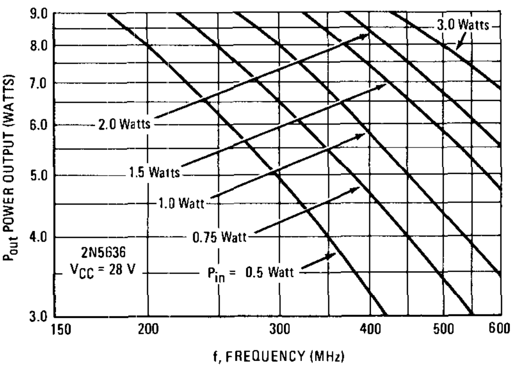


FIGURE 6

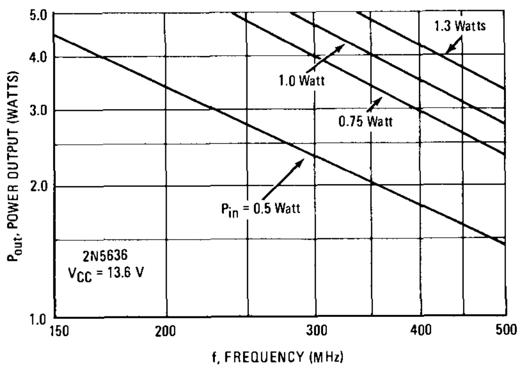


FIGURE 7

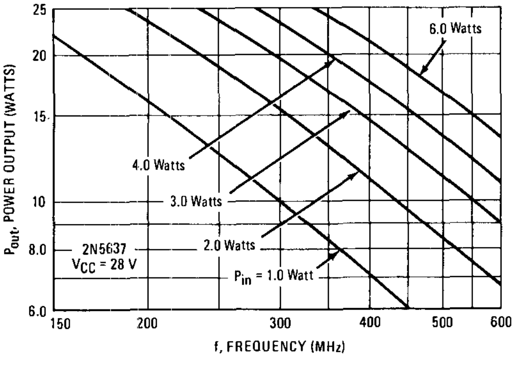
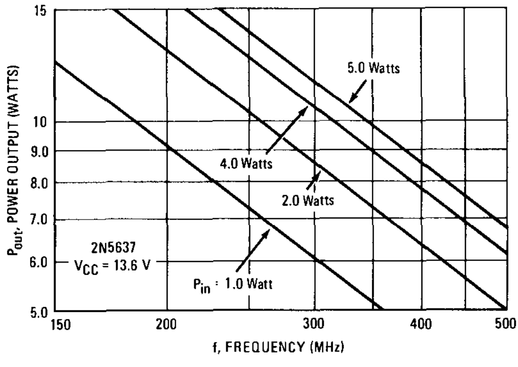


FIGURE 8



TYPICAL PERFORMANCE DATA

POWER OUTPUT versus POWER INPUT

FIGURE 9

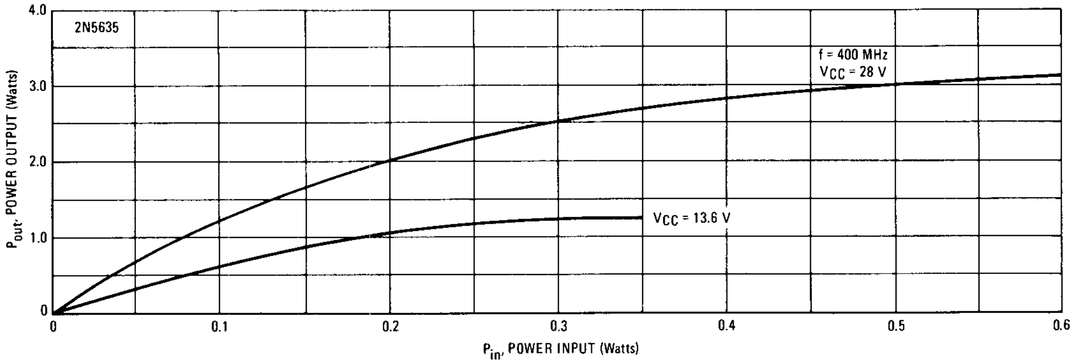


FIGURE 10

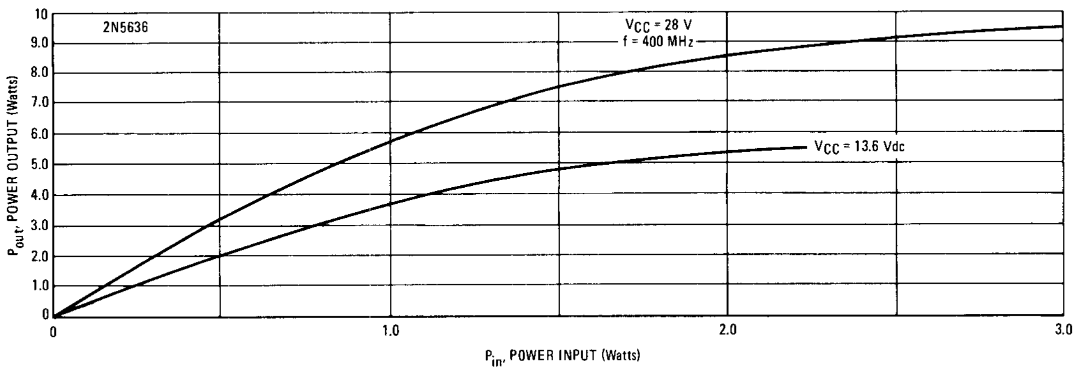
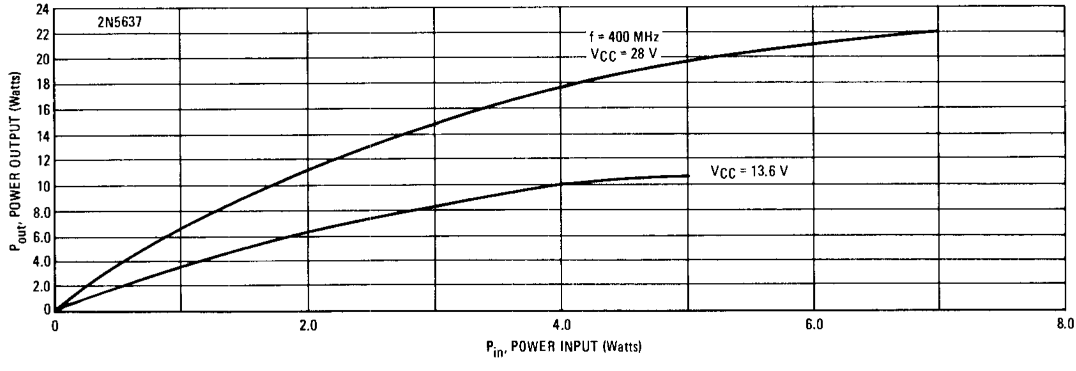


FIGURE 11



CIRCUIT DESIGN DATA

PARALLEL EQUIVALENT INPUT RESISTANCE versus FREQUENCY

FIGURE 12

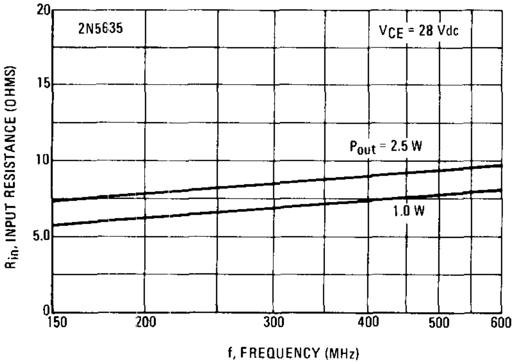


FIGURE 14

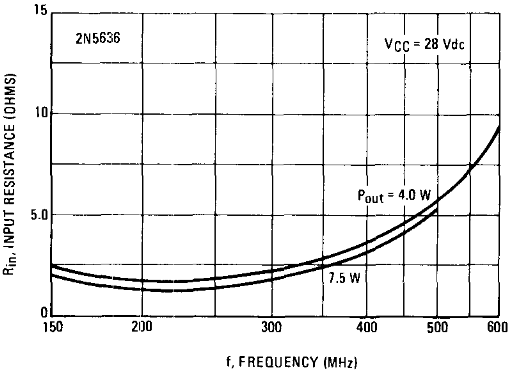
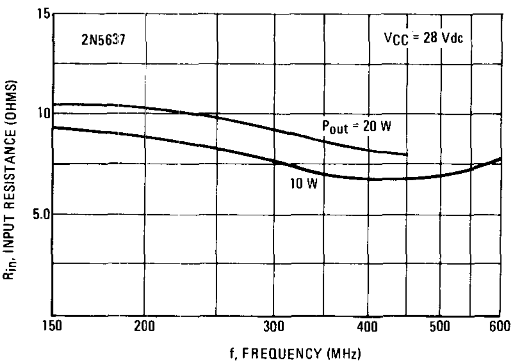


FIGURE 16



PARALLEL EQUIVALENT INPUT CAPACITANCE versus FREQUENCY

FIGURE 13

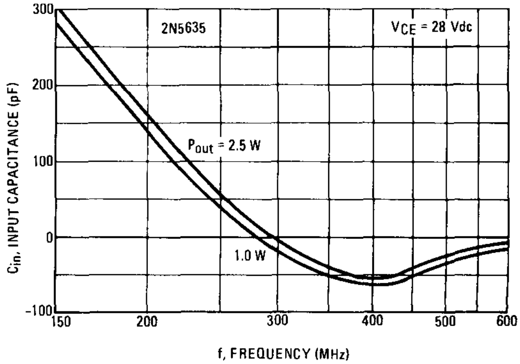


FIGURE 15

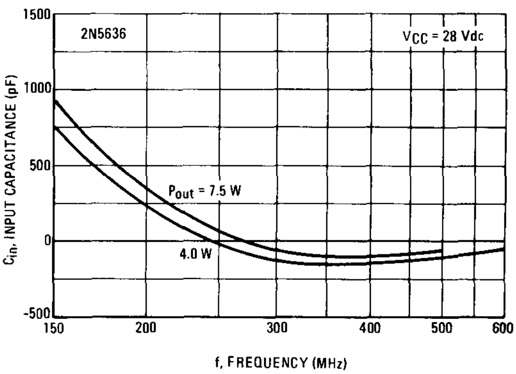
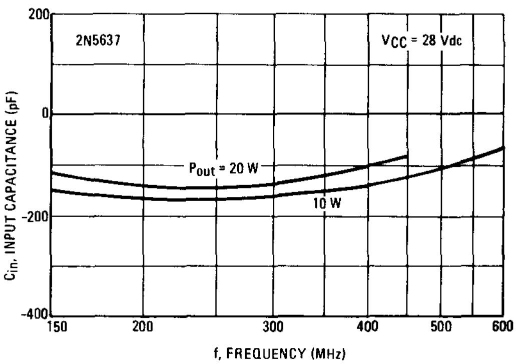


FIGURE 17



CIRCUIT DESIGN DATA

LARGE SIGNAL OUTPUT CAPACITANCE versus FREQUENCY

FIGURE 18

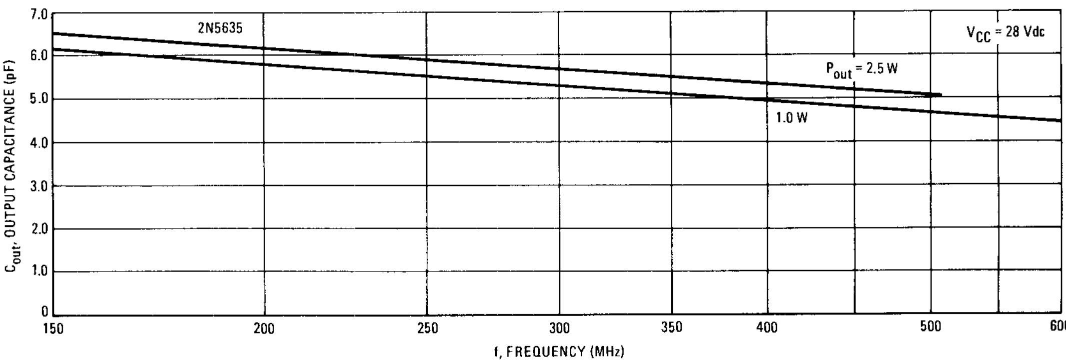


FIGURE 19

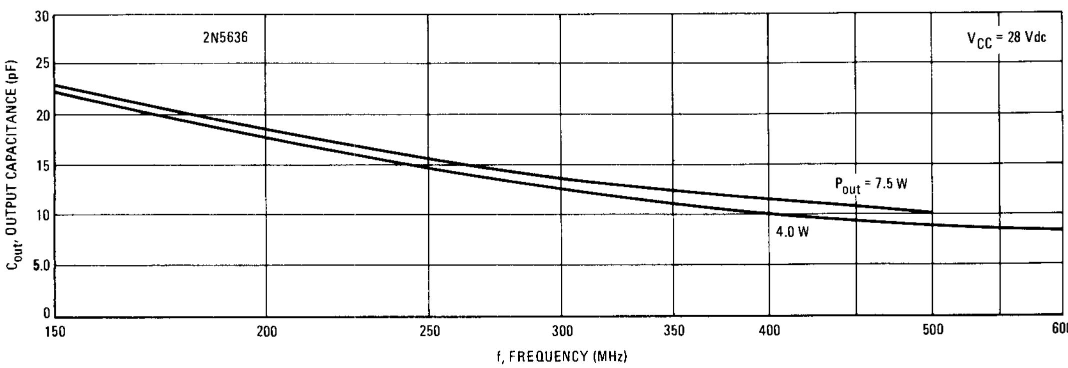
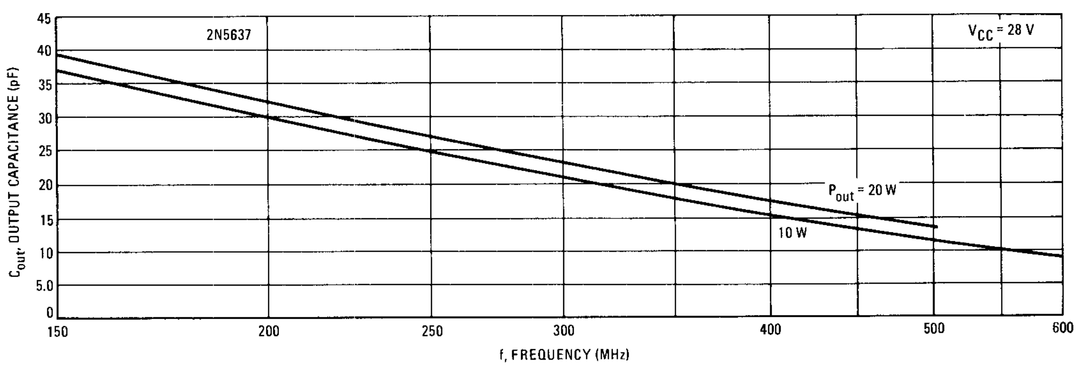


FIGURE 20



DC SAFE OPERATING AREA

FIGURE 21

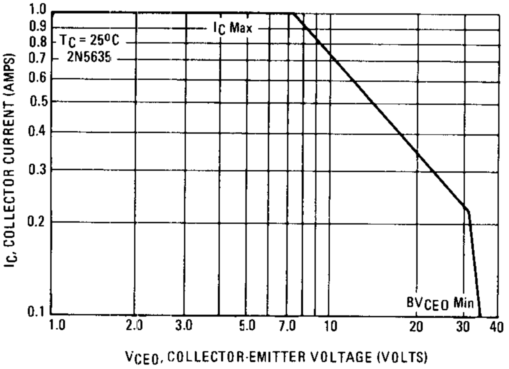


FIGURE 23

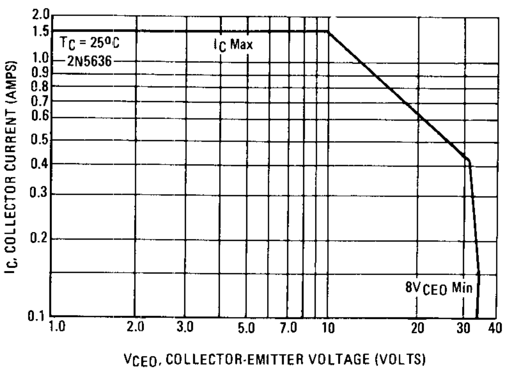
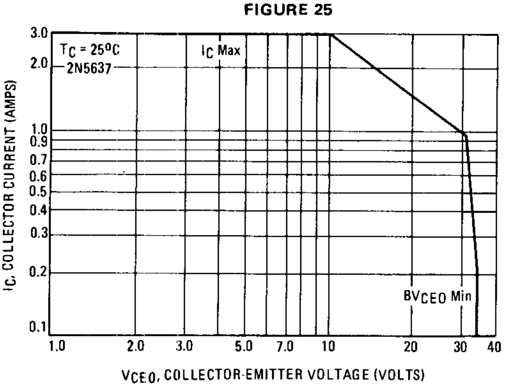


FIGURE 25



POWER DISSIPATION DERATING CURVE

FIGURE 22

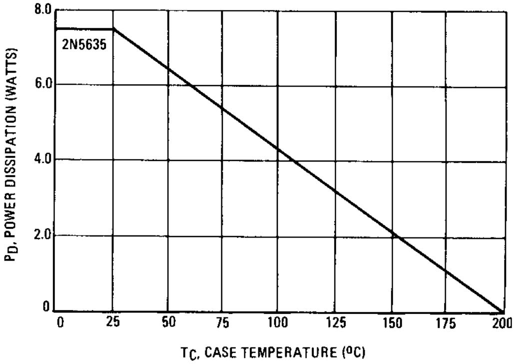


FIGURE 24

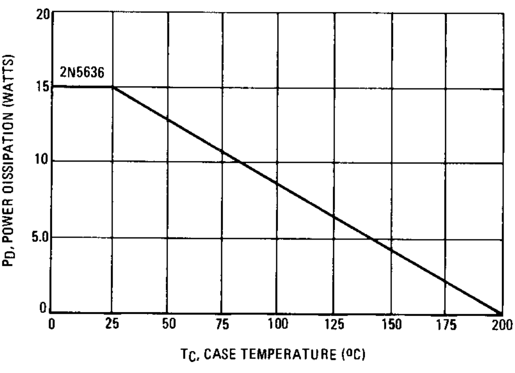
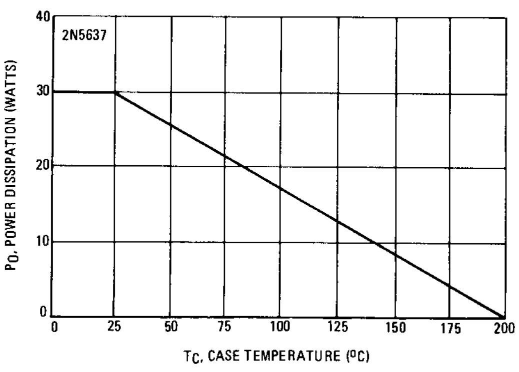


FIGURE 26



2N5638 (SILICON)
2N5639
2N5640

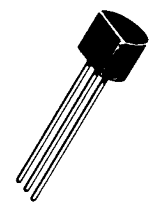
N-CHANNEL JUNCTION FIELD-EFFECT TRANSISTORS

. . . depletion mode (Type A) Junction Field-Effect Transistors designed for chopper and high-speed switching applications.

- Low Drain-Source "ON" Resistance –
  $r_{ds(on)}$ = 30 Ohms (2N5638)
  60 Ohms (2N5639)
  100 Ohms (2N5640)
- Low Reverse Transfer Capacitance –
  C_{rss} = 4.0 pF (Max) @ f = 1.0 MHz
- Fast Switching Characteristics –
  t_r = 5.0 ns (Max) (2N5638)

N-CHANNEL JUNCTION FIELD-EFFECT TRANSISTORS

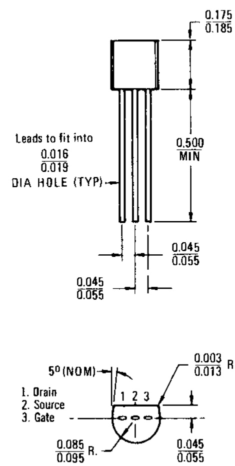
TYPE A



MAXIMUM RATINGS

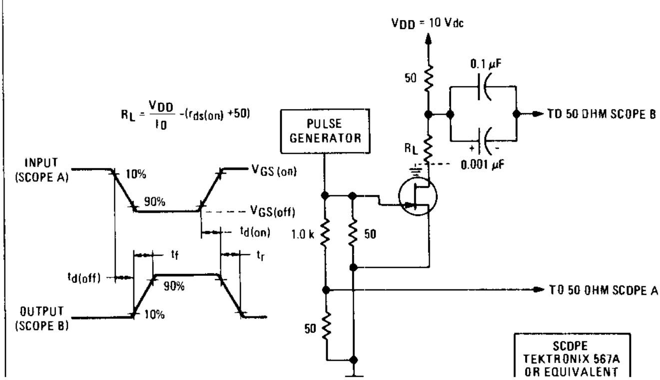
Rating	Symbol	Value	Unit
Drain-Source Voltage	V_{DS}	30	Vdc
*Drain-Gate Voltage	V_{DG}	30	Vdc
*Reverse Gate-Source Voltage	V_{GSR}	30	Vdc
*Forward Gate Current	I_{GF}	10	mAdc
*Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	310 2.82	mW mW/°C
*Storage Temperature Range	T_{stg}	-65 to +150	°C
Operating Junction Temperature Range	T_J	-65 to +135	°C

*Indicates JEDEC Registered Data.



Case 29 (5)
(TO-92)

FIGURE 1 – SWITCHING TIMES TEST CIRCUIT



*ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Gate-Source Breakdown Voltage (I_G = 10 μAdc, V_{DS} = 0)		$V_{(BR)GSS}$	30	–	Vdc
Gate Reverse Current		I_{GSS}			
(V_{GS} = -15 Vdc, V_{DS} = 0)			–	1.0	nAdc
(V_{GS} = -15 Vdc, V_{DS} = 0, T_A = 100°C)			–	1.0	μAdc
Drain Cutoff Current		$I_{D(off)}$			
(V_{DS} = 15 Vdc, V_{GS} = -12 Vdc)	2N5638		–	1.0	nAdc
(V_{DS} = 15 Vdc, V_{GS} = -8.0 Vdc)	2N5639		–	1.0	
(V_{DS} = 15 Vdc, V_{GS} = -6.0 Vdc)	2N5640		–	1.0	
(V_{DS} = 15 Vdc, V_{GS} = -12 Vdc, T_A = 100°C)	2N5638		–	1.0	μAdc
(V_{DS} = 15 Vdc, V_{GS} = -8.0 Vdc, T_A = 100°C)	2N5639		–	1.0	
(V_{DS} = 15 Vdc, V_{GS} = -6.0 Vdc, T_A = 100°C)	2N5640		–	1.0	
ON CHARACTERISTICS					
Zero-Gate Voltage Drain Current (Note 1)		I_{DSS}			mAdc
(V_{DS} = 20 Vdc, V_{GS} = 0)	2N5638		50	–	
	2N5639		25	–	
	2N5640		5.0	–	
Drain-Source "ON" Voltage		$V_{DS(on)}$			Vdc
(I_D = 12 mAdc, V_{GS} = 0)	2N5638		–	0.5	
(I_D = 6.0 mAdc, V_{GS} = 0)	2N5639		–	0.5	
(I_D = 3.0 mAdc, V_{GS} = 0)	2N5640		–	0.5	
Static Drain-Source "ON" Resistance		$r_{DS(on)}$			Ohms
(I_D = 1.0 mAdc, V_{GS} = 0)	2N5638		–	30	
	2N5639		–	60	
	2N5640		–	100	
SMALL-SIGNAL CHARACTERISTICS					
Static Drain-Source "ON" Resistance		$r_{ds(on)}$			Ohms
(V_{GS} = 0, I_D = 0, f = 1.0 kHz)	2N5638		–	30	
	2N5639		–	60	
	2N5640		–	100	
Input Capacitance (V_{DS} = 0, V_{GS} = -12 Vdc, f = 1.0 MHz)		C_{iss}	–	10	pF
Reverse Transfer Capacitance (V_{DS} = 0, V_{GS} = -12 Vdc, f = 1.0 MHz)		C_{rss}	–	4.0	pF

SWITCHING CHARACTERISTICS (Figure 1)

Characteristic	Conditions	$I_{D(on)}$	Device	Symbol	Min	Max	Unit
Turn-On Delay Time	V_{DD} = 10 Vdc, $V_{GS(on)}$ = 0, $V_{GS(off)}$ = -10 Vdc, R_G' = 50 ohms	$I_{D(on)}$ = 12 mAdc	2N5638	$t_{d(on)}$	–	4.0	ns
		6.0 mAdc	2N5639		–	6.0	
		3.0 mAdc	2N5640		–	8.0	
Rise Time		$I_{D(on)}$ = 12 mAdc	2N5638	t_r	–	5.0	ns
		6.0 mAdc	2N5639		–	8.0	
		3.0 mAdc	2N5640		–	10	
Turn-Off Delay Time		$I_{D(on)}$ = 12 mAdc	2N5638	$t_{d(off)}$	–	5.0	ns
		6.0 mAdc	2N5639		–	10	
		3.0 mAdc	2N5640		–	15	
Fall Time		$I_{D(on)}$ = 12 mAdc	2N5638	t_f	–	10	ns
		6.0 mAdc	2N5639		–	20	
		3.0 mAdc	2N5640		–	30	

*Indicates JEDEC Registered Data.

Note 1. Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 3.0%.

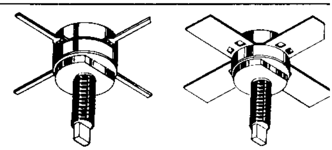
2N5641 (SILICON)
2N5642
2N5643

NPN SILICON RF POWER TRANSISTORS

. . . designed for VHF power amplifier or oscillator applications in military and industrial equipment. These devices are particularly suited for use in Class AB, B, or C amplifier applications to 400 MHz.

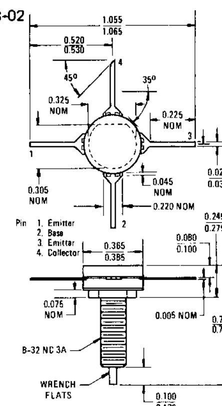
- Balanced Emitter Construction to provide the designer with the device technology that assures ruggedness and resists transistor damage caused by load mismatch.
- Stripline packaging for lower lead inductance and better broadband capability.
- Ceramic Packaging
- Specified 28 Volt, 175 MHz Characteristics –
  2N5641 – 7.0 Watts Output Power at 8.4 dB Gain
  2N5642 – 20 Watts Output Power at 8.2 dB Gain
  2N5643 – 40 Watts Output Power at 7.6 dB Gain

NPN SILICON
RF POWER
TRANSISTORS

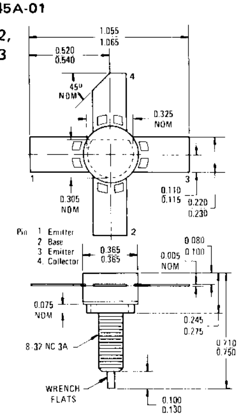


CASE 144B–02 2N5641 | CASE 145A-01 2N5642 2N5643

CASE 144B-02
2N5641



CASE 145A-01
2N5642,
2N5643



*MAXIMUM RATINGS

Rating	Symbol	2N5641	2N5642	2N5643	Unit
Collector-Emitter Voltage	V_{CEO}	←	35	→	Vdc
Collector-Base Voltage	V_{CB}	←	65	→	Vdc
Emitter-Base Voltage	V_{EB}	←	4.0	→	Vdc
Collector Current – Continuous	I_C	1.0	3.0	5.0	Adc
Total Device Dissipation @ $T_A = 25^{\circ}C$ Derate above $25^{\circ}C$	P_D	15 86	30 171	60 342	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}		-65 to +200		°C

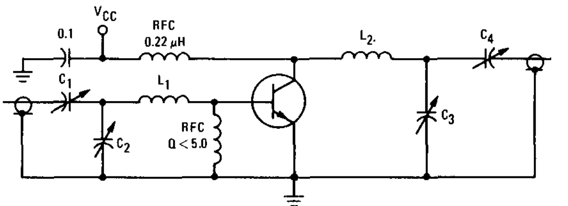
*Indicates JEDEC Registered Data.

*ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Collector-Emitter Breakdown Voltage (Note 1) (I_C = 200 mAdc, I_B = 0)		BV_{CEO}	35	–	–	Vdc
Collector-Emitter Breakdown Voltage (I_C = 200 mAdc, V_{BE} = 0)		BV_{CES}	65	–	–	Vdc
Emitter-Base Breakdown Voltage		BV_{EBO}				Vdc
(I_E = 5.0 mAdc, I_C = 0)	2N5641		4.0	–	–	
(I_E = 10 mAdc, I_C = 0)	2N5642,2N5643		4.0	–	–	
Collector Cutoff Current (V_{CB} = 30 Vdc, I_E = 0)		I_{CBO}	–	–	1.0	mAdc
ON CHARACTERISTICS						
DC Current Gain		h_{FE}				–
(I_C = 100 mAdc, V_{CE} = 5.0 Vdc)	2N5641		5.0	–	–	
(I_C = 200 mAdc, V_{CE} = 5.0 Vdc)	2N5642		5.0	–	–	
(I_C = 500 mAdc, V_{CE} = 5.0 Vdc)	2N5643		5.0	–	–	
DYNAMIC CHARACTERISTICS						
Output Capacitance		C_{ob}				pF
(V_{CB} = 30 Vdc, I_E = 0, f = 0.1 to 1.0 MHz)	2N5641		–	8.5	15	
	2N5642		–	22	35	
	2N5643		–	45	65	
FUNCTIONAL TEST						
Power Input (Figure 1)		P_{in}				Watts
(P_{out} = 7.0 Watts, V_{CE} = 28 Vdc, f = 175 MHz)	2N5641		–	0.4	1.0	
(P_{out} = 20 Watts, V_{CE} = 28 Vdc, f = 175 MHz)	2N5642		–	1.9	3.0	
(P_{out} = 40 Watts, V_{CE} = 28 Vdc, f = 175 MHz)	2N5643		–	5.0	7.0	
Common-Emitter Amplifier Power Gain (Figure 1)		G_{PE}				dB
(P_{out} = 7.0 Watts, V_{CE} = 28 Vdc, f = 175 MHz)	2N5641		8.4	12.5	–	
(P_{out} = 20 Watts, V_{CE} = 28 Vdc, f = 175 MHz)	2N5642		8.2	10.2	–	
(P_{out} = 40 Watts, V_{CE} = 28 Vdc, f = 175 MHz)	2N5643		7.6	8.1		
Collector Efficiency (Figure 1)		η				%
(P_{out} = 7.0 Watts, V_{CE} = 28 Vdc, f = 175 MHz)	2N5641		60	–	–	
(P_{out} = 20 Watts, V_{CE} = 28 Vdc, f = 175 MHz)	2N5642		60	–	–	
(P_{out} = 40 Watts, V_{CE} = 28 Vdc, f = 175 MHz)	2N5643		60	–	–	

Note 1: Pulsed through 25 mH inductor.
*Indicates JEDEC Registered Data.

FIGURE 1 – 175 MHz TEST CIRCUIT



2N5641	2N5642	2N5643
C_1, C_3, C_4 – 5.0 – 80 pF	C_1 – 3.0 – 30 pF	C_1, C_2, C_3, C_4 – ARCO 464 25-280 pF
C_2 – 9.0 – 180 pF	C_2, C_3, C_4 – 9.0 – 180 pF	L_1 – 1″ Straight #14 AWG
L_1 – 1¼″ Straight #14 AWG	L_1 – 1″ Straight #14 AWG	L_2 – 1 Turn #16 AWG, ¼″ I.D.
L_2 – 3 Turns #16 AWG, 14″ I.D.	L_2 – 1 Turn #16 AWG, ¼″ I.D.	

TYPICAL PERFORMANCE DATA

POWER OUTPUT versus FREQUENCY

FIGURE 2

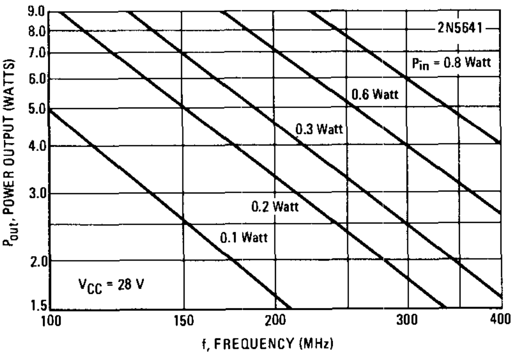


FIGURE 3

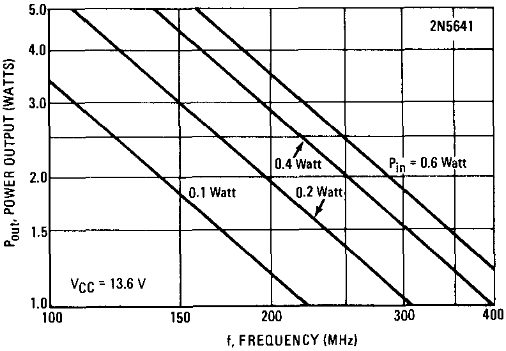


FIGURE 4

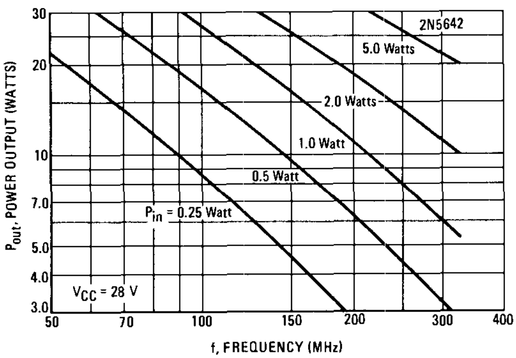


FIGURE 5

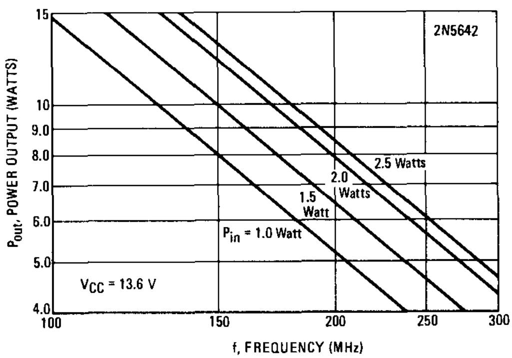


FIGURE 6

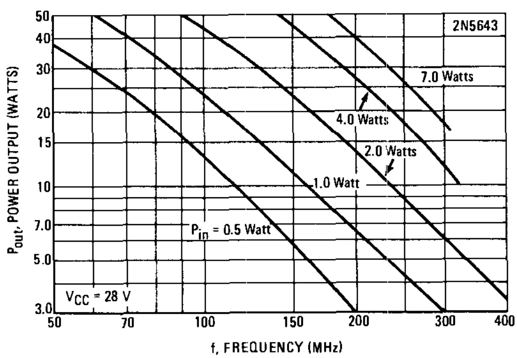
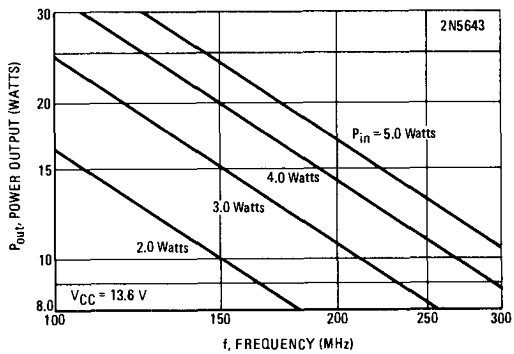


FIGURE 7



TYPICAL PERFORMANCE DATA
POWER OUTPUT versus POWER INPUT

FIGURE 8

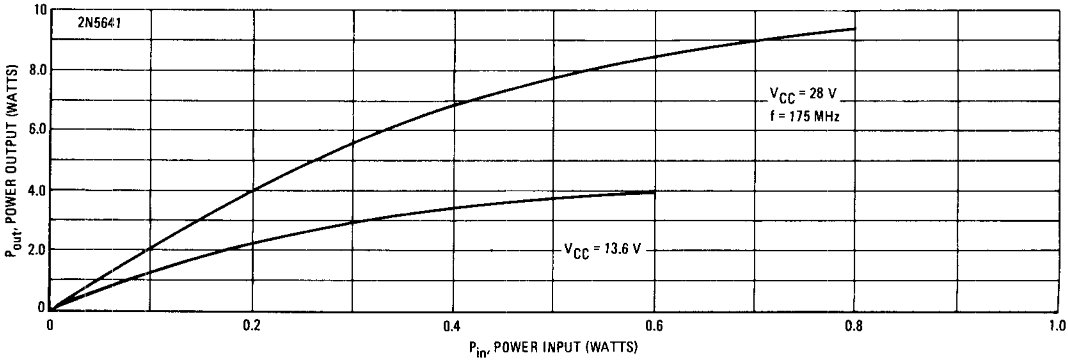


FIGURE 9

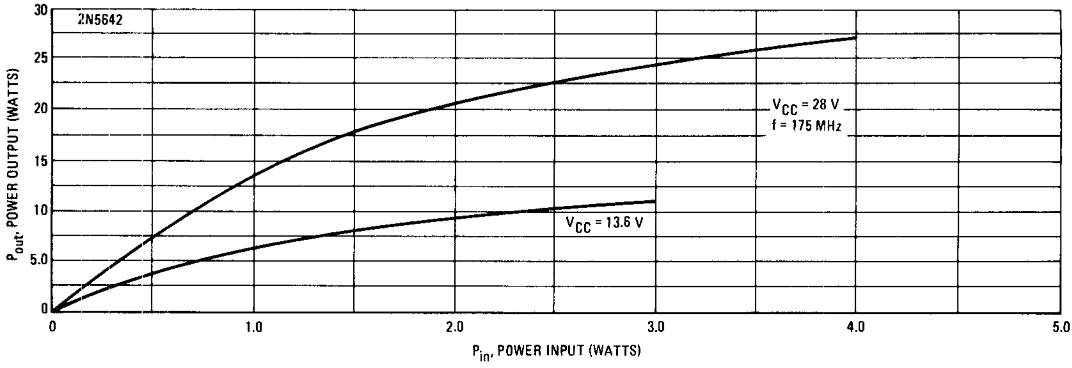
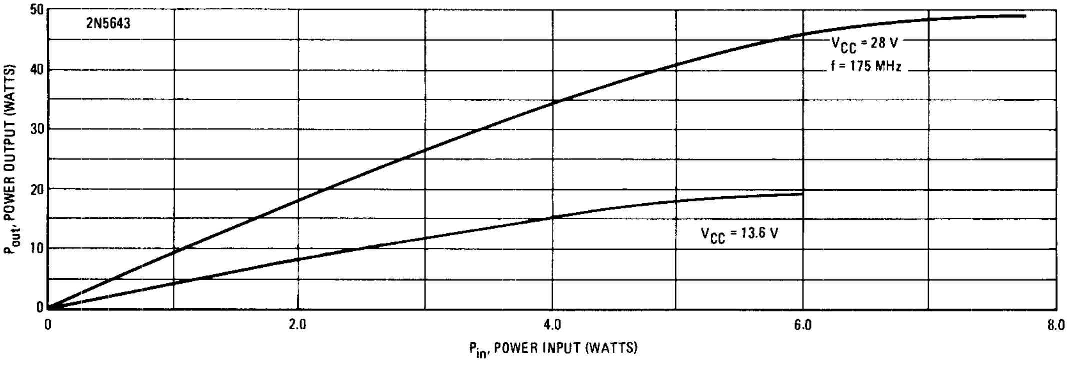


FIGURE 10



CIRCUIT DESIGN DATA

PARALLEL EQUIVALENT INPUT RESISTANCE versus FREQUENCY

FIGURE 11

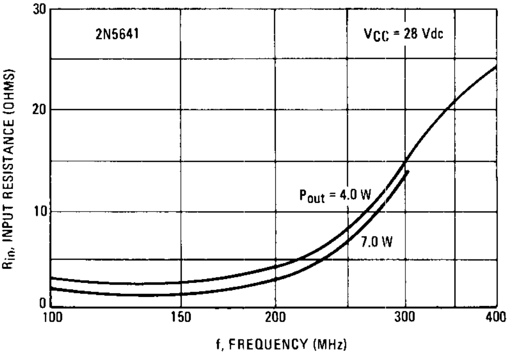


FIGURE 13

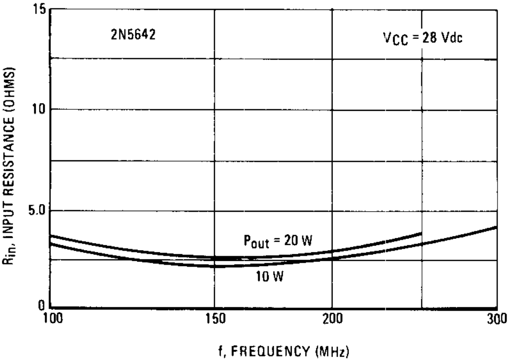
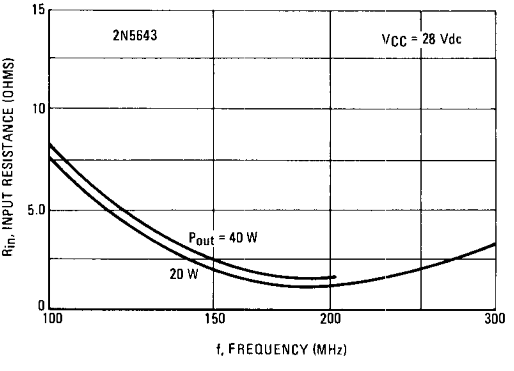


FIGURE 15



PARALLEL EQUIVALENT INPUT CAPACITANCE versus FREQUENCY

FIGURE 12

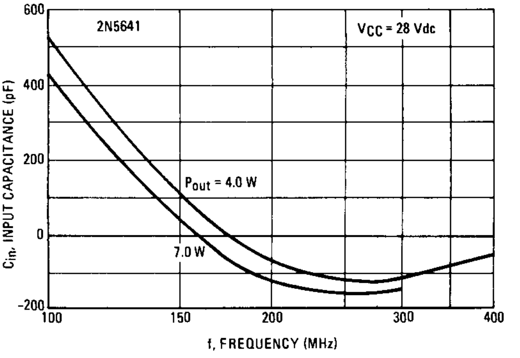


FIGURE 14

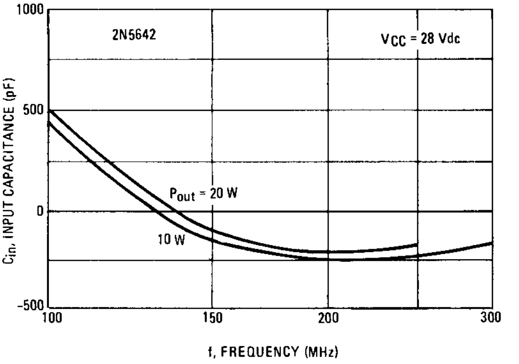
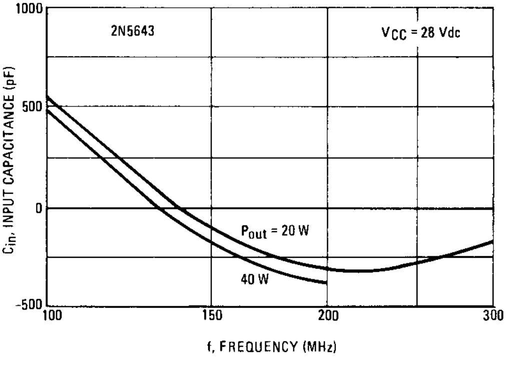


FIGURE 16



CIRCUIT DESIGN DATA

LARGE SIGNAL OUTPUT CAPACITANCE versus FREQUENCY

FIGURE 17

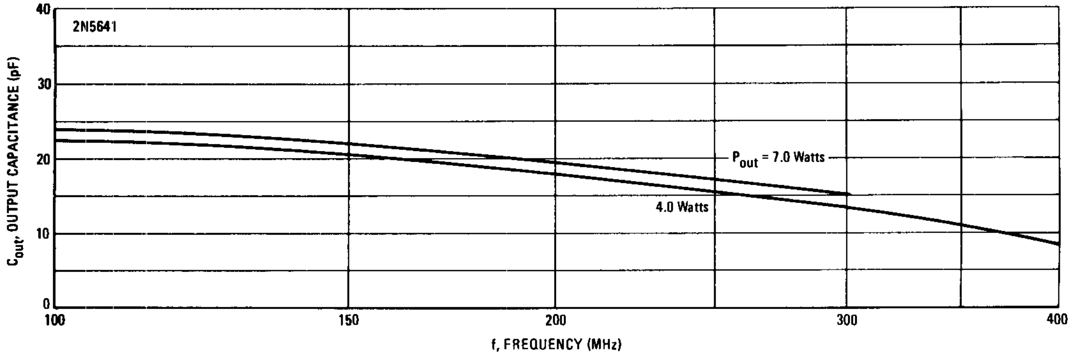


FIGURE 18

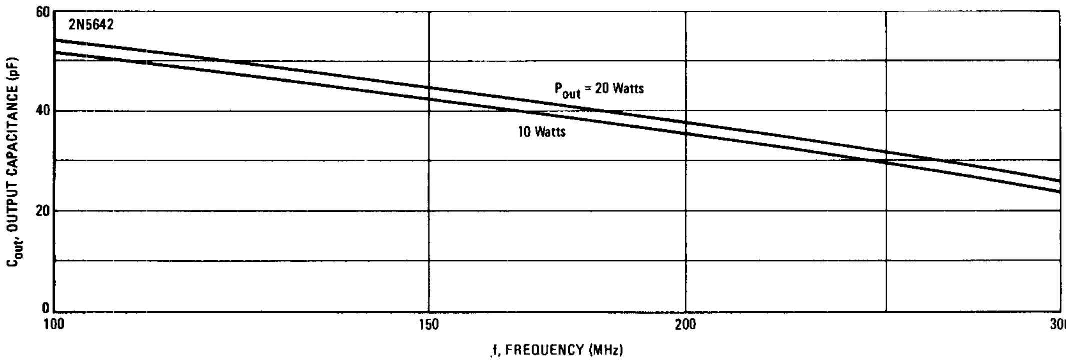
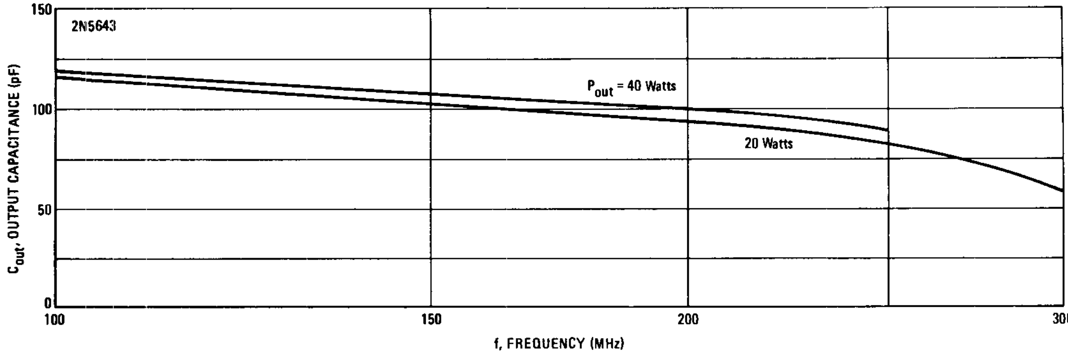


FIGURE 19



DC SAFE OPERATING AREA

FIGURE 20

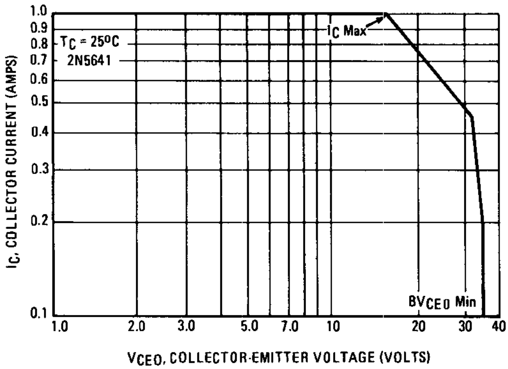


FIGURE 22

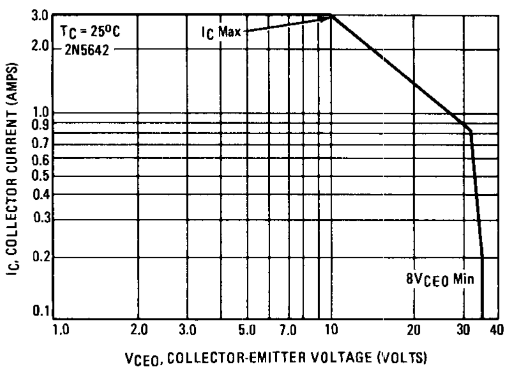
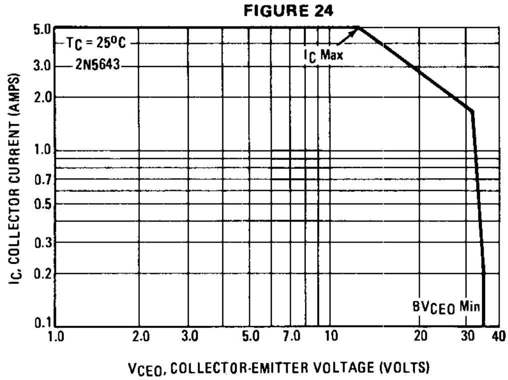


FIGURE 24



POWER DISSIPATION DERATING CURVE

FIGURE 21

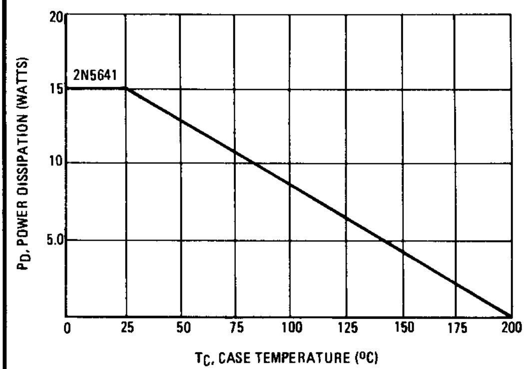


FIGURE 23

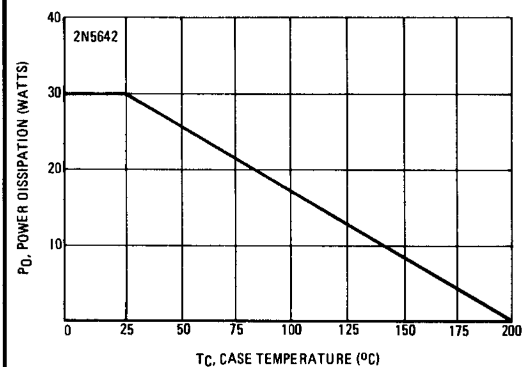
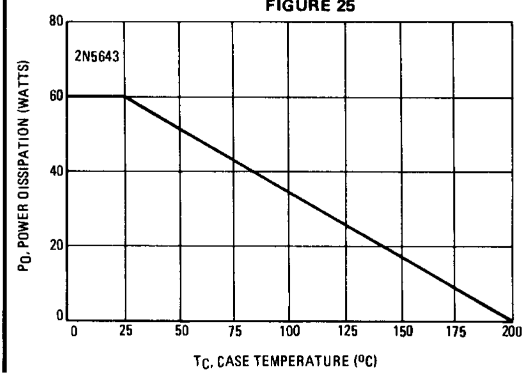


FIGURE 25



2N5653 (SILICON)
2N5654

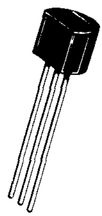
SILICON N-CHANNEL JUNCTION FIELD-EFFECT TRANSISTORS

Depletion Mode (Type A) Junction Field-Effect Transistors designed primarily for low-power, chopper and switching applications.

- Fast Switching Times — 2N5653
  $t_{d(on)}$ = 4.0 ns (Max)
  t_r = 5.0 ns (Max)
  $t_{d(off)}$ = 5.0 ns (Max)
  t_f = 10 ns (Max)
- Low Drain-Source "ON" Resistance —
  $r_{ds(on)}$ = 50 Ohms (Max) @ I_D = 1.0 mAdc - 2N5653
- Low Reverse Transfer Capacitance —
  C_{rss} = 3.5 pF (Max) @ V_{GS} = -12 Vdc

N-CHANNEL JUNCTION FIELD-EFFECT TRANSISTORS

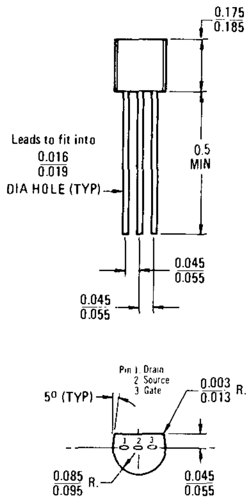
(Type A)



*MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain-Gate Voltage	V_{DG}	30	Vdc
Reverse Gate-Source Voltage	V_{GSR}	30	Vdc
Forward Gate Current	I_{GF}	10	mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	310 2.82	mW mW/°C
Storage Temperature Range	T_{stg}	-65 to +150	°C

*Indicates JEDEC Registered Data.



CASE 29 (5)
TO-92

Drain and Source may be Interchanged.

*ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Gate-Source Breakdown Voltage (I_G = 10 μAdc, V_{DS} = 0)	$V_{(BR)GSS}$	30	–	Vdc
Gate Reverse Current	I_{GSS}			
(V_{GS} = -15 Vdc, V_{DS} = 0)		–	1.0	nAdc
(V_{GS} = -15 Vdc, V_{DS} = 0, T_A = 100°C)		–	1.0	μAdc
Drain Cutoff Current	$I_{D(off)}$			
(V_{DS} = 15 Vdc, V_{GS} = -12 Vdc) 2N5653		–	1.0	nAdc
(V_{DS} = 15 Vdc, V_{GS} = -8.0 Vdc) 2N5654		–	1.0	
(V_{DS} = 15 Vdc, V_{GS} = -12 Vdc, T_A = 100°C) 2N5653		–	1.0	μAdc
(V_{DS} = 15 Vdc, V_{GS} = -8.0 Vdc, T_A = 100°C) 2N5654		–	1.0	
ON CHARACTERISTICS				
Zero-Gate Voltage Drain Current (Note 1)	I_{DSS}			mAdc
(V_{DS} = 20 Vdc, V_{GS} = 0) 2N5653		40	–	
2N5654		15	–	
Drain-Source "ON" Voltage	$V_{DS(on)}$			Vdc
(I_D = 10 mAdc, V_{GS} = 0) 2N5653		–	0.75	
(I_D = 5.0 mAdc, V_{GS} = 0) 2N5654		–	0.75	
SMALL-SIGNAL CHARACTERISTICS				
Static Drain-Source "ON" Resistance	$r_{ds(on)}$			Ohms
(V_{GS} = 0, I_D = 1.0 mAdc) 2N5653		–	50	
2N5654		–	100	
(V_{GS} = 0, I_D = 0, f = 1.0 kHz) 2N5653		–	50	
2N5654		–	100	
Input Capacitance (V_{DS} = 0, V_{GS} = -12 Vdc, f = 1.0 MHz)	C_{iss}	–	10	pF
Reverse Transfer Capacitance (V_{DS} = 0, V_{GS} = -12 Vdc, f = 1.0 MHz)	C_{rss}	–	3.5	pF

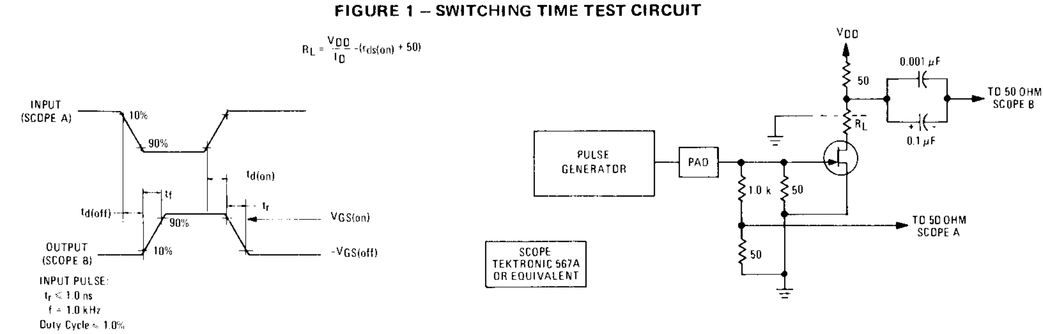
SWITCHING CHARACTERISTICS

Characteristic	Test Condition	Device	Symbol	Min	Max	Unit
Turn-On Delay Time	Test Condition for 2N5653: (V_{DD} = 10 Vdc, $V_{GS(on)}$ = 0, $V_{GS(off)}$ = -12 Vdc, $I_{D(on)}$ = 10 mAdc, R_G' = 50 Ohms)	2N5653	$t_{d(on)}$	–	4.0	ns
		2N5654		–	6.0	
Rise Time		2N5653	t_r	–	5.0	ns
		2N5654		–	8.0	
Turn-Off Delay Time	Test Condition for 2N5654: (V_{DD} = 10 Vdc, $V_{GS(on)}$ = 0, $V_{GS(off)}$ = -12 Vdc, $I_{D(on)}$ = 5.0 mAdc, R_G' = 50 Ohms) (Figure 1)	2N5653	$t_{d(off)}$	–	5.0	ns
		2N5654		–	10	
Fall Time		2N5653	t_f	–	10	ns
		2N5654		–	20	

*Indicates JEDEC Registered Data.

Note 1: Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 3.0%.

FIGURE 1 – SWITCHING TIME TEST CIRCUIT



2N5668 (SILICON)
2N5669
2N5670

SILICON N-CHANNEL JUNCTION FIELD-EFFECT TRANSISTORS

Depletion Mode (Type A) Junction Field-Effect Transistors designed for VHF amplifier and mixer applications.

- Low Cross Modulation and Intermodulation Distortion
- Drain and Source Interchangeable
- Low 100-MHz Noise Figure –
  NF = 2.5 dB (Max)
- Low Reverse Transfer and Input Capcitances –
  C_{rss} = 1.0 pF (Typ); C_{iss} = 4.7 pF (Typ)
- High Maximum Stable Gain Due to Drain and Gate Lead Separation

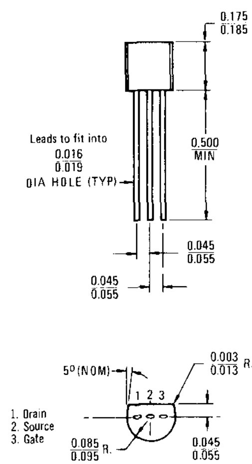
N-CHANNEL JUNCTION FIELD-EFFECT TRANSISTORS

(Type A)

*MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain-Source Voltage	V_{DS}	25	Vdc
*Drain-Gate Voltage	V_{DG}	25	Vdc
*Reverse Gate-Source Voltage	V_{GSR}	25	Vdc
*Forward Gate Current	I_{GF}	10	mAdc
Drain Current	I_D	20	mAdc
*Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	310 2.82	mW mW/°C
*Storage Temperature Range	T_{stg}	-65 to +150	°C

*Indicates JEDEC Registered Data.



BOTTOM VIEW
CASE 29 (5)
TO-92

Drain and Source may be Interchanged.

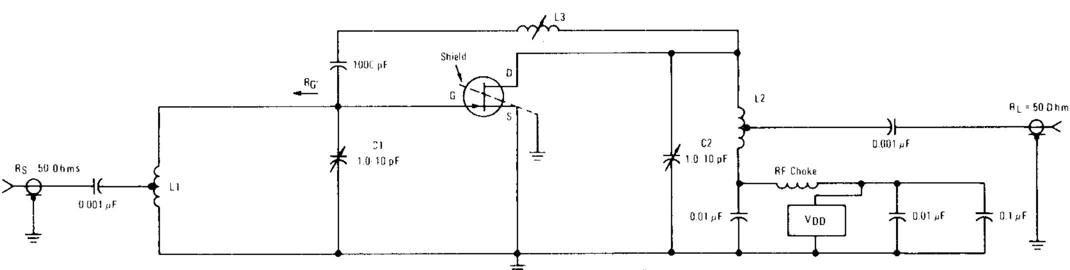
ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic		Symbol	Min	Typ	Max	Unit
***OFF CHARACTERISTICS**						
Gate-Source Breakdown Voltage (I_G = 10 μAdc, V_{DS} = 0)		$V_{(BR)GSS}$	25	–	–	Vdc
Gate-Source Cutoff Voltage (V_{DS} = 15 Vdc, I_D = 10 nAdc)	2N5668 2N5669 2N5670	$V_{GS(off)}$	0.2 1.0 2.0	– – –	4.0 6.0 8.0	Vdc
Gate Reverse Current (V_{GS} = -15 Vdc, V_{DS} = 0) (V_{GS} = -15 Vdc, V_{DS} = 0, T_A = 100°C)		I_{GSS}	– –	– –	2.0 2.0	nAdc μAdc
***ON CHARACTERISTICS**						
Zero-Gate Voltage Drain Current (Note 1) (V_{DS} = 15 Vdc, V_{GS} = 0)	2N5668 2N5669 2N5670	I_{DSS}	1.0 4.0 8.0	– – –	5.0 10 20	mAdc
SMALL-SIGNAL CHARACTERISTICS						
*Forward Transadmittance (V_{DS} = 15 Vdc, V_{GS} = 0, f = 1.0 kHz)	2N5668 2N5669 2N5670	$\|y_{fs}\|$	1500 2000 3000	– – –	6500 6500 7500	μmhos
*Forward Transconductance (V_{DS} = 15 Vdc, V_{GS} = 0, f = 100 MHz)	2N5668 2N5669 2N5670	$Re(y_{fs})$	1000 1600 2500	– – –	– – –	μmhos
*Output Admittance (V_{DS} = 15 Vdc, V_{GS} = 0, f = 1.0 kHz)	2N5668 2N5669 2N5670	$\|y_{os}\|$	– – –	– – –	20 50 75	μmhos
*Output Conductance (V_{DS} = 15 Vdc, V_{GS} = 0, f = 100 MHz)	2N5668 2N5669 2N5670	$Re(y_{os})$	– – –	10 25 35	50 100 150	μmhos
*Input Conductance (V_{DS} = 15 Vdc, V_{GS} = 0, f = 100 MHz)		$Re(y_{is})$	–	125	800	μmhos
*Input Capacitance (V_{DS} = 15 Vdc, V_{GS} = 0, f = 1.0 MHz)		C_{iss}	–	4.7	7.0	pF
*Reverse Transfer Capacitance (V_{DS} = 15 Vdc, V_{GS} = 0, f = 1.0 MHz)		C_{rss}	–	1.0	3.0	pF
Output Capacitance (V_{DS} = 15 Vdc, V_{GS} = 0, f = 1.0 MHz)		C_{oss}	–	1.4	4.0	pF
*Common Source Noise Figure (Figure 1) (V_{DS} = 15 Vdc, V_{GS} = 0, f = 100 MHz, at $R_{G'}$ = 1.0 k ohm)		NF	–	–	2.5	dB
Power Gain (Figure 1) (V_{DS} = 15 Vdc, V_{GS} = 0, f = 100 MHz)		G_{ps}	16	–	–	dB

*Indicates JEDEC Registered Data, excluding typical values.

Note 1: Pulse Test: Pulse With = 100 ms, Duty Cycle ≤ 10%.

FIGURE 1 — 100 MHz, POWER GAIN AND NOISE FIGURE TEST CIRCUIT



L1 ≈ 8.5 Turns of #14 AWG Tinned Copper, Dia. ≈ 3/8", ≈ 0.9" Long Tapped at ≈ 2 1/2 Turns (adjust to give R_G = 1.0 k ohm), Parallel Resistance ≈ 40 k ohms; tunes at ≈ 8.0 pF.

L2 ≈ 13.5 Turns #16 AWG Tinned Copper, Dia. ≈ 3/8", ≈ 1.2" Long. Tapped at ≈ 5 Turns, Parallel Resistance ≈ 40 k ohms, tunes at ≈ 4.0 pF

L3 ≈ 17 Turns of #28 AWG Enameled Copper Wire, Close Wound on 9/32" Ceramic Form, Tuning Provided by a Powdered Iron Slug

2N5679 (SILICON)
2N5680

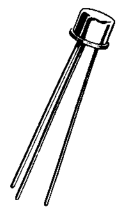
LOW-POWER PNP SILICON TRANSISTORS

. . . designed for use as a driver for high-power transistors in general-purpose amplifier and switching circuit applications.

- High Current-Gain—Bandwidth Product — f_T = 30 MHz (Min) @ I_C = 10 mAdc
- Low Collector-Emitter Saturation Voltage — $V_{CE(sat)}$ = 0.6 Vdc (Max) @ I_C = 0.25 Adc
- DC Current Gain Bracketed at 0.25 Adc
- Complement to NPN 2N5681 and 2N5682

1 AMPERE POWER TRANSISTORS PNP SILICON

100-120 VOLTS 10 WATTS



*MAXIMUM RATINGS

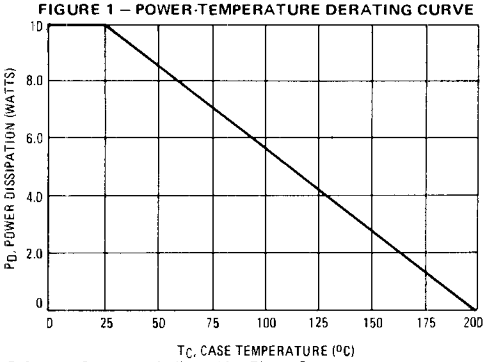
Rating	Symbol	2N5679	2N5680	Unit
Collector-Emitter Voltage	V_{CEO}	100	120	Vdc
Collector-Base Voltage	V_{CB}	100	120	Vdc
Emitter-Base Voltage	V_{EB}	4.0		Vdc
Collector Current — Continuous	I_C	1.0		Adc
Base Current	I_B	0.5		Adc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	1.0 0.0057		Watt W/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	10 0.057		Watts W/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	-65 to +200		°C

THERMAL CHARACTERISTICS

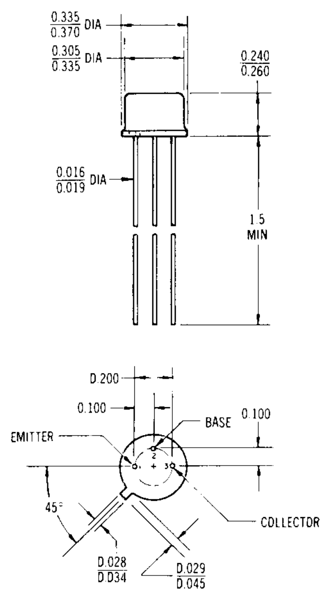
Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	θ_{JC}	17.5	°C/W
Thermal Resistance, Junction to Ambient	θ_{JA}	175	°C/W

*Indicates JEDEC Registered Data.

FIGURE 1 — POWER-TEMPERATURE DERATING CURVE



Safe Area Curves are indicated by Figure 2.
All limits are applicable and must be observed.



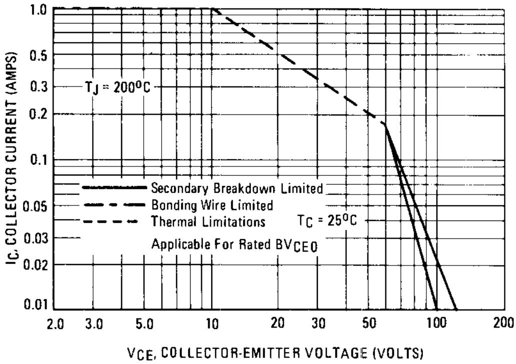
CASE 31 (1)
TO-5
Collector Connected to Case

*ELECTRICAL CHARACTERISTICS ($T_C = 25^oC$ unless otherwise noted)

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Sustaining Voltage (I_C = 10 mAdc, I_B = 0)	2N5679 2N5680	$V_{CEO(sus)}$	100 120	– –	Vdc
Collector Cutoff Current (V_{CE} = 70 Vdc, I_B = 0) (V_{CE} = 80 Vdc, I_B = 0)		I_{CEO}	– –	10 10	μAdc
Collector Cutoff Current (V_{CE} = 100 Vdc, $V_{BE(off)}$ = 1.5 Vdc) (V_{CE} = 120 Vdc, $V_{BE(off)}$ = 1.5 Vdc) (V_{CE} = 100 Vdc, $V_{BE(off)}$ = 1.5 Vdc, $T_C = 150^oC$) (V_{CE} = 120 Vdc, $V_{BE(off)}$ = 1.5 Vdc, $T_C = 150^oC$)	 2N5679 2N5680 2N5679 2N5680	I_{CEX}	 – – – –	 1.0 1.0 1.0 1.0	 μAdc mAdc
Collector Cutoff Current (V_{CB} = 100 Vdc, I_E = 0) (V_{CB} = 120 Vdc, I_E = 0)	 2N5679 2N5680	I_{CBO}	 – –	 1.0 1.0	μAdc
Emitter Cutoff Current (V_{BE} = 4.0 Vdc, I_C = 0)		I_{EBO}	–	1.0	μAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 250 mAdc, V_{CE} = 2.0 Vdc) (I_C = 1.0 Adc, V_{CE} = 2.0 Vdc)		h_{FE}	 40 5.0	 150 –	–
Collector-Emitter Saturation Voltage (I_C = 250 mAdc, I_B = 25 mAdc) (I_C = 500 mAdc, I_B = 50 mAdc) (I_C = 1.0 Adc, I_B = 200 mAdc)		$V_{CE(sat)}$	 – – –	 0.6 1.0 2.0	Vdc
Base-Emitter On Voltage (I_C = 250 mAdc, V_{CE} = 2.0 Vdc)		$V_{BE(on)}$	–	1.0	Vdc
DYNAMIC CHARACTERISTICS					
Current-Gain—Bandwidth Product (I_C = 100 mAdc, V_{CE} = 10 Vdc, f = 10 MHz)		f_T	30	–	–
Output Capacitance (V_{CB} = 20 Vdc, I_E = 0, f = 1.0 MHz)		C_{ob}	–	50	pF
Small-Signal Current Gain (I_C = 0.2 Adc, V_{CE} = 1.5 Vdc, f = 1.0 kHz)		h_{fe}	40	–	–

*Indicates JEDEC Registered Data.

FIGURE 2 – DC SAFE OPERATING AREA



The Safe Operating Area Curves indicate I_C–V_{CE} limits below which the device will not enter secondary breakdown. Collector load lines for specific circuits must fall within the applicable Safe Area to avoid causing a catastrophic failure. To insure operation below the maximum T_J, power-temperature derating must be observed for both steady state and pulse power conditions.

2N5681 (SILICON)
2N5682

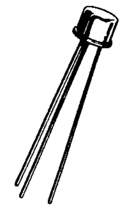
LOW-POWER NPN SILICON TRANSISTORS

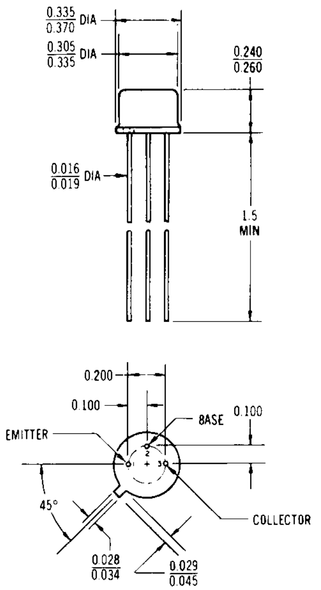
. . . designed for use as a driver for high-power transistors in general-purpose amplifier and switching circuit applications.

- High Current-Gain–Bandwidth Product – f_T = 30 MHz (Min) @ I_C = 10 mAdc
- Low Collector-Emitter Saturation Voltage – $V_{CE(sat)}$ = 0.6 Vdc (Max) @ I_C = 0.25 Adc
- DC Current Gain Bracketed at 0.25 Adc
- Complement to PNP 2N5679 and 2N5680

1 AMPERE
POWER TRANSISTORS
NPN SILICON

100-120 VOLTS
10 WATTS





CASE 31 (1)
TO-5
Collector Connected to Case

*MAXIMUM RATINGS

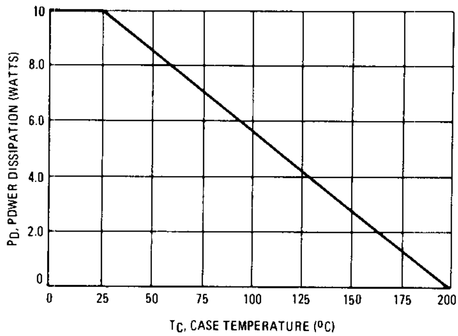
Rating	Symbol	2N5681	2N5682	Unit
Collector-Emitter Voltage	V_{CEO}	100	120	Vdc
Collector-Base Voltage	V_{CB}	100	120	Vdc
Emitter-Base Voltage	V_{EB}	4.0		Vdc
Collector Current – Continuous	I_C	1.0		Adc
Base Current	I_B	0.5		Adc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	1.0 0.0057		Watt W/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	10 0.057		Watts W/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	-65 to +200		°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	θ_{JC}	17.5	°C/W
Thermal Resistance, Junction to Ambient	θ_{JA}	175	°C/W

*Indicates JEDEC Registered Data.

FIGURE 1 – POWER-TEMPERATURE OERATING CURVE



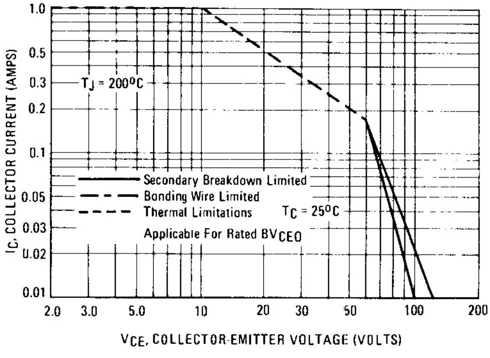
Safe Area Curves are indicated by Figure 2.
All limits are applicable and must be observed.

*ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Sustaining Voltage (I_C = 10 mAdc, I_B = 0)	2N5681 2N5682	$V_{CEO(sus)}$	100 120	– –	Vdc
Collector Cutoff Current (V_{CE} = 70 Vdc, I_B = 0) (V_{CE} = 80 Vdc, I_B = 0)		I_{CEO}	– –	10 10	μAdc
Collector Cutoff Current (V_{CE} = 100 Vdc, $V_{EB(off)}$ = 1.5 Vdc) (V_{CE} = 120 Vdc, $V_{EB(off)}$ = 1.5 Vdc) (V_{CE} = 100 Vdc, $V_{EB(off)}$ = 1.5 Vdc, T_C = 150°C) (V_{CE} = 120 Vdc, $V_{EB(off)}$ = 1.5 Vdc, T_C = 150°C)	2N5681 2N5682 2N5681 2N5682	I_{CEX}	– – – –	1.0 1.0 1.0 1.0	μAdc mAdc
Collector Cutoff Current (V_{CB} = 100 Vdc, I_E = 0) (V_{CB} = 120 Vdc, I_E = 0)	2N5681 2N5682	I_{CBO}	– –	1.0 1.0	μAdc
Emitter Cutoff Current (V_{BE} = 4.0 Vdc, I_C = 0)		I_{EBO}	–	1.0	μAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 250 mAdc, V_{CE} = 2.0 Vdc) (I_C = 1.0 Adc, V_{CE} = 2.0 Vdc)		h_{FE}	40 5.0	150 –	–
Collector-Emitter Saturation Voltage (I_C = 250 mAdc, I_B = 25 mAdc) (I_C = 500 mAdc, I_B = 50 mAdc) (I_C = 1.0 Adc, I_B = 200 mAdc)		$V_{CE(sat)}$	– – –	0.6 1.0 2.0	Vdc
Base-Emitter On Voltage (I_C = 250 mAdc, V_{CE} = 2.0 Vdc)		$V_{BE(on)}$	–	1.0	Vdc
DYNAMIC CHARACTERISTICS					
Current-Gain—Bandwidth Product (I_C = 100 mAdc, V_{CE} = 10 Vdc, f = 10 MHz)		f_T	30	–	–
Output Capacitance (V_{CB} = 20 Vdc, I_E = 0, f = 1.0 MHz)		C_{ob}	–	50	pF
Small-Signal Current Gain (I_C = 0.2 Adc, V_{CE} = 1.5 Vdc, f = 1.0 kHz)		h_{fe}	40	–	–

*Indicates JEDEC Registered Data.

FIGURE 2 – DC SAFE OPERATING AREA



The Safe Operating Area Curves indicate I_C–V_{CE} limits below which the device will not enter secondary breakdown. Collector load lines for specific circuits must fall within the applicable Safe Area to avoid causing a catastrophic failure. To insure operation below the maximum T_J, power-temperature derating must be observed for both steady state and pulse power conditions.

2N5683 (SILICON)
2N5684

HIGH CURRENT PNP SILICON TRANSISTORS

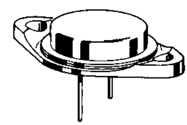
. . . designed for use in high-power amplifier and switching circuit applications.

- DC Current Gain – h_{FE} = 15 - 60 @ I_C = 25 Adc
- Low Collector-Emitter Saturation Voltage – $V_{CE(sat)}$ = 1.0 Vdc (Max) @ I_C = 25 Adc
- Complements to 2N5685, 2N5686

50 AMPERE POWER TRANSISTORS

PNP SILICON

60–80 VOLTS
300 WATTS



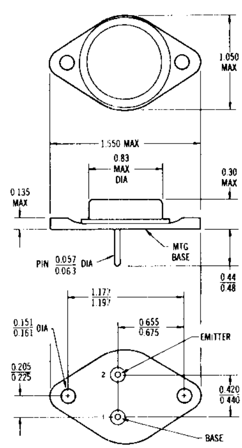
*MAXIMUM RATINGS

Rating	Symbol	2N5683	2N5684	Unit
Collector-Emitter Voltage	V_{CEO}	60	80	Vdc
Collector-Base Voltage	V_{CB}	60	80	Vdc
Emitter-Base Voltage	V_{EB}	5.0		Vdc
Collector Current – Continuous	I_C	50		Adc
Base Current	I_B	15		Adc
Total Device Dissipation @ $T_C = 25^oC$ Derate above 25^oC	P_D	300 1.715		Watts $W/^oC$
Operating and Storage Junction Temperature Range	T_J, T_{stg}	-65 to +200		^oC

*THERMAL CHARACTERISTICS

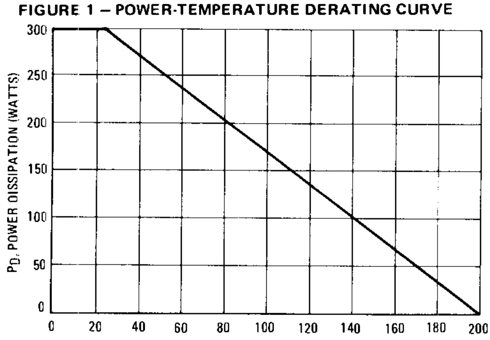
Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	θ_{JC}	0.584	$^oC/W$

*Indicates JEDEC Registered Data.



Collector Connected to Case
Case 197
TO-3 except Pin Diameter

FIGURE 1 – POWER-TEMPERATURE DERATING CURVE



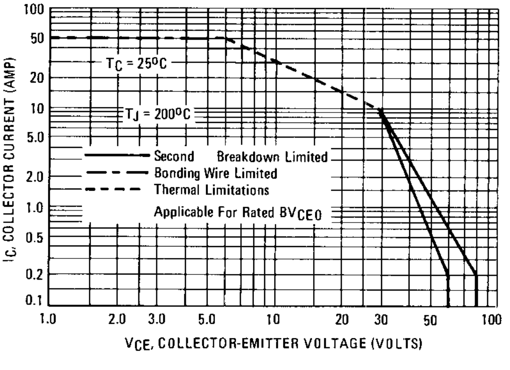
Safe Area Curves are indicated by Figure 2. All limits are applicable and must be observed.

*ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Sustaining Voltage (Note 1) (I_C = 0.2 Adc, I_B = 0)	2N5683 2N5684	$V_{CEO(sus)}$	60 80	– –	Vdc
Collector Cutoff Current (V_{CE} = 30 Vdc, I_B = 0) (V_{CE} = 40 Vdc, I_B = 0)	2N5683 2N5684	I_{CEO}	– –	1.0 1.0	mAdc
Collector Cutoff Current (V_{CE} = 60 Vdc, $V_{BE(off)}$ = 1.5 Vdc) (V_{CE} = 80 Vdc, $V_{BE(off)}$ = 1.5 Vdc) (V_{CE} = 60 Vdc, $V_{BE(off)}$ = 1.5 Vdc, T_C = 150°C) (V_{CE} = 80 Vdc, $V_{BE(off)}$ = 1.5 Vdc, T_C = 150°C)	2N5683 2N5684 2N5683 2N5684	I_{CEX}	– – – –	2.0 2.0 10 10	mAdc
Collector Cutoff Current (V_{CB} = 60 Vdc, I_E = 0) (V_{CB} = 80 Vdc, I_E = 0)	2N5683 2N5684	I_{CBO}	– –	2.0 2.0	mAdc
Emitter Cutoff Current (V_{BE} = 5.0 Vdc, I_C = 0)		I_{EBO}	–	5.0	mAdc
ON CHARACTERISTICS					
DC Current Gain (Note 1) (I_C = 25 Adc, V_{CE} = 2.0 Vdc) (I_C = 50 Adc, V_{CE} = 5.0 Vdc)		h_{FE}	15 5.0	60 –	–
Collector-Emitter Saturation Voltage (Note 1) (I_C = 25 Adc, I_B = 2.5 Adc) (I_C = 50 Adc, I_B = 10 Adc)		$V_{CE(sat)}$	– –	1.0 5.0	Vdc
Base-Emitter Saturation Voltage (Note 1) (I_C = 25 Adc, I_B = 2.5 Adc)		$V_{BE(sat)}$	–	2.0	Vdc
Base-Emitter On Voltage (Note 1) (I_C = 25 Adc, V_{CE} = 2.0 Vdc)		$V_{BE(on)}$	–	2.0	Vdc
DYNAMIC CHARACTERISTICS					
Current-Gain—Bandwidth Product (I_C = 5.0 Adc, V_{CE} = 10 Vdc, f = 1.0 MHz)		f_T	2.0	–	MHz
Output Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 0.1 MHz)		C_{ob}	–	2000	pF
Small-Signal Current Gain (I_C = 10 Adc, V_{CE} = 5.0 Vdc, f = 1.0 kHz)		h_{fe}	15	–	–

*Indicates JEDEC Registered Data
Note 1: Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

FIGURE 2 – DC SAFE OPERATING AREA



The Safe Operating Area Curves indicate I_C—V_{CE} limits below which the device will not enter secondary breakdown. Collector load lines for specific circuits must fall within the applicable Safe Area to avoid causing a catastrophic failure. To insure operation below the maximum T_J, power-temperature derating must be observed for both steady state and pulse power conditions.

2N5685 (SILICON)
2N5686

HIGH-CURRENT NPN SILICON TRANSISTORS

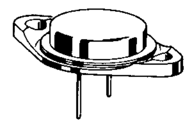
. . . designed for use in high-power amplifier and switching circuit applications.

- DC Current Gain –
  h_{FE} = 15 - 60 @ I_C = 25 Adc
- Low Collector-Emitter Saturation Voltage –
  $V_{CE(sat)}$ = 1.0 Vdc (Max) @ I_C = 25 Adc
- Complements to 2N5683 and 2N5684

50 AMPERE
POWER TRANSISTORS

NPN SILICON

60-80 VOLTS
300 WATTS



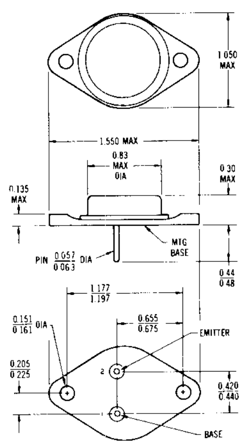
*MAXIMUM RATINGS

Rating	Symbol	2N5685	2N5686	Unit
Collector-Emitter Voltage	V_{CEO}	60	80	Vdc
Collector-Base Voltage	V_{CB}	60	80	Vdc
Emitter-Base Voltage	V_{EB}	5.0		Vdc
Collector Current – Continuous	I_C	50		Adc
Base Current	I_B	15		Adc
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	300 1.715		Watts W/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	-65 to +200		°C

*THERMAL CHARACTERISTICS

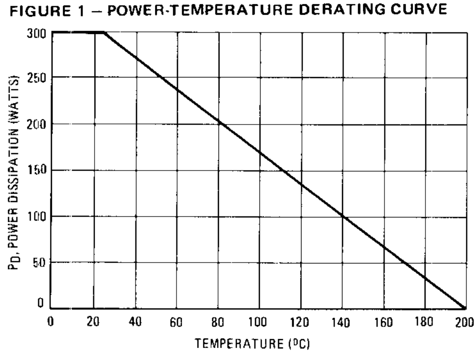
Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	θ_{JC}	0.584	°C/W

*Indicates JEDEC Registered Data.



Collector Connected to Case
Case 197
TO-3 except Pin Diameter

FIGURE 1 – POWER-TEMPERATURE DERATING CURVE



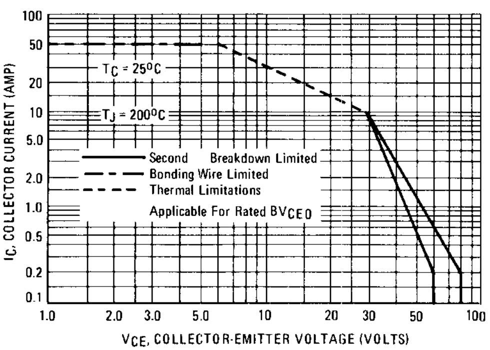
Safe Area Curves are indicated by Figure 2. All limits are applicable and must be observed.

*ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Sustaining Voltage (Note 1)		$V_{CEO(sus)}$			Vdc
(I_C = 0.2 Adc, I_B = 0)	2N5685		60	–	
	2N5686		80	–	
Collector Cutoff Current		I_{CEO}			mAdc
(V_{CE} = 30 Vdc, I_B = 0)	2N5685		–	1.0	
(V_{CE} = 40 Vdc, I_B = 0)	2N5686		–	1.0	
Collector Cutoff Current		I_{CEX}			mAdc
(V_{CE} = 60 Vdc, $V_{EB(off)}$ = 1.5 Vdc)	2N5685		–	2.0	
(V_{CE} = 80 Vdc, $V_{EB(off)}$ = 1.5 Vdc)	2N5686		–	2.0	
(V_{CE} = 60 Vdc, $V_{EB(off)}$ = 1.5 Vdc, T_C = 150°C)	2N5685		–	10	
(V_{CE} = 80 Vdc, $V_{EB(off)}$ = 1.5 Vdc, T_C = 150°C)	2N5686		–	10	
Collector Cutoff Current		I_{CBO}			mAdc
(V_{CB} = 60 Vdc, I_E = 0)	2N5685		–	2.0	
(V_{CB} = 80 Vdc, I_E = 0)	2N5686		–	2.0	
Emitter Cutoff Current (V_{BE} = 5.0 Vdc, I_C = 0)		I_{EBO}	–	5.0	mAdc
ON CHARACTERISTICS					
DC Current Gain (Note 1)		h_{FE}			–
(I_C = 25 Adc, V_{CE} = 2.0 Vdc)			15	60	
(I_C = 50 Adc, V_{CE} = 5.0 Vdc)			5.0	–	
Collector-Emitter Saturation Voltage (Note 1)		$V_{CE(sat)}$			Vdc
(I_C = 25 Adc, I_B = 2.5 Adc)			–	1.0	
(I_C = 50 Adc, I_B = 10 Adc)			–	5.0	
Base-Emitter Saturation Voltage (Note 1) (I_C = 25 Adc, I_B = 2.5 Adc)		$V_{BE(sat)}$	–	2.0	Vdc
Base-Emitter On Voltage (Note 1) (I_C = 25 Adc, V_{CE} = 2.0 Vdc)		$V_{BE(on)}$	–	2.0	Vdc
DYNAMIC CHARACTERISTICS					
Current-Gain—Bandwidth Product (I_C = 5.0 Adc, V_{CE} = 10 Vdc, f = 1.0 MHz)		f_T	2.0	–	MHz
Output Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 0.1 MHz)		C_{ob}	–	1200	pF
Small-Signal Current Gain (I_C = 10 Adc, V_{CE} = 5.0 Vdc, f = 1.0 kHz)		h_{fe}	15	–	

*Indicates JEDEC Registered Data
Note 1: Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

FIGURE 2 — DC SAFE OPERATING AREA



The Safe Operating Area Curves indicate I_C—V_{CE} limits below which the device will not enter secondary breakdown. Collector load lines for specific circuits must fall within the applicable Safe Area to avoid causing a catastrophic failure. To insure operation below the maximum T_J, power-temperature derating must be observed for both steady state and pulse power conditions.

3N169 (SILICON)
3N170
3N171

SILICON N-CHANNEL MOS FIELD-EFFECT TRANSISTORS

Enhancement Mode (Type C) transistors designed for low-power switching applications.

- Low Switching Voltages – $V_{GS(th)} \leqslant 3.0$ Vdc
- Fast Switching Times – $t_r \leqslant 10$ ns
- Low Drain-Source Resistance $r_{ds(on)}$ = 200 Ohms (Max)
- Low Reverse Transfer Capacitance C_{rss} = 1.3 pF (Max)
- Manufactured Using the New Silicon Nitride Process Resulting in a Stable $V_{GS(th)}$ and Gate Oxide Breakdown Protection to Typical Transients of ±150 Volts Peak

MOS FIELD-EFFECT TRANSISTORS

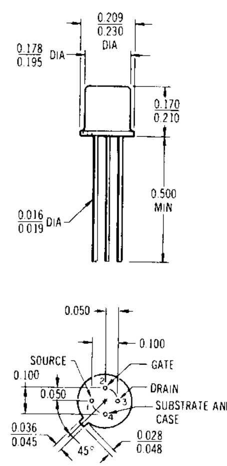
N-CHANNEL

TYPE C

MAXIMUM RATINGS (T_A = 25°C unless otherwise noted)

Rating	Symbol	Value	Unit
*Drain-Source Voltage	V_{DS}	25	Vdc
*Drain-Gate Voltage	V_{DG}	±35	Vdc
*Gate-Source Voltage	V_{GS}	±35	Vdc
*Drain Current	I_D	30	mAdc
Power Dissipation @ T_A = 25°C Derate above 25°C	P_D	300 1.7	mW mW/°C
*Power Dissipation @ T_C = 25°C *Derate above 25°C	P_D	800 4.56	mW mW/°C
Operating Junction Temperature	T_J	175	°C
*Storage Temperature Range	T_{stg}	-65 to +200	°C

*Indicates JEDEC Registered Data.



TO-72
CASE 20 (2)

HANDLING PRECAUTIONS:

MOS field-effect transistors have extremely high input resistance. They can be damaged by the accumulation of excess static charge. Avoid possible damage to the devices while handling, testing, or in actual operation, by following the procedures outlined below:

1. To avoid the build-up of static charge, the leads of the devices should remain shorted together with a metal ring except when being tested or used.
2. Avoid unnecessary handling. Pick up devices by the case instead of the leads.
3. Do not insert or remove devices from circuits with the power on because transient voltages may cause permanent damage to the devices.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Substrate connected to source.

Characteristic	Figure No.	Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Drain-Source Breakdown Voltage (I_D = 10 μAdc, V_{GS} = 0)	—	$V_{(BR)DSS}$	25	—	Vdc
*Gate Leakage Current	—	I_{GSS}			pAdc
(V_{GS} = −35 Vdc, V_{DS} = 0)			—	10	
(V_{GS} = −35 Vdc, V_{DS} = 0, T_A = 125°C)			—	100	
*Zero-Gate-Voltage Drain Current	—	I_{DSS}			nAdc
(V_{DS} = 10 Vdc, V_{GS} = 0)			—	10	
(V_{DS} = 10 Vdc, V_{GS} = 0, T_A = 125°C)			—	1.0	μAdc
***ON CHARACTERISTICS**					
Gate-Source Threshold Voltage (V_{DS} = 10 Vdc, I_D = 10 μAdc) 3N169	—	$V_{GS(th)}$	0.5	1.5	Vdc
3N170			1.0	2.0	
3N171			1.5	3.0	
"ON" Drain Current (V_{GS} = 10 Vdc, V_{DS} = 10 Vdc)	3	$I_{D(on)}$	10	—	mAdc
Drain-Source "ON" Voltage (I_D = 10 mAdc, V_{GS} = 10 Vdc)	—	$V_{DS(on)}$	—	2.0	Vdc
SMALL SIGNAL CHARACTERISTICS					
*Drain-Source Resistance (V_{GS} = 10 Vdc, I_D = 0, f = 1.0 kHz)	4	$r_{ds(on)}$	—	200	Ohms
Forward Transfer Admittance (V_{DS} = 10 Vdc, I_D = 2.0 mAdc, f = 1.0 kHz)	1	$\lvert y_{fs} \rvert$	1000	—	μmhos
*Reverse Transfer Capacitance (V_{DS} = 0, V_{GS} = 0, f = 1.0 MHz)	2	C_{rss}	—	1.3	pF
*Input Capacitance (V_{DS} = 10 Vdc, V_{GS} = 0, f = 1.0 MHz)	2	C_{iss}	—	5.0	pF
*Drain-Substrate Capacitance ($V_{D(SUB)}$ = 10 Vdc, f = 1.0 MHz)	—	$C_{d(sub)}$	—	5.0	pF
***SWITCHING CHARACTERISTICS** (V_{DD} = 10 Vdc, $I_{D(on)}$ = 10 mAdc, $V_{GS(on)}$ = 10 Vdc, $V_{GS(off)}$ = 0, R_G' = 50 Ohms)					
Turn-On Delay Time	6,10	$t_{d(on)}$	—	3.0	ns
Rise Time	7,10	t_r	—	10	ns
Turn-Off Delay Time	8,10	$t_{d(off)}$	—	3.0	ns
Fall Time	9,10	t_f	—	15	ns

*Indicates JEDEC Registered Data.

FIGURE 1 — FORWARD TRANSFER ADMITTANCE

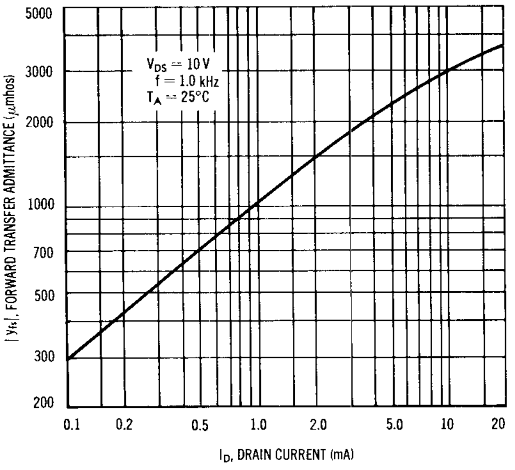


FIGURE 2 — CAPACITANCE

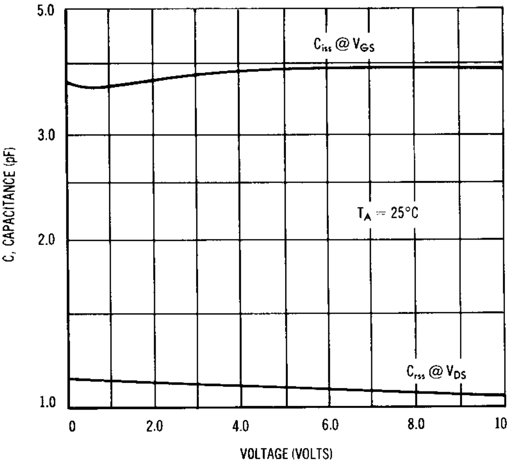


FIGURE 3 – TRANSFER CHARACTERISTICS

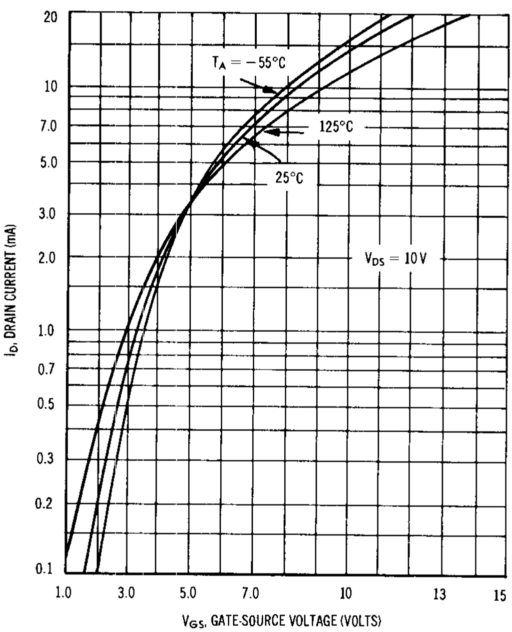


FIGURE 4 – DRAIN-SOURCE "ON" RESISTANCE

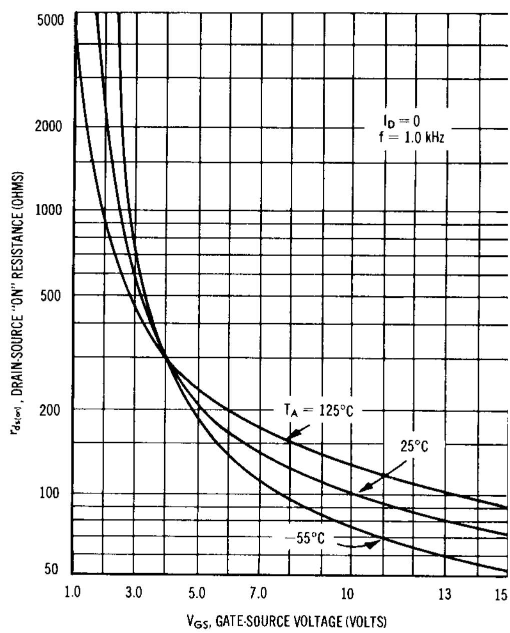
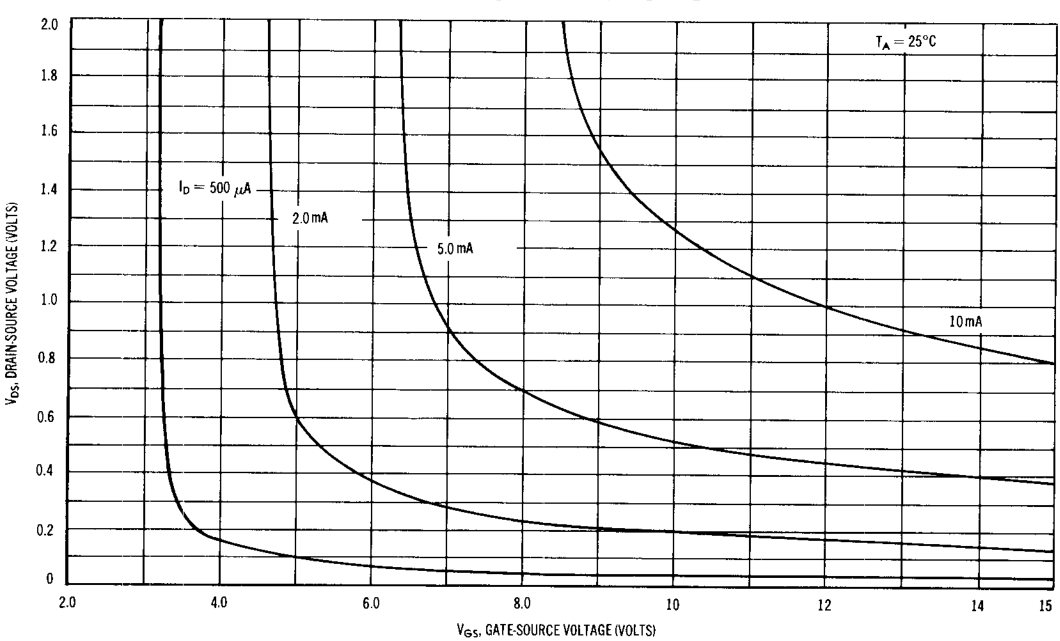


FIGURE 5 – "ON" DRAIN-SOURCE VOLTAGE



TYPICAL SWITCHING CHARACTERISTICS
$T_A = 25^oC$

FIGURE 6 – TURN-ON DELAY TIME

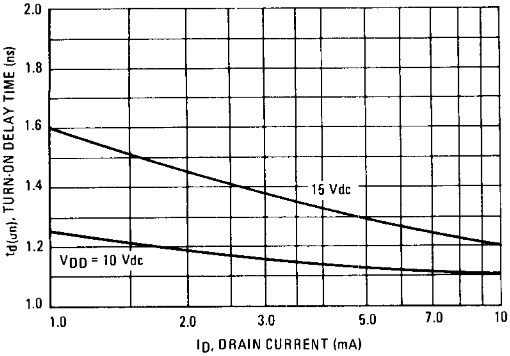


FIGURE 7 – RISE TIME

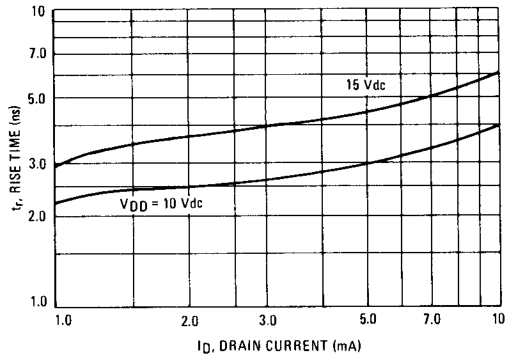


FIGURE 8 – TURN-OFF DELAY TIME

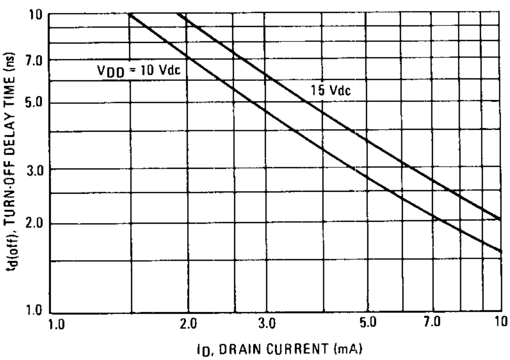


FIGURE 9 – FALL TIME

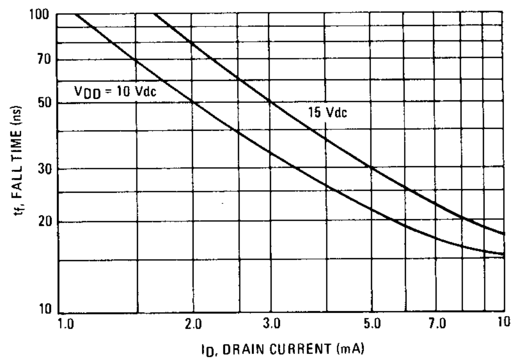
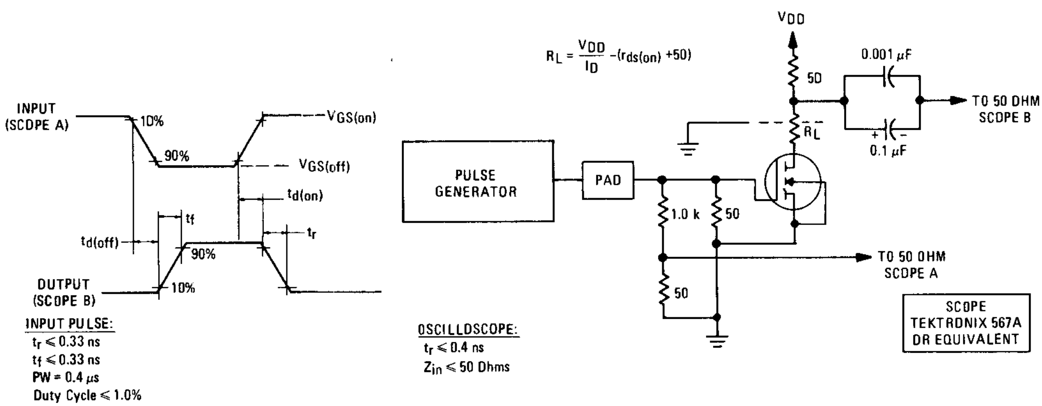


FIGURE 10 – SWITCHING TIME TEST CIRCUIT



HOUSE NUMBERED DEVICE SPECIFICATIONS

DIODES
RECTIFIERS
RECTIFIER ASSEMBLIES
THYRISTORS
TRANSISTORS

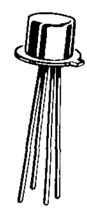
AF239 (GERMANIUM)

PNP GERMANIUM AMPLIFIER TRANSISTOR

. . . designed for use in UHF RF amplifier and autodyne converter applications.

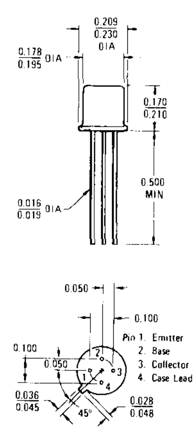
- Forward AGC Capability
- Unneutralized 800 MHz Power Gain — 14 dB (Typ)
- Noise Figure — NF = 5.0 dB (Typ) @ f = 800 MHz
- Low Collector Base Time Constant — $r_b'C_c$ = 2.0 ps (Typ)

SELECTIVE METAL ETCH PNP GERMANIUM AMPLIFIER TRANSISTOR



MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	15	Vdc
Collector-Base Voltage	V_{CB}	20	Vdc
Emitter-Base Voltage	V_{EB}	0.3	Vdc
Collector Current — Continuous	I_C	10	mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	60 0.8	mW mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	-65 to +100	°C

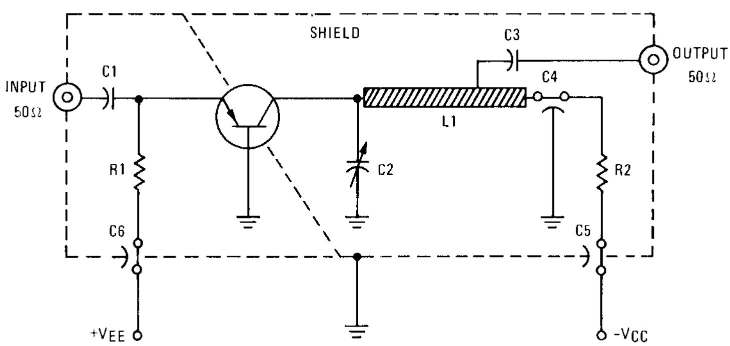


CASE 20 (10)
TO-72 PACKAGE

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector Cutoff Current (V_{CE} = 15 Vdc, I_B = 0)	I_{CEO}	–	–	500	μAdc
Collector Cutoff Current (V_{CB} = 20 Vdc, I_E = 0)	I_{CBO}	–	–	8.0	μAdc
Emitter Cutoff Current (V_{BE} = 0.3 Vdc, I_C = 0)	I_{EBO}	–	–	100	μAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 1.5 mAdc, V_{CE} = 12 Vdc)	h_{FE}	15	40	–	–
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain–Bandwidth Product (I_C = 1.5 mAdc, V_{CE} = 12 Vdc, f = 100 MHz)	f_T	600	770	–	MHz
Common-Emitter Reverse Transfer Capacitance (V_{CE} = 12 Vdc, I_E = 0, f = 1.0 MHz)	C_{re}	–	0.23	0.30	pF
Collector-Base Time Constant (I_E = 1.5 mAdc, V_{CB} = 12 Vdc, f = 31.8 MHz)	$r_b'C_c$	–	2.0	5.0	ps
Noise Figure (Figure 1)	NF				dB
(I_C = 1.5 mAdc, V_{CE} = 12 Vdc, R_S = 50 ohms, f = 800 MHz)		–	5.0	6.0	
(I_C = 1.5 mAdc, V_{CE} = 12 Vdc, R_S = 50 ohms, f = 860 MHz)		–	–	6.7	
FUNCTIONAL TEST					
Common-Base Amplifier Power Gain (Figure 1)	G_{pb}				dB
(I_C = 1.5 mAdc, V_{CE} = 12 Vdc, f = 800 MHz)		11.2	14	–	
(I_C = 1.5 mAdc, V_{CE} = 12 Vdc, f = 860 MHz)		–	13.2	–	

FIGURE 1 – 800 MHz POWER GAIN AND NOISE FIGURE TEST CIRCUIT



C1, C3 – 10 pF DUR-MICA
C4, C5, C6 – 240 pF FEEDTHROUGH ERIE OR EQUIVALENT
C2 – 0.4-6.0 pF JOHANSEN OR EQUIVALENT
R1 – 2.2 kΩ, 0.25 W
R2 – 100Ω, 0.25 W
L1 – SILVER PLATED BRASS STRIP 0.08" WIDE, 0.025" THICK. APPROX. LENGTH 1" – TAP @ 1/3 LENGTH

COMMON-BASE y PARAMETERS
$T_A = 25^oC$

FIGURE 2 – INPUT ADMITTANCE

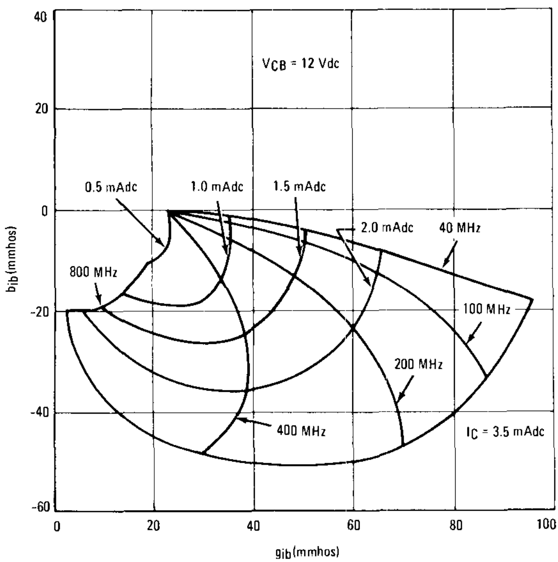


FIGURE 3 – REVERSE TRANSFER ADMITTANCE

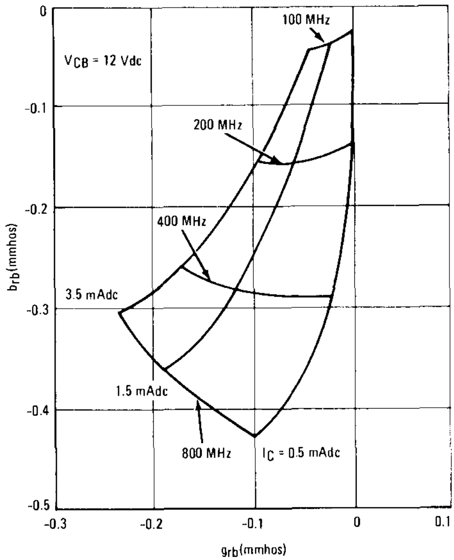


FIGURE 4 – FORWARD TRANSFER ADMITTANCE

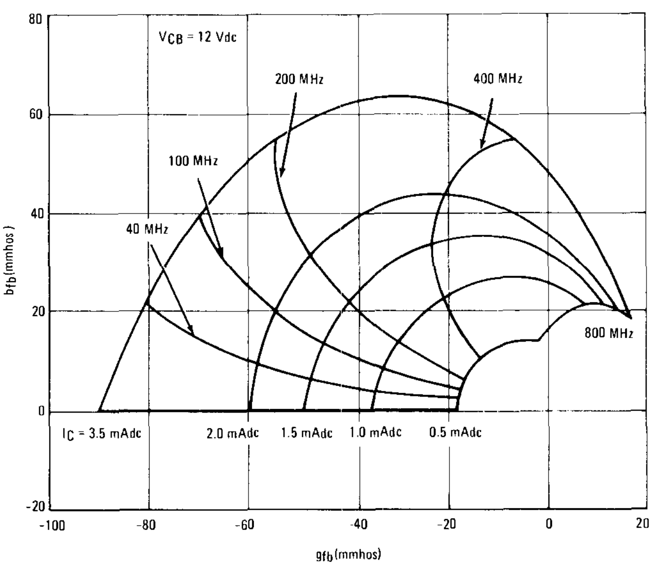
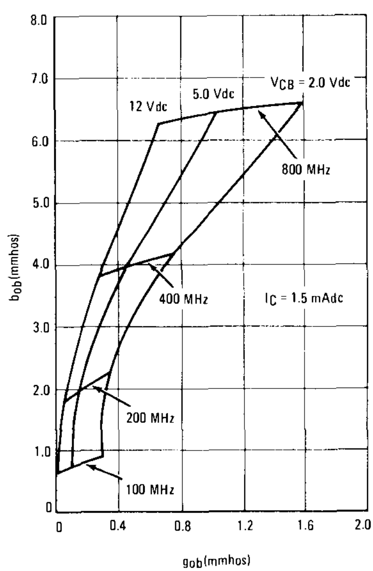


FIGURE 5 – OUTPUT ADMITTANCE



AF239 (continued)

FIGURE 6 – CURRENT-GAIN–BANDWIDTH PRODUCT

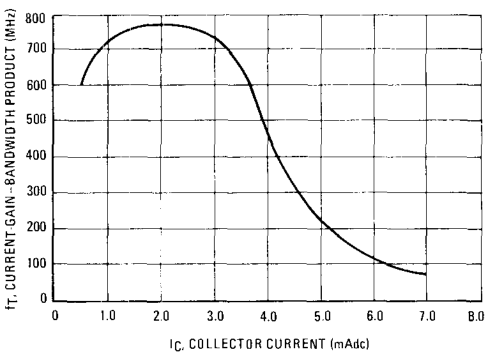
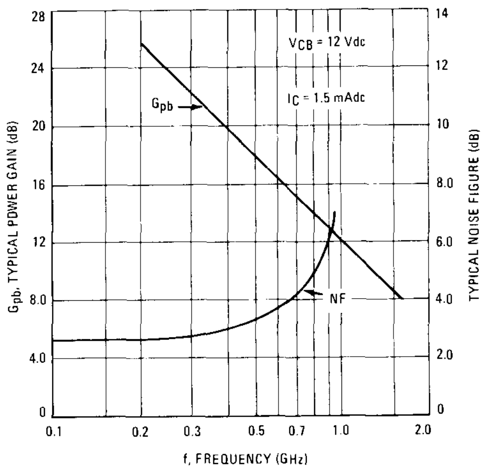
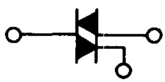


FIGURE 7 – TYPICAL POWER GAIN AND NOISE FIGURE
(See Figure 1)



MAC21-1 (SILICON)
thru
MAC21-7



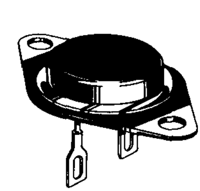
TRIAC
(THYRISTORS)

25 AMPERES RMS
25 thru 500 VOLTS

SILICON BIDIRECTIONAL THYRISTORS

. . . designed for full-wave ac control applications, such as heating and lighting. These TRIAC type thyristors switch from a blocking to a conducting state for either polarity of applied main terminal voltage with positive or negative gate triggering.

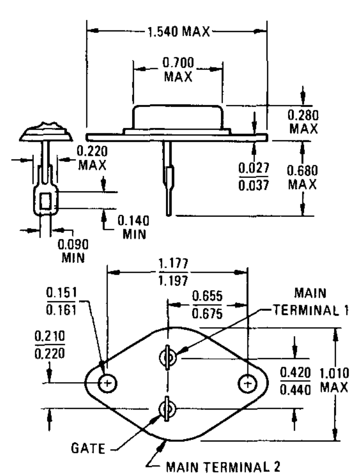
- TO-41 Package (Low silhouette TO-3 with Lugs)
- Low On-State Voltage
- All-Diffused Junctions for Greater Parameter Uniformity



MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Repetitive Peak Off-State Voltage (T_J = 110°C) MAC21–1 –2 –3 –4 –5 –6 –7	V_{DRM}*	 25 50 100 200 300 400 500	Volts
On-State Current RMS	$I_{T(RMS)}$	25	Amp
Peak Surge Current (One Full cycle, 60 Hz, T_J = –40 to +110°C)	I_{TSM}	225	Amp
Circuit Fusing Considerations (T_J = –40 to +110°C, t = 1.0 to 8.3 ms)	I^2t	210	A^2s
Peak Gate Power	P_{GM}	5.0	Watts
Average Gate Power	$P_{G(AV)}$	0.5	Watt
Peak Gate Current	I_{GM}	2.0	Amp
Operating Junction Temperature Range	T_J	–40 to +110	°C
Storage Temperature Range	T_{stg}	–40 to +150	°C

*For either direction of blocking voltage. V_{DRM} for all types can be applied on a continuous dc basis without incurring damage. Ratings apply for open gate conditions. Thyristor devices shall not be tested with a constant current source for blocking capability such that the voltage applied exceeds the rated blocking voltage.



CASE 178(2)

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
Peak Blocking Current (Either Direction) Rated V_{DRM} @ T_J = 110°C	I_{DRM}	–	–	4.0	mA
On-State Voltage (Either Direction) I_{TM} = 35 A Peak	V_{TM}	–	1.3	1.5	Volts
Gate Trigger Current, Continuous dc MT2(+)G(+); MT2(–)G(–)	I_{GT}	–	20	75	mA
Main Terminal Voltage = 7.0 Vdc, R_L = 47 ohms MT2(+)G(–); MT2(–)G(+)	I_{GT}	–	30	100	mA
Gate Trigger Voltage, Continuous dc MT2(+)G(+); MT2(–)G(–)	V_{GT}	–	1.0	3.0	Volts
Main Terminal Voltage = 7.0 Vdc, R_L = 47 ohms MT2(+)G(–); MT2(–)G(+)	V_{GT}	–	1.2	3.0	Volts
Gate Trigger Voltage, Continuous dc — All Modes Main Terminal Voltage = Rated V_{DRM}, R_L = 100 ohms, T_J = 110°C	V_{GD}	0.2	–	–	Volt
Holding Current (Either Direction) Main Terminal Voltage = 7.0 Vdc, Gate Open, Initiating Current = 150 mA	I_H	–	10	75	mA
Turn-On Time I_{TM} = 25 Adc, I_{GT} = 200 mA	t_{on}	–	1.0	–	μs
Critical Forward Voltage Application Rate (Exponential Rise of Voltage) @ V_{DRM}, T_J = 110°C, Gate Open	dv/dt	–	100	–	V/μs
Thermal Resistance, Junction to Case	θ_{JC}	–	–	1.2	°C/W

FIGURE 1 – CHARACTERISTICS AND SYMBOLS

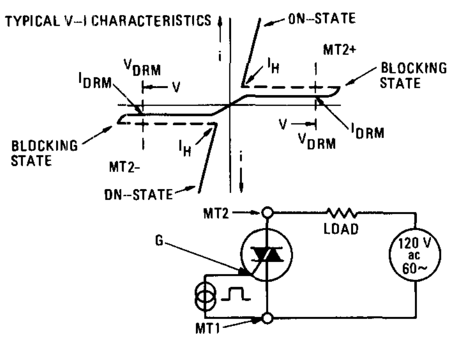


FIGURE 2 – CASE TEMPERATURE versus CURRENT

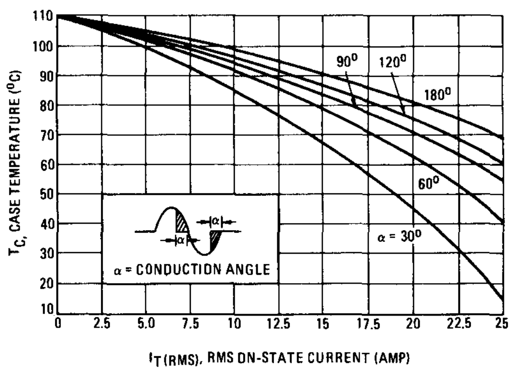


FIGURE 3 – MAXIMUM ON–STATE CHARACTERISTICS

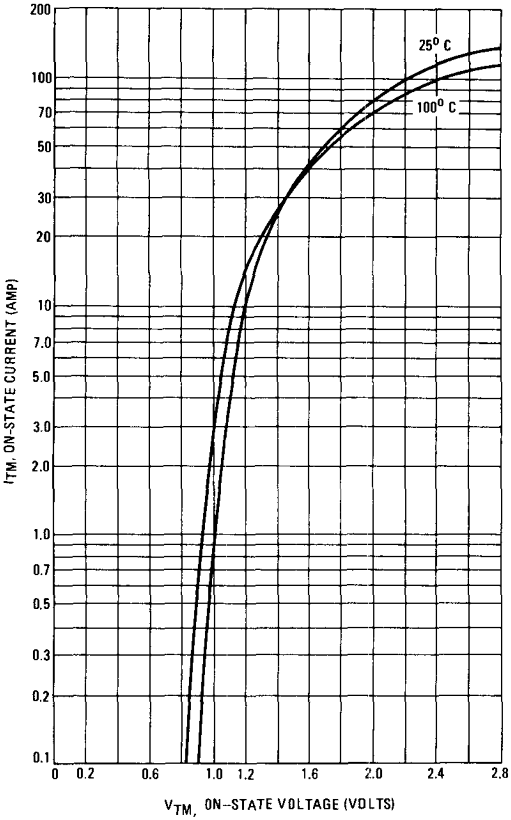


FIGURE 4 – POWER DISSIPATION

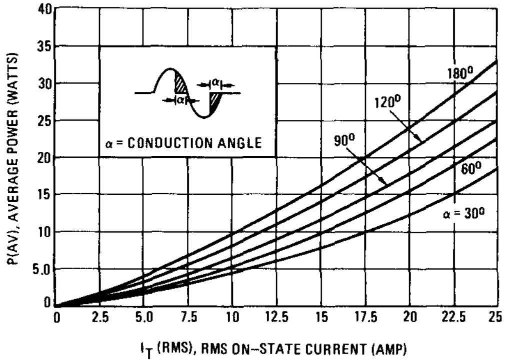


FIGURE 5 – MULTI-CYCLE SURGE RATING

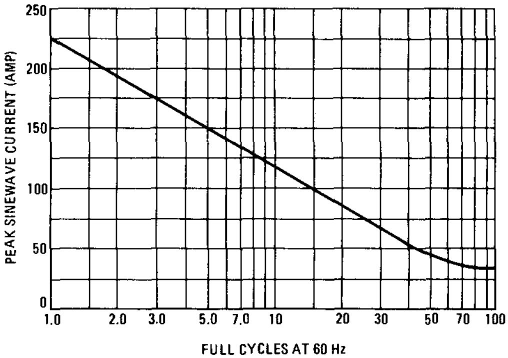


FIGURE 6 – THERMAL RESPONSE

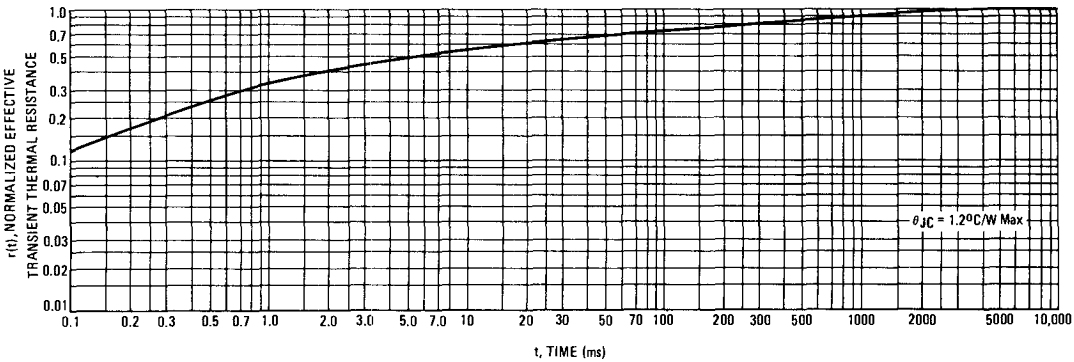


FIGURE 7 — TYPICAL GATE TRIGGER CURRENT

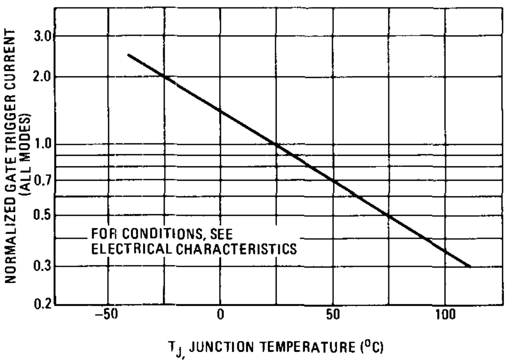


FIGURE 8 — TYPICAL GATE TRIGGER VOLTAGE

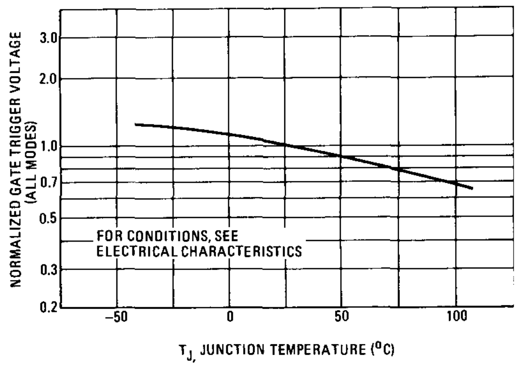
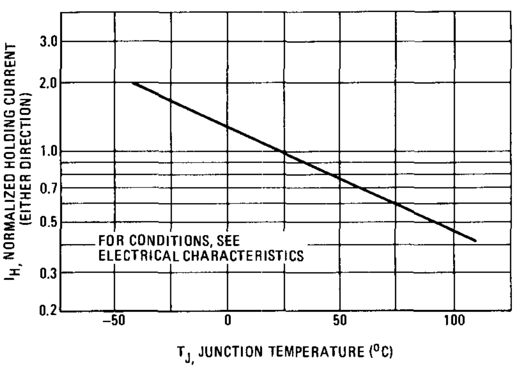


FIGURE 9 — TYPICAL HOLDING CURRENT



MCR407-1 (SILICON)
thru
MCR407-4

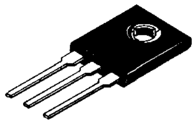
PLASTIC THYRISTORS
(PLASTIC SILICON CONTROLLED RECTIFIERS)

. . . Annular PNPN devices designed for high volume consumer applications such as temperature, light, and speed control; process and remote control, and warning systems where reliability of operation is important.

- Annular Passivated Surface for Reliability and Uniformity
- Power Rated at Economical Prices
- Practical Level Triggering and Holding Characteristics
- Flat, Rugged, Thermopad Construction--for Low Thermal Resistance, High Heat Dissipation and Durability

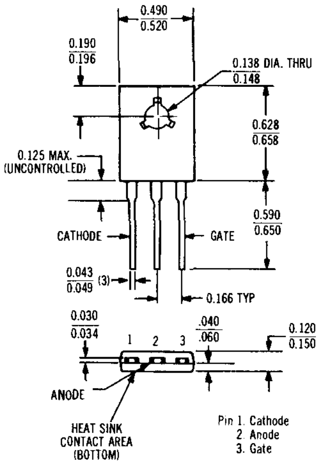
PLASTIC SILICON CONTROLLED RECTIFIERS

4.0 AMPERES RMS
30 thru 200 VOLTS



MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Peak Reverse Blocking Voltage (Note 1) MCR407-1 -2 -3 -4	V_{RRM}	30 60 100 200	Volts
Forward Current RMS (All Conduction Angles)	$I_{T(RMS)}$	4.0	Amp
Peak Forward Surge Current (½ cycle, 60 Hz, $T_J = -40$ to $+110^oC$)	I_{TSM}	20	Amp
Circuit Fusing Considerations ($T_J = -40$ to $+110^oC$) t = 1.0 to 8.3 ms)	I^2t	1.6	A^2s
Peak Gate Power - Forward	P_{GFM}	0.5	Watt
Average Gate Power - Forward	$P_{GF(AV)}$	0.1	Watt
Peak Gate Current - Forward	I_{GFM}	0.2	Amp
Peak Gate Voltage - Reverse	V_{GRM}	6.0	Volts
Operating Junction Temperature Range	T_J	−40 to +110	°C
Storage Temperature Range	T_{stg}	−40 to +150	°C
Mounting Torque (6-32) (Note 2)	—	12	in. lb.



CASE 90 (1)

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted, R_{GK} = 1000 ohms)

Characteristics	Symbol	Min	Typ	Max	Unit
Peak Forward Blocking Voltage (T_J = 110°C) Note 1 MCR407-1	V_{DRM}	30	–	–	Volts
-2		60	–	–	
-3		100	–	–	
-4		200	–	–	
Peak Forward Blocking Current (Rated V_{DRM}, T_J = 110°C)	I_{DRM}	–	–	100	μA
Peak Reverse Blocking Current (Rated V_{RRM}, T_J = 110°C)	I_{RRM}	–	–	100	μA
On State Voltage (I_{TM} = 4.0 A)	V_{TM}	–	–	2.6	Volts
Gate Trigger Current (Continuous dc) (Anode Voltage - 7.0 Vdc, R_L = 100 ohms, T_C = 25°C)	I_{GT}	–	–	500	μA
Gate Trigger Voltage (Continuous dc) (Anode Voltage = 7.0 Vdc, R_L = 100 ohms, T_C = 25°C)	V_{GT}	–	–	1.0	Volts
(Anode Voltage = Rated V_{DRM}, R_L = 100 ohms, T_J = 110°C)	V_{GD}	0.2	–	–	
Holding Current (Anode Voltage = 7.0 Vdc, T_C = 25°C)	I_H	–	–	5.0	mA
Turn-Off Time	t_{on}	Circuit Dependent Consult Manufacturer			
Turn-Off Time	t_{off}				
Forward Voltage Application Rate (T_J = 110°C)	dv/dt	–	10	–	V/μs
Thermal Resistance, Junction to Case	θ_{JC}	–	–	2.0	°C/W
Thermal Resistance, Junction to Ambient	θ_{JA}	–	–	50	°C/W

NOTES:

1. V_{DRM} and V_{RRM} for all types can be applied on a continuous dc basis without incurring damage. Ratings apply for zero or negative gate voltage but positive gate voltage shall not be applied concurrently with a negative potential on the anode. When checking forward or reverse blocking capability, thyristor devices should not be tested with a constant current source in a manner that the voltage applied exceeds the rated blocking voltage.
2. Torque rating applies with use of torque washer (Shakeproof WD19522 #6 or equivalent). Mounting torque in excess of 8 in. lbs. does not appreciably lower case-to-sink thermal resistance. Anode lead and heatsink contact pad are common.

   For soldering purposes (either terminal connection or device mounting), soldering temperatures shall not exceed +225°C. For optimum results, an activated flux (oxide removing) is recommended.

FIGURE 1 – CASE TEMPERATURE versus CURRENT

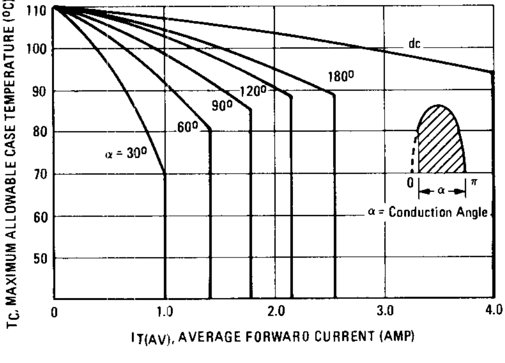
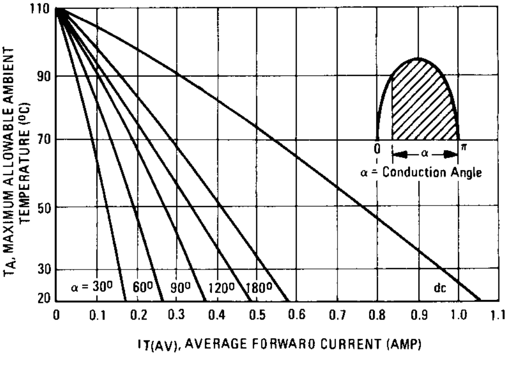


FIGURE 2 – AMBIENT TEMPERATURE versus CURRENT



MCR2315 SERIES (SILICON)
MCR2614L SERIES

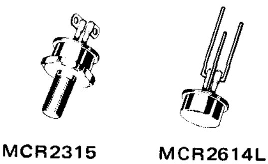
SILICON CONTROLLED RECTIFIERS

. . . designed for applications requiring blocking voltages through 400 volts and rms currents through 8.0 amperes. These devices are available in a choice of space-saving, economical packages for mounting versatility.

- Low Forward Voltage Drop – Typically 1.0 Volt at 5.0 A at 25°C
- Fast, Stable Switching Times – Typically 1.0 μs Turn-On, 12 μs Turn-Off at 25°C
- All-Diffused Junctions for Greater Parameter Uniformity
- Fatigue-Free Solder Construction
- Glass-to-Metal Hermetic Seal

SILICON CONTROLLED RECTIFIERS

8.0 AMPERES RMS
25 thru 400 VOLTS



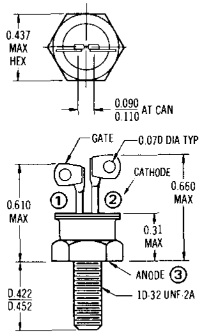
MCR2315 CASE 86 MCR2614L CASE 87L

MAXIMUM RATINGS

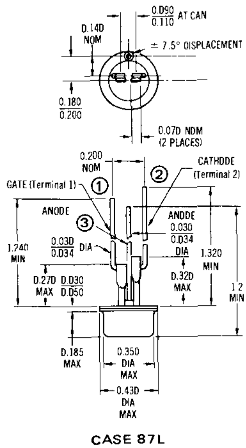
Rating	Symbol	Value	Unit
Peak Reverse Blocking Voltage* MCR2315 MCR2614L –1	V_{RRM} *	25	Volts
–2		50	
–3		100	
–4		200	
–5		300	
–6		400	
Forward Current RMS (All Conduction Angles)	$I_{T(RMS)}$	8.0	Amp
Peak Surge Forward Current (One cycle, 60 Hz, T_J = –40 to +100°C)	I_{TSM}	80	Amp
Circuit Fusing Considerations (T_J = –40 to +100°C; t ≤ 8.3 ms)	I^2t	40	A^2s
Peak Gate Power – Forward	P_{GFM}	5.0	Watts
Average Gate Power – Forward	$P_{GF(AV)}$	0.5	Watt
Peak Forward Gate Current	I_{GFM}	2.0	Amp
Peak Gate Voltage Forward	V_{GFM}	10	Volts
Reverse	V_{GRM}	10	
Operating Junction Temperature Range	T_J	–40 to +100	°C
Storage Temperature Range	T_{stg}	–40 to +150	°C
Stud Torque (MCR2315 series)		15	in. lb.

*$V_{RRM(rep)}$ for all types can be applied on a continuous dc basis without incurring damage. Ratings apply for zero or negative gate voltage.

Devices should not be tested with a constant current source for forward or reverse blocking capability such that the voltage applied exceeds the rated blocking voltage.



CASE 86



CASE 87L

ELECTRICAL CHARACTERISTICS (T_J = 25°C unless otherwise noted)

Apply to all case types unless otherwise noted

Characteristic	Symbol	Min	Typ	Max	Unit
Peak Forward Blocking Voltage* (T_J = 100°C) MCR2315, MCR2614L -1	V_{DRM}*	25	–	–	Volts
-2		50	–	–	
-3		100	–	–	
-4		200	–	–	
-5		300	–	–	
-6		400	–	–	
Peak Forward Blocking Current (Rated V_{DRM}, T_J = 100°C, gate open)	I_{DRM}	–	–	3.0	mA
Peak Reverse Blocking Current (Rated V_{RRM}, T_J = 100°C, gate open)	I_{RRM}	–	–	3.0	mA
On State Voltage (I_{TM} = 5.0 Adc)	V_{TM}	–	1.0	1.6	Volts
Gate Trigger Current (Continuous dc) (Anode Voltage = 7.0 Vdc, R_L = 100Ω)	I_{GT}	–	10	40	mA
Gate Trigger Voltage (Continuous dc) (Anode Voltage = 7.0 Vdc, R_L = 100 Ω)	V_{GT}	–	0.6	1.5	Volts
(Anode Voltage = 7.0 Vdc, R_L = 100 Ω, T_J = 100°C)	V_{GD}	0.2	–	–	
Holding Current (Anode Voltage = 7.0 Vdc, gate open)	I_H	–	10	50	mA
Turn-On Time (I_{TM} = 5.0 Adc, I_{GT} = 20 mAdc)	t_{on}	–	1.0	–	μs
Turn-Off Time (I_{TM} = 5.0 Adc, I_R = 5.0 Adc)	t_{off}	–	15	–	μs
(I_{TM} = 5.0 Adc, I_R = 5.0 Adc, T_J = 100°C)		–	30	–	
Forward Voltage Application Rate (T_J = 100°C)	dv/dt	–	50	–	V/μs
Thermal Resistance, Junction to Case MCR2614L	θ_{JC}	–	1.5	2.7	°C/W
MCR2315		–	1.8	3.0	
Thermal Resistance, Case to Ambient** MCR2614L	θ_{CA}	–	50**	–	°C/W

*V_{DRM} for all types can be applied on a continuous dc basis without incurring damage. Ratings apply for zero or negative gate voltage. Devices should not be tested with a constant current source for forward or reverse blocking capability in a manner that the voltage applied exceeds the rated blocking voltage.

**Applies for the worst-case conditions of: (a) highest θ_{CA} package configuration, (b) leads terminated at end points, (c) temperature measured at hottest spot on device (center of case bottom), and (d) still air mounting.

FIGURE 1 – CURRENT DERATING - HALF WAVE

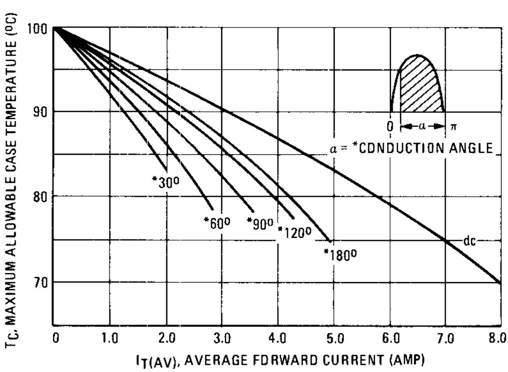
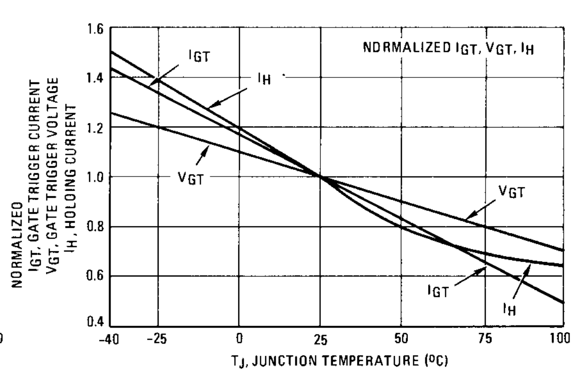


FIGURE 2 – TYPICAL PARAMETER VARIATIONS versus TEMPERATURE



MD2218, MD2218A (SILICON)
MD2218F, MD2218AF
MQ2218

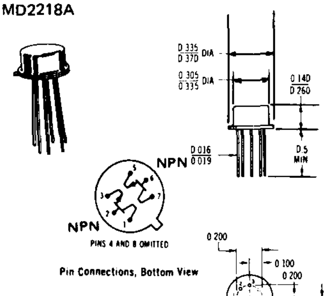
DUAL AND QUAD NPN SILICON ANNULAR TRANSISTORS

. . . designed for high-speed switching circuits, dc to VHF amplifier applications and complementary circuitry with the PNP MD2904, MD2904A, MD2904F, MD2904AF and MQ2904.

- DC Current Gain Specified from 0.1 to 300 mAdc
- High Current-Gain—Bandwidth Product — f_T = 200 MHz (Min) @ I_C = 20 mAdc
- Each Transistor Similar to the 2N2218

NPN SILICON TRANSISTORS

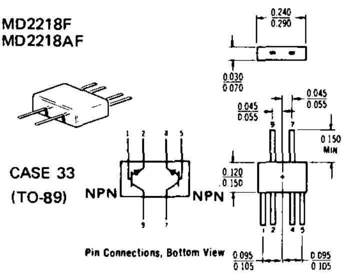
MD2218
MD2218A



CASE 32C

All leads isolated from case

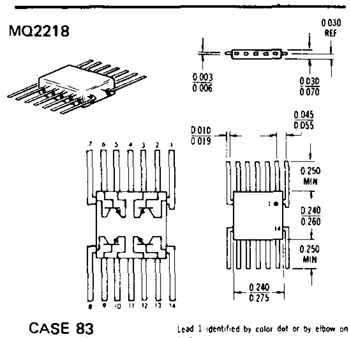
MD2218F
MD2218AF



CASE 33
(TO-89)

All leads isolated from case

MQ2218



CASE 83
(TO-86)

All leads isolated from case

†MAXIMUM RATINGS (Each Transistor)

Rating	Symbol	MD2218 MD2218F MQ2218	MD2218A MD2218AF	Unit
Collector-Emitter Voltage	V_{CEO}	30	40	Vdc
Collector-Base Voltage	V_{CB}	60	75	Vdc
Emitter-Base Voltage	V_{EB}	5.0	6.0	Vdc
Collector Current	I_C	600		mAdc
Operating and Storage Junction Temperature Range	T_J, T_{stg}	-65 to +200		°C
		One Side	Both Sides	
Total Device Dissipation @ T_A = 25°C	P_D			
MD2218, MD2218A		500	600	mW
Derate above 25°C		2.9	3.4	mW/°C
MD2218F, MD2218AF		250	350	mW
Derate above 25°C		1.5	2.0	mW/°C
Total Device Dissipation @ T_C = 25°C	P_D			
MD2218, MD2218A		1.6	3.0	Watts
Derate above 25°C		9.1	17.2	mW/°C
MD2218F, MD2218AF		800	900	mW
Derate above 25°C		4.6	5.2	mW/°C
		One Device	Four Devices	
Total Device Dissipation @ T_A = 25°C	P_D			
MQ2218		400	500	mW
Derate above 25°C		2.28	2.86	mW/°C
Total Device Dissipation @ T_C = 25°C	P_D			
MQ2218		0.65	3.5	Watts
Derate above 25°C		3.71	14.8	mW/°C

†Devices mounted on a printed circuit board in the vertical position shielded from air movement.

ELECTRICAL CHARACTERISTICS (Each Transistor) (T_A = 25°C unless otherwise noted)

Characteristics apply to corresponding flat package, and quad type number.

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage* (I_C = 10 mAdc, I_B = 0)	MD2218 MD2218A	BV_{CEO}*	30 40	– –	Vdc
Collector-Base Breakdown Voltage (I_C = 10 μAdc, I_E = 0)	MD2218 MD2218A	BV_{CBO}	60 75	– –	Vdc
Emitter-Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)	MD2218 MD2218A	BV_{EBO}	5.0 6.0	– –	Vdc
Collector Cutoff Current (V_{CE} = 50 Vdc, $V_{EB(off)}$ = 3.0 Vdc)	MD2218 MD2218A	I_{CEX}	– –	0.020 0.015	μAdc
Base Cutoff Current (V_{CE} = 50 Vdc, $V_{EB(off)}$ = 3.0 Vdc)	MD2218 MD2218A	I_{BL}	–	0.03	μAdc
ON CHARACTERISTICS					
DC Current Gain*		h_{FE}*			–
(I_C = 0.1 mAdc, V_{CE} = 10 Vdc)			20	–	
(I_C = 1.0 mAdc, V_{CE} = 10 Vdc)			25	–	
(I_C = 10 mAdc, V_{CE} = 10 Vdc)			35	–	
(I_C = 150 mAdc, V_{CE} = 10 Vdc)			40	120	
(I_C = 150 mAdc, V_{CE} = 1.0 Vdc)			20	–	
(I_C = 300 mAdc, V_{CE} = 10 Vdc)	MD2218 MD2218A		20 25	– –	
Collector-Emitter Saturation Voltage* (I_C = 150 mAdc, I_B = 15 mAdc)	MD2218 MD2218A	$V_{CE(sat)}$*	– –	0.4 0.3	Vdc
(I_C = 300 mAdc, I_B = 30 mAdc)	MD2218 MD2218A		– –	1.2 0.9	
Base-Emitter Saturation Voltage* (I_C = 150 mAdc, I_B = 15 mAdc)	MD2218 MD2218A	$V_{BE(sat)}$*	0.6 0.6	1.3 1.2	Vdc
(I_C = 300 mAdc, I_B = 30 mAdc)	MD2218 MD2218A		– –	2.0 1.8	
DYNAMIC CHARACTERISTICS					
Current-Gain—Bandwidth Product (I_C = 20 mAdc, V_{CE} = 20 Vdc, f = 100 MHz)		f_T	200	–	MHz
Output Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 100 kHz)		C_{ob}	–	8.0	pF
Input Capacitance (V_{BE} = 0.5 Vdc, I_C = 0, f = 100 kHz)	MD2218 MD2218A	C_{ib}	– –	30 25	pF
SWITCHING CHARACTERISTICS					
Delay Time (V_{CC} = 30 Vdc, $V_{EB(off)}$ = 0.5 Vdc, I_C = 150 mAdc, I_{B1} = 15 mAdc)	MD2218 MD2218A	t_d	– –	20 15	ns
Rise Time (V_{CC} = 30 Vdc, $V_{EB(off)}$ = 0.5 Vdc, I_C = 150 mAdc, I_{B1} = 15 mAdc)	MD2218 MD2218A	t_r	– –	40 30	ns
Storage Time (V_{CC} = 30 Vdc, I_C = 150 mAdc, I_{B1} = I_{B2} = 15 mAdc)	MD2218 MD2218A	t_s	– –	280 250	ns
Fall Time (V_{CC} = 30 Vdc, I_C = 150 mAdc, I_{B1} = I_{B2} = 15 mAdc)	MD2218 MD2218A	t_f	– –	70 60	ns

*Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

For more detailed information pertaining to the electrical characteristics curves, see the 2N2218 data sheet.

MD2219, MD2219A (SILICON)
MD2219F, MD2219AF
MQ2219A

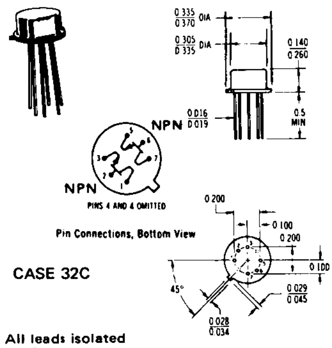
DUAL AND QUAD NPN SILICON ANNULAR TRANSISTORS

. . . designed for high-speed switching circuits, dc to VHF amplifier applications and complementary circuitry with the PNP MD2905, MD2905A, MD2905F, MD2905AF, and MQ2905A.

- DC Current Gain Specified from 0.1 to 300 mAdc
- High Current-Gain–Bandwidth Product – f_T = 200 MHz (Min) @ I_C = 20 mAdc
- Each Transistor Similar to the 2N2219

NPN SILICON TRANSISTORS

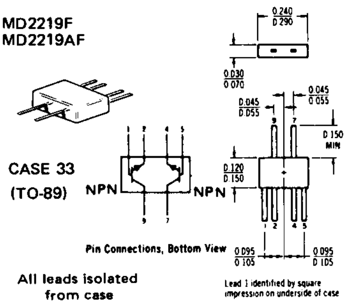
MD2219
MD2219A



CASE 32C

All leads isolated from case

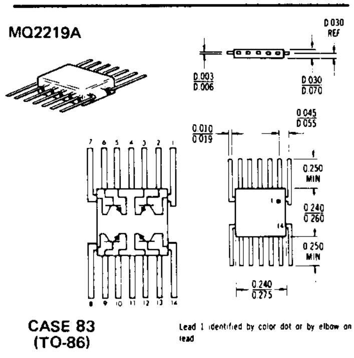
MD2219F
MD2219AF



CASE 33 (TO-89)

All leads isolated from case

MQ2219A



CASE 83 (TO-86)

All leads isolated from case

†MAXIMUM RATINGS (Each Transistor)

Rating	Symbol	MD2219 MD2219F	MD2219A MD2219AF MQ2219A	Unit
Collector-Emitter Voltage	V_{CEO}	30	40	Vdc
Collector-Base Voltage	V_{CB}	60	75	Vdc
Emitter-Base Voltage	V_{EB}	5.0	6.0	Vdc
Collector Current	I_C	600		mAdc
Operating and Storage Junction Temperature Range	T_J, T_{stg}	-65 to +200		°C
		One Side	Both Sides	
Total Device Dissipation @ $T_A = 25°C$	P_D			
MD2219, MD2219A		500	600	mW
Derate above 25°C		2.9	3.4	mW/°C
MD2219F, MD2219AF		250	350	mW
Derate above 25°C		1.5	2.0	mW/°C
Total Device Dissipation @ $T_C = 25°C$	P_D			
MD2219, MD2219A		1.6	3.0	Watts
Derate above 25°C		9.1	17.2	mW/°C
MD2219F, MD2219AF		800	900	mW
Derate above 25°C		4.6	5.2	mW/°C
		One Device	Four Devices	
Total Device Dissipation @ $T_A = 25°C$	P_D			
MQ2219A		400	500	mW
Derate above 25°C		2.28	2.86	mW/°C
Total Device Dissipation @ $T_C = 25°C$	P_D			
MQ2219A		0.65	3.5	Watts
Derate above 25°C		3.71	14.8	mW/°C

†Devices mounted on a printed circuit board in the vertical position shielded from air movement.

ELECTRICAL CHARACTERISTICS (Each Transistors) (T_A = 25°C unless otherwise noted)

Characteristics apply to corresponding flat package, and quad type number.

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage* (I_C = 10 mAdc, I_B = 0)	MD2219 MD2219A	BV_{CEO}*	30 40	– –	Vdc
Collector-Base Breakdown Voltage (I_C = 10 μAdc, I_E = 0)	MD2219 MD2219A	BV_{CBO}	60 75	– –	Vdc
Emitter-Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)	MD2219 MD2219A	BV_{EBO}	5.0 6.0	– –	Vdc
Collector Cutoff Current (V_{CE} = 50 Vdc, $V_{EB(off)}$ = 3.0 Vdc)	MD2219 MD2219A	I_{CEX}	– –	0.020 0.015	μAdc
Base Cutoff Current (V_{CE} = 50 Vdc, $V_{EB(off)}$ = 3.0 Vdc)	MD2219 MD2219A	I_{BL}	–	0.03	μAdc
ON CHARACTERISTICS					
DC Current Gain*		h_{FE}*			–
(I_C = 0.1 mAdc, V_{CE} = 10 Vdc)			35	–	
(I_C = 1.0 mAdc, V_{CE} = 10 Vdc)			50	–	
(I_C = 10 mAdc, V_{CE} = 10 Vdc)			75	–	
(I_C = 150 mAdc, V_{CE} = 10 Vdc)			100	300	
(I_C = 150 mAdc, V_{CE} = 1.0 Vdc)			50	–	
(I_C = 300 mAdc, V_{CE} = 10 Vdc)			30	–	
Collector-Emitter Saturation Voltage*		$V_{CE(sat)}$*			Vdc
(I_C = 150 mAdc, I_B = 15 mAdc)	MD2219 MD2219A		– –	0.4 0.3	
(I_C = 300 mAdc, I_B = 30 mAdc)	MD2219 MD2219A		– –	1.2 0.9	
Base-Emitter Saturation Voltage*		$V_{BE(sat)}$*			Vdc
(I_C = 150 mAdc, I_B = 15 mAdc)	MD2219 MD2219A		0.6 0.6	1.3 1.2	
(I_C = 300 mAdc, I_B = 30 mAdc)	MD2219 MD2219A		– –	2.0 1.8	
DYNAMIC CHARACTERISTICS					
Current-Gain—Bandwidth Product (I_C = 20 mAdc, V_{CE} = 20 Vdc, f = 100 MHz)		f_T	250	–	MHz
Output Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 100 kHz)		C_{ob}	–	8.0	pF
Input Capacitance (V_{BE} = 0.5 Vdc, I_C = 0, f = 100 kHz)	MD2219 MD2219A	C_{ib}	– –	30 25	pF
SWITCHING CHARACTERISTICS					
Delay Time (V_{CC} = 30 Vdc, $V_{EB(off)}$ = 0.5 Vdc, I_C = 150 mAdc, I_{B1} = 15 mAdc)	MD2219 MD2219A	t_d	– –	20 15	ns
Rise Time (V_{CC} = 30 Vdc, $V_{EB(off)}$ = 0.5 Vdc, I_C = 150 mAdc, I_{B1} = 15 mAdc)	MD2219 MD2219A	t_r	– –	40 30	ns
Storage Time (V_{CC} = 30 Vdc, I_C = 150 mAdc, I_{B1} = I_{B2} = 15 mAdc)	MD2219 MD2219A	t_s	– –	280 250	ns
Fall Time (V_{CC} = 30 Vdc, I_C = 150 mAdc, I_{B1} = I_{B2} = 15 mAdc)	MD2219 MD2219A	t_f	– –	70 60	ns

*Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.
For more detailed information pertaining to the electrical characteristics, see the 2N2219 data sheet.

MD2904, MD2904A (SILICON)
MD2904F, MD2904AF
MQ2904

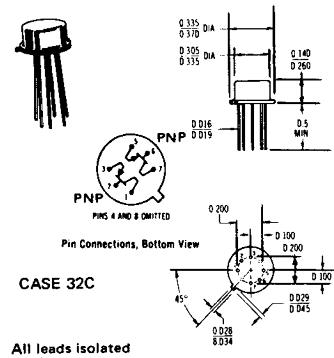
DUAL AND QUAD PNP SILICON ANNULAR TRANSISTORS

. . . designed for high-speed switching circuits, dc to VHF amplifier applications and complementary circuitry with the NPN MD2218, MD2218A, MD2218F, MD2218AF, and MQ2218.

- DC Current Gain Specified – 0.1 to 500 mAdc
- High Current-Gain–Bandwidth Product – f_T = 200 MHz (Min) @ I_C = 50 mAdc
- Each Transistor Similar to the 2N2904

PNP SILICON TRANSISTORS

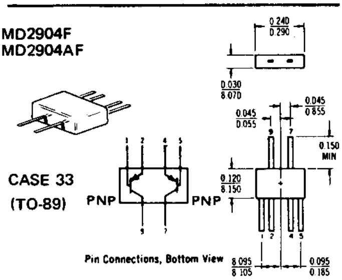
MD2904
MD2904A



CASE 32C

All leads isolated from case

MD2904F
MD2904AF

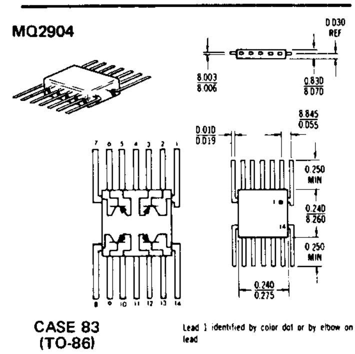


CASE 33 (TO-89)

All leads isolated from case

Lead 1 identified by square impression on underside of case

MQ2904



CASE 83 (TO-86)

Lead 1 identified by color dot or by elbow on lead

14-LEAD FLAT PACKAGE

All leads isolated from case

†MAXIMUM RATINGS (Each Transistor)

Rating	Symbol	MD2904 MD2904F MQ2904	MD2904A MD2904AF	Unit
Collector-Emitter Voltage	V_{CEO}	40	60	Vdc
Collector-Base Voltage	V_{CB}	60		Vdc
Emitter-Base Voltage	V_{EB}	5.0		Vdc
Collector Current	I_C	600		mAdc
Operating and Storage Junction Temperature Range	T_J, T_{stg}	-65 to +200		°C
		One Side	Both Sides	
Total Device Dissipation @ T_A = 25°C	P_D			
MD2904, MD2904A		500	600	mW
Derate above 25°C		2.9	3.4	mW/°C
MD2904F, MD2904AF		250	350	mW
Derate above 25°C		1.5	2.0	mW/°C
Total Device Dissipation @ T_C = 25°C	P_D			
MD2904, MD2904A		1.6	3.0	Watts
Derate above 25°C		9.1	17.2	mW/°C
MD2904F, MD2904AF		800	900	mW
Derate above 25°C		4.6	5.2	mW/°C
		One Device	Four Devices	
Total Device Dissipation @ T_A = 25°C	P_D			
MQ2904		400	500	mW
Derate above 25°C		2.28	2.86	mW/°C
Total Device Dissipation @ T_C = 25°C	P_D			
MQ2904		0.65	3.5	Watts
Derate above 25°C		3.71	14.8	mW/°C

† Devices mounted on a printed circuit board in the vertical position shielded from air movement.

ELECTRICAL CHARACTERISTICS (Each Transistor) (T_A = 25°C unless otherwise noted)

Characteristics apply to corresponding flat package, and quad type number.

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage* (I_C = 10 mAdc, I_B = 0)	MD2904 MD2904A	BV_{CEO}*	40 60	– –	Vdc
Collector-Base Breakdown Voltage (I_C = 10 μAdc, I_E = 0)		BV_{CBO}	60	–	Vdc
Emitter-Base Breakdown Voltage (I_B = 10 μAdc, I_C = 0)		BV_{EBO}	5.0	–	Vdc
Collector Cutoff Current (V_{CE} = 50 Vdc, $V_{BE(off)}$ = 3.0 Vdc) (V_{CE} = 50 Vdc, $V_{BE(off)}$ = 3.0 Vdc, T_A = 150°C)		I_{CEX}	– –	0.020 30	μAdc
Base Cutoff Current (V_{CE} = 50 Vdc, $V_{BE(off)}$ = 3.0 Vdc)		I_{BL}	–	0.030	μAdc
ON CHARACTERISTICS					
DC Current Gain*		h_{FE}*			–
(I_C = 0.1 mAdc, V_{CE} = 10 Vdc)	MD2904 MD2904A		20 40	– –	
(I_C = 1.0 mAdc, V_{CE} = 10 Vdc)	MD2904 MD2904A		25 40	– –	
(I_C = 10 mAdc, V_{CE} = 10 Vdc)	MD2904 MD2904A		35 40	– –	
(I_C = 150 mAdc, V_{CE} = 10 Vdc)	All Types		40	120	
(I_C = 500 mAdc, V_{CE} = 10 Vdc)	MD2904 MD2904A		20 40	– –	
Collector-Emitter Saturation Voltage* (I_C = 150 mAdc, I_B = 15 mAdc) (I_C = 500 mAdc, I_B = 50 mAdc)		$V_{CE(sat)}$*	– –	0.4 1.6	Vdc
Base-Emitter Saturation Voltage* (I_C = 150 mAdc, I_B = 15 mAdc) (I_C = 500 mAdc, I_B = 50 mAdc)		$V_{BE(sat)}$*	– –	1.3 2.6	Vdc
DYNAMIC CHARACTERISTICS					
Current-Gain—Bandwidth Product (I_C = 50 mAdc, V_{CE} = 20 Vdc, f = 100 MHz)		f_T	200	–	MHz
Output Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 100 kHz)		C_{ob}	–	8.0	pF
Input Capacitance (V_{BE} = 2.0 Vdc, I_C = 0, f = 100 kHz)		C_{ib}	–	30	pF
SWITCHING CHARACTERISTICS					
Turn-On-Time	(V_{CC} = 30 Vdc, $V_{BE(off)}$ = 0.5 Vdc, I_C = 150 mAdc, I_{B1} = 15 mAdc)	t_{on}	–	45	ns
Delay Time		t_d	–	12	ns
Rise Time		t_r	–	35	ns
Turn-Off-Time	(V_{CC} = 30 Vdc, I_C = 150 mAdc, I_{B1} = I_{B2} = 15 mAdc)	t_{off}	–	130	ns
Storage Time		t_s	–	100	ns
Fall Time		t_f	–	40	ns

*Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

For more detailed information pertaining to the electrical characteristic curves, see the 2N2904 data sheet.

MD2905, MD2905A (SILICON)
MD2905F, MD2905AF
MQ2905A

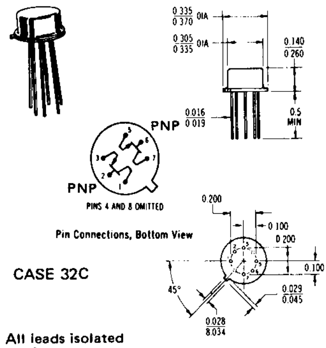
DUAL AND QUAD PNP SILICON ANNULAR TRANSISTORS

. . . designed for high-speed switching circuits, dc to VHF amplifier applications and complementary circuitry with the NPN MD2219, MD2219A, MD2219F, MD2219AF, and MQ2219A.

- DC Current Gain Specified — 0.1 to 500 mAdc
- High Current-Gain—Bandwidth Product — f_T = 200 MHz (Min) @ I_C = 50 mAdc
- Each Transistor Similar to the 2N2905

PNP SILICON TRANSISTORS

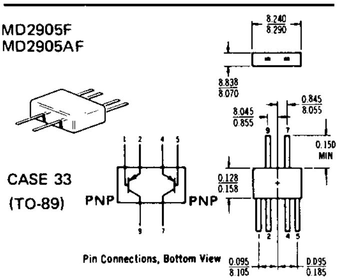
MD2905
MD2905A



CASE 32C

All leads isolated from case

MD2905F
MD2905AF

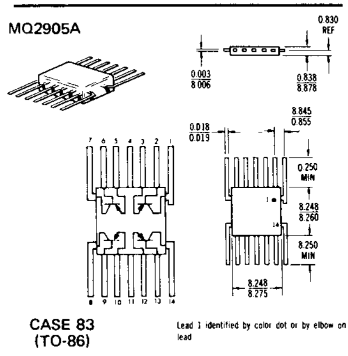


CASE 33 (TO-89)

All leads isolated from case

Lead 1 identified by square impression on underside of case.

MQ2905A



CASE 83 (TO-86)

Lead 1 identified by color dot or by elbow on lead

14-LEAD FLAT PACKAGE

All leads isolated from case

†MAXIMUM RATINGS (Each Transistor)

Rating	Symbol	MD2905 MD2905F	MD2905A MD2905AF MQ2905A	Unit
Collector-Emitter Voltage	V_{CEO}	40	60	Vdc
Collector-Base Voltage	V_{CB}	60		Vdc
Emitter-Base Voltage	V_{EB}	5.0		Vdc
Collector Current	I_C	600		mAdc
Operating and Storage Junction Temperature Range	T_J, T_{stg}	-65 to +200		°C
		One Side	Both Sides	
Total Device Dissipation @ T_A = 25°C	P_D			
MD2905, MD2905A		500	600	mW
Derate above 25°C		2.9	3.4	mW/°C
MD2905F, MD2905AF		250	350	mW
Derate above 25°C		1.5	2.0	mW/°C
Total Device Dissipation @ T_C = 25°C	P_D			
MD2905, MD2905A		1.6	3.0	Watts
Derate above 25°C		9.1	17.2	mW/°C
MD2905F, MD2905AF		800	900	mW
Derate above 25°C		4.6	5.2	mW/°C
		One Device	Four Devices	
Total Device Dissipation @ T_A = 25°C	P_D			
MQ2905A		400	500	mW
Derate above 25°C		2.28	2.86	mW/°C
Total Device Dissipation @ T_C = 25°C	P_D			
MQ2905A		0.65	3.5	Watts
Derate above 25°C		3.71	14.8	mW/°C

†Devices mounted on a printed circuit board in the vertical position shielded from air movement.

ELECTRICAL CHARACTERISTICS (Each Transistor) (T_A = 25°C unless otherwise noted)

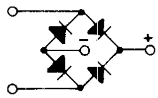
Characteristics apply to corresponding flat package, and quad type number.

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage* (I_C = 10 mAdc, I_B = 0)	MD2905 MD2905A	BV_{CEO}*	40 60	– –	Vdc
Collector-Base Breakdown Voltage (I_C = 10 μAdc, I_E = 0)		BV_{CBO}	60	–	Vdc
Emitter-Base Breakdown Voltage (I_B = 10 μAdc, I_C = 0)		BV_{EBO}	5.0	–	Vdc
Collector Cutoff Current (V_{CE} = 50 Vdc, $V_{BE(off)}$ = 3.0 Vdc) (V_{CE} = 50 Vdc, $V_{BE(off)}$ = 3.0 Vdc, T_A = 150°C)		I_{CEX}	 – –	 0.020 30	μAdc
Base Cutoff Current (V_{CE} = 50 Vdc, $V_{BE(off)}$ = 3.0 Vdc)		I_{BL}	–	0.030	μAdc
ON CHARACTERISTICS					
DC Current Gain*		h_{FE}*			–
(I_C = 0.1 mAdc, V_{CE} = 10 Vdc)	MD2905 MD2905A		35 75	– –	
(I_C = 1.0 mAdc, V_{CE} = 10 Vdc)	MD2905 MD2905A		50 100	– –	
(I_C = 10 mAdc, V_{CE} = 10 Vdc)	MD2905 MD2905A		75 100	– –	
(I_C = 150 mAdc, V_{CE} = 10 Vdc)	All Types		100	300	
(I_C = 500 mAdc, V_{CE} = 10 Vdc)	MD2905 MD2905A		30 50	– –	
Collector-Emitter Saturation Voltage* (I_C = 150 mAdc, I_B = 15 mAdc) (I_C = 500 mAdc, I_B = 50 mAdc)		$V_{CE(sat)}$*	 – –	 0.4 1.6	Vdc
Base-Emitter Saturation Voltage* (I_C = 150 mAdc, I_B = 15 mAdc) (I_C = 500 mAdc, I_B = 50 mAdc)		$V_{BE(sat)}$*	 – –	 1.3 2.6	Vdc
DYNAMIC CHARACTERISTICS					
Current-Gain—Bandwidth Product (I_C = 50 mAdc, V_{CE} = 20 Vdc, f = 100 MHz)		f_T	200	–	MHz
Output Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 100 kHz)		C_{ob}	–	8.0	pF
Input Capacitance (V_{BE} = 2.0 Vdc, I_C = 0, f = 100 kHz)		C_{ib}	–	30	pF
SWITCHING CHARACTERISTICS					
Turn-On-Time	(V_{CC} = 30 Vdc, $V_{BE(off)}$ = 0.5 Vdc, I_C = 150 mAdc, I_{B1} = 15 mAdc)	t_{on}	–	45	ns
Delay Time		t_d	–	12	ns
Rise Time		t_r	–	35	ns
Turn-Off-Time	(V_{CC} = 30 Vdc, I_C = 150 mAdc, I_{B1} = I_{B2} = 15 mAdc)	t_{off}	–	130	ns
Storage Time		t_s	–	100	ns
Fall Time		t_f	–	40	ns

*Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

For more detailed information pertaining to the electrical characteristic curves, see the 2N2905 data sheet.

MDA980-1 thru MDA980-6 (SILICON)
MDA990-1 thru MDA990-6



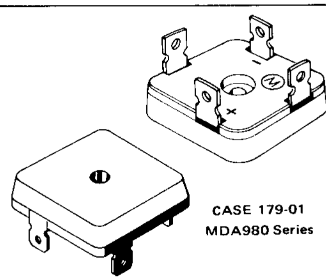
SINGLE-PHASE FULL-WAVE BRIDGE

12 and 27 AMPERES
50 thru 600 VOLTS

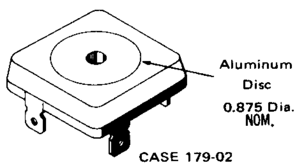
MINIATURE INTEGRAL DIODE ASSEMBLIES

. . . passivated, diffused silicon dice interconnected and transfer molded into voidless hybrid rectifier circuit assemblies. The MDA990 series incorporates an electrically insulated aluminum disc for improved heat dissipation when mounted directly on a metal chassis or heat sink.

- Large surge capability – 300 A (For 1/2 cycle)
- Efficient Thermal Management Provides Maximum Power Handling in Minimum Space



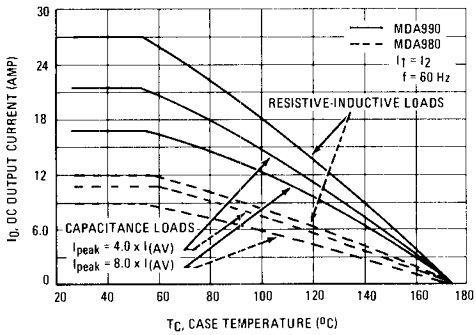
CASE 179-01
MDA980 Series



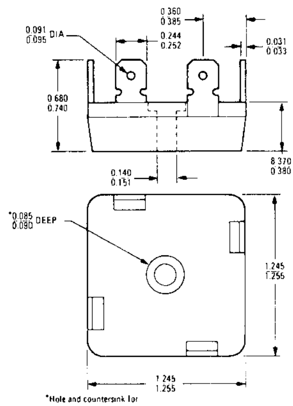
CASE 179-02
MDA 990 Series

MAXIMUM CIRCUIT RATINGS

FIGURE 1 – CURRENT DERATING **



**Case temperature is measured at the interface of the bottom of the case and heat sink.



CASE 179-01-02

MECHANICAL CHARACTERISTICS

CASE: Transfer-molded plastic encapsulation.

POLARITY: Terminal-designation embossed on case
+DC output
–DC output
AC not marked

MOUNTING POSITION: Bolt down-highest heat transfer efficiency accomplished through the surface opposite the terminals.

WEIGHT: MDA980 – 21 grams (approx)
MDA990 – 22.5 grams (approx)

TERMINALS: Suitable for fast-on connections, readily solderable connections, corrosion resistant.

MOUNTING TORQUE: 20 in. lb. Max

MAXIMUM RATINGS

Rating (Per Leg)	Symbol	-1	-2	-3	-4	-5	-6	Unit
Peak Repetitive Reverse Voltage Working Peak Reverse Voltage	$V_{RM(rep)}$ $V_{RM(wkg)}$	50	100	200	300	400	600	Volts
DC Blocking Voltage	V_R	50	100	200	300	400	600	Volts
DC Output Voltage Resistive Load Capacitive Load	 Vdc Vdc	 30 50	 62 100	 124 200	 185 300	 250 400	 380 600	 Volts Volts
Sine Wave RMS Input Voltage (Line to Line)	V_r	35	70	140	210	280	420	Volts
DC Output Current @ T_C = +55°C MDA980 MDA990	I_O I_O	← 12 → ← 27 →						Amp Amp
Peak Full Wave One Cycle Surge Current (60 Hz Non-Repetitive, @ Rated Conditions), Figure 4	I_{FM} (surge)	← 300 (for 1/2 Cycle) →						Amp
Operating and Storage Junction Temperature Range	T_J, T_{stg}	← -65 to +175 →						°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Type	Value Max	Unit
Thermal Resistance, Junction to Case	θ_{JC}	MDA980 MDA990	18 7.5	°C/W

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Value Max	Unit
Maximum Forward Voltage Drop (Per Leg) MDA980 – I_F = 6.0 Adc MDA990 – I_F = 13.5 Adc	 V_F V_F	 1.0 1.0	 Vdc Vdc
Maximum Reverse Current (Across ac terminals) MDA980 and MDA990 @ Rated V_{RM}	I_R	0.5	mAdc

FIGURE 2 – CURRENT VERSUS AMBIENT TEMPERATURE

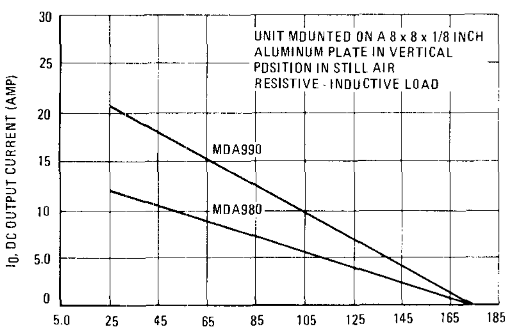


FIGURE 3 – MAXIMUM SURGE CAPABILITY

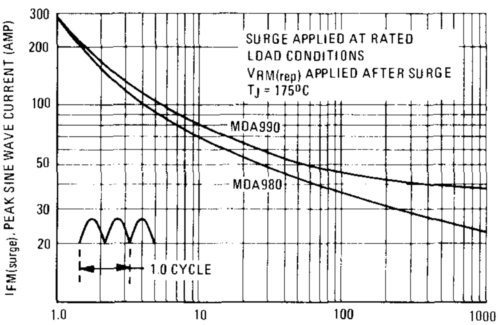


FIGURE 4 – TYPICAL THERMAL RESPONSE

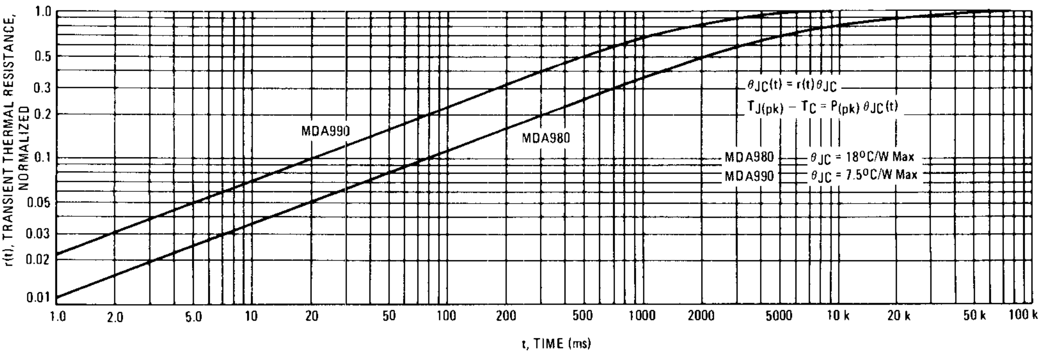


FIGURE 5 – NORMALIZED EFFECTIVE THERMAL RESISTANCE

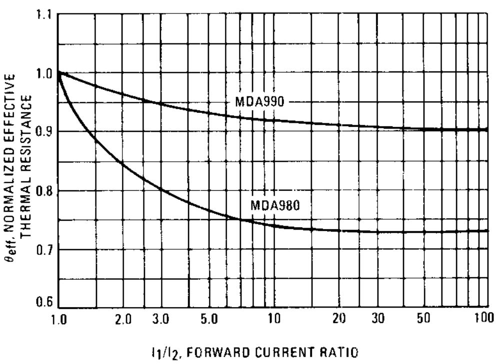
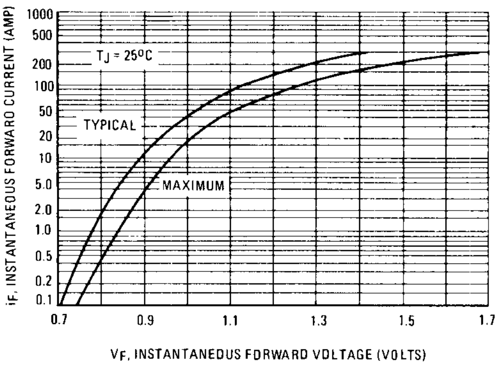


FIGURE 6 – FORWARD VOLTAGE CHARACTERISTICS (PER LEG)



Application of "Effective Thermal Resistance"

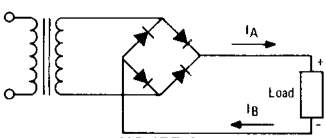


FIGURE A

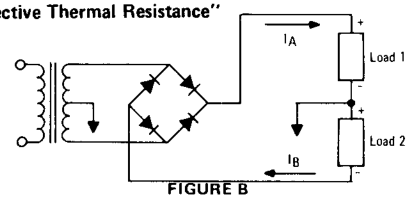


FIGURE B

There are two basic circuit configurations in which the bridge rectifier can be used. The standard bridge circuit of Figure A has one load with currents I_A and I_B equal. This is the configuration used for the information presented in Figure 3 (maximum surge capability), and in Figure 1 and 2 (current derating, resistive, inductive and capacitive loads). The circuit of Figure B utilizes a center-tapped transformer with two loads and current I_A is not necessarily equal to I_B. (Please note: I_A and I_B are the average currents, not the instantaneous currents). Due to the thermal coupling between the rectifier legs within the bridge, the effective thermal resistance of a rectifier leg will vary as the ratio of I_A to I_B is changed. Figure 5 shows normalized effective thermal resistance versus I_1/I_2, where I_1 is the larger of the two currents I_A and I_B.

By using Figure 5 and Figure 1, the capability of the bridge can be determined for conditions other than $I_1 = I_2$ (or $I_A = I_B$) using the relationship:

$$T'_C = T_{J(Max)} \quad (1-\theta_{eff}) + \theta_{eff}\, T_C$$

where $T_{J(Max)}$ = maximum operating junction, temperature
θ_{eff} = normalized effective thermal resistance as shown in Figure 5.

T_C = Case temperature determined from Figure 1 and the value of I_1,
T'_C = true allowable case temperature for the particular I_1 and I_1/I_2 ratio.

For example: using an MDA980 device to determine the allowable case temperature for I_A = 9.0 A and I_B = 3.0 A (resistive load). Then

$I_1/I_2 = 9/3 = 3.0$
θ_{eff} = 0.8 as shown in Figure 5
From Figure 1, $I_A = I_1$ = 9.0 A,
Therefore: T_C = 93°C.
$T'_C = 175\ (1-0.8) + (0.8)\ (93)$
$T'_C = 35 + 74$
T'_C = 109°C

Thus the allowable case temperature has been increased from 93°C for $I_1 = I_2$ = 9.0 A to 109°C for I_1 = 9.0 A, I_2 = 3.0 A.

MDA980-1 thru MDA980-6/MDA990-1 thru MDA990-6 (continued)

TYPICAL DYNAMIC CHARACTERISTICS (PER LEG)

FIGURE 7 — FORWARD VOLTAGE TEMPERATURE COEFFICIENTS

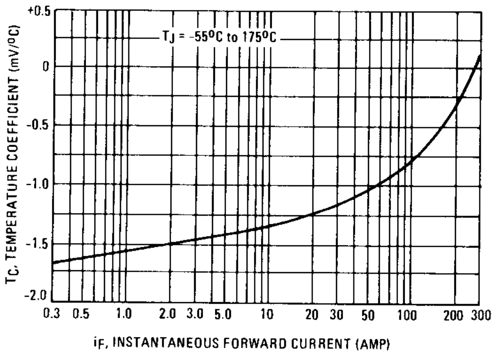


FIGURE 8 — REVERSE RECOVERY TIME

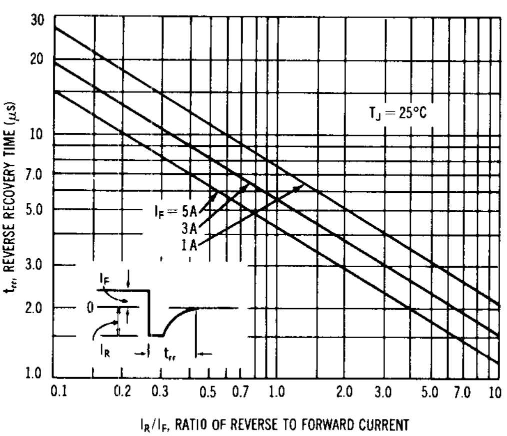


FIGURE 9 — FORWARD RECOVERY TIME

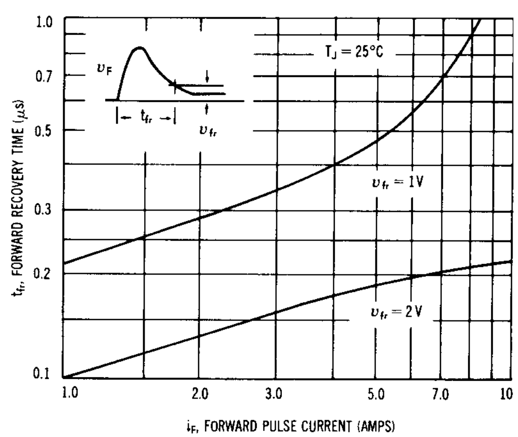


FIGURE 10 — RECTIFICATION EFFICIENCY

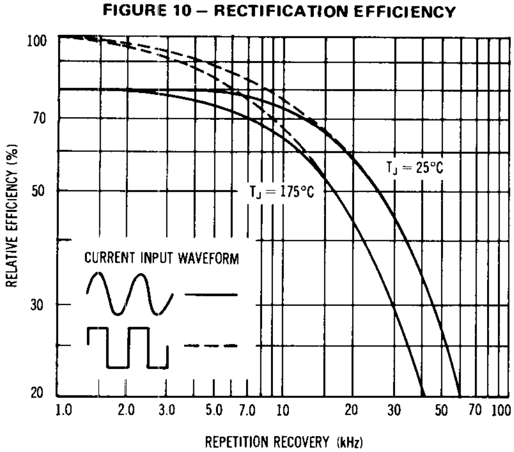
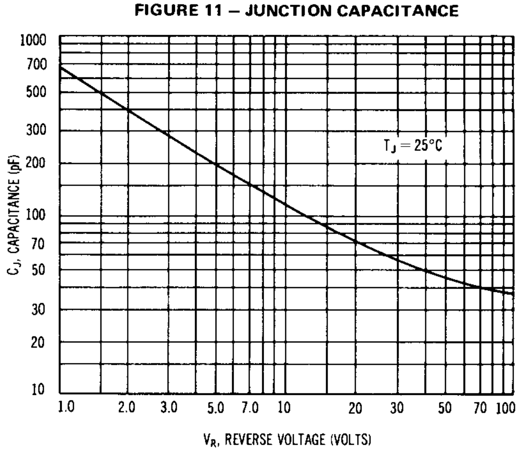


FIGURE 11 — JUNCTION CAPACITANCE



MFE3006 (SILICON) thru MFE3008

N-CHANNEL DUAL-GATE SILICON-NITRIDE PASSIVATED MOS FIELD-EFFECT TRANSISTORS

. . . depletion mode (Type B) dual gate transistors designed for VHF amplifier and mixer applications. These types are specified as follows:

MFE3006 – RF Amplifier @ 100 MHz
MFE3007 – RF Amplifier @ 200 MHz
MFE3008 – Mixer @ 100 and 200 MHz

- Silicon Nitride Passivation for Excellent Long Term Stability
- High Common-Source Power Gain –
  MFE3006: G_{ps} = 20 dB (Min) @ f = 100 MHz
  MFE3007: G_{ps} = 18 dB (Min) @ f = 200 MHz
- High Common-Source Conversion Gain –
  MFE3008: G_{ps} = 14 dB (Min) @ f = 100 MHz
  G_{ps} = 10 dB (Min) @ f = 200 MHz
- Low Reverse Transfer Capacitance –
  C_{rss} = 0.02 pF (Typ) @ V_{DS} = 15 Vdc

N-CHANNEL

DUAL GATE MOS FIELD-EFFECT TRANSISTORS

TYPE B

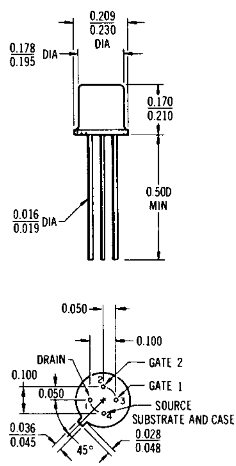
MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain-Source Voltage	V_{DS}	+25	Vdc
Gate 1 Source Voltage	V_{G1S}	±35	Vdc
Gate 2 Source Voltage	V_{G2S}	±35	Vdc
Drain Current	I_D	30	mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	300 1.7	mW mW/°C
Operating Junction Temperature Range	T_J	-65 to +175	°C
Storage Temperature Range	T_{stg}	-65 to +175	°C

HANDLING PRECAUTIONS:

MOS field-effect transistors have extremely high input resistance. They can be damaged by the accumulation of excess static charge. Avoid possible damage to the devices while handling, testing, or in actual operation, by following the procedures outlined below:

1. To avoid the build-up of static charge, the leads of the devices should remain shorted together with a metal ring except when being tested or used.
2. Avoid unnecessary handling. Pick up devices by the case instead of the leads.
3. Do not insert or remove devices from circuits with the power on because transient voltages may cause permanent damage to the devices.



CASE 20 (9)
(TO-72)

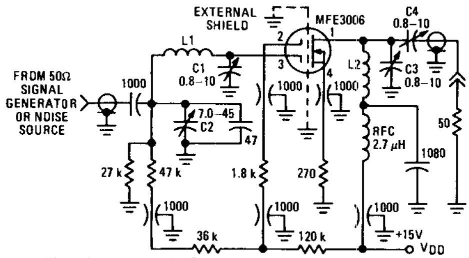
ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)
Substrate Connected to Source

Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Drain-Source Breakdown Voltage (I_D = 10 μAdc, V_S = 0, V_{G1} = V_{G2} = -4.0 Vdc)		$V_{(BR)DSX}$	25	—	—	Vdc
Gate 1 to Source Cutoff Voltage (V_{DS} = 15 Vdc, V_{G2S} = 4.0 Vdc, I_D = 200 μAdc)		$V_{G1S(off)}$	—	—	-3.0	Vdc
Gate 2 to Source Cutoff Voltage (V_{DS} = 15 Vdc, V_{G1S} = 0, I_D = 200 μAdc)		$V_{G2S(off)}$	—	—	-3.0	Vdc
Gate 1 Reverse Leakage Current (V_{G1S} = -10 Vdc, V_{G2S} = 0, V_{DS} = 0) (V_{G1S} = -35 Vdc, V_{G2S} = 0, V_{DS} = 0)		I_{G1SS}	 — —	 — —	 1.0 10	nAdc
Gate 2 Reverse Leakage Current (V_{G2S} = -10 Vdc, V_{G1S} = 0, V_{DS} = 0) (V_{G2S} = -35 Vdc, V_{G1S} = 0, V_{DS} = 0)		I_{G2SS}	 — —	 — —	 1.0 10	nAdc
ON CHARACTERISTICS						
Zero-Gate Voltage Drain Current (V_{DS} = 15 Vdc, V_{G1S} = 0, V_{G2S} = 4.0 Vdc)	 MFE3006 MFE3007 MFE3008	I_{DSS}	 2.0 5.0 2.0	 7.0 10 9.0	 18 20 20	mAdc
SMALL-SIGNAL CHARACTERISTICS						
Forward Transadmittance (Gate 1 to Drain) (V_{DS} = 15 Vdc, V_{G2S} = 4.0 Vdc, I_D = 10 mAdc, f = 1.0 kHz)	 MFE3006/8 MFE3007	y_{fs}	 8000 10,000	 — —	 18,000 18,000	μmhos
Input Capacitance (V_{DS} = 15 Vdc, V_{G2S} = 4.0 Vdc, I_D = 10 mAdc, f = 1.0 MHz)	 MFE3006/8 MFE3007	C_{iss}	 — —	 4.5 4.5	 6.0 5.5	pF
Output Capacitance (V_{DS} = 15 Vdc, V_{G2S} = 4.0 Vdc, I_D = 10 mAdc, f = 1.0 MHz)	 MFE3006/8 MFE3007	C_{oss}	 — —	 2.5 2.5	 4.0 3.5	pF
Reverse Transfer Capacitance (V_{DS} = 15 Vdc, V_{G2S} = 4.0 Vdc, I_D = 10 mAdc, f = 1.0 MHz)		C_{rss}	—	0.02	—	pF
Common-Source Noise Figure (V_{DS} = 15 Vdc, V_{G2S} = 4.0 Vdc, I_D = 10 mAdc, R_S = 1000 Ohms) f = 100 MHz, Figure 1 f = 200 MHz, Figure 4	 MFE3006 MFE3007	NF	 — —	 2.5 3.0	 4.0 4.0	dB
Common-Source Power Gain (V_{DS} = 15 Vdc, V_{G2S} = 4.0 Vdc, I_D = 10 mAdc) f = 100 MHz, Figure 1 f = 200 MHz, Figure 4	 MFE3006 MFE3007	G_{ps}	 20 18	 25 21	 — —	dB
Level of Unwanted Signal for 1.0% Cross Modulation (V_{DS} = 15 Vdc, V_{G2S} = 4.0 Vdc, I_D = 10 mAdc)		—	—	100	—	mV
Common-Source Conversion Power Gain (V_{DS} = 15 Vdc, V_{G2S} = 0.5 Vdc, Local Oscillator Voltage = 3.0 Vrms) Signal Frequency = 100 MHz, Local Oscillator Frequency = 130 MHz, Figure 3 Signal Frequency = 200 MHz, Local Oscillator Frequency = 230 MHz, Figure 6	 MFE3008 MFE3008	G_{ps}	 14 10	 17 13	 — —	dB

TEST CIRCUITS

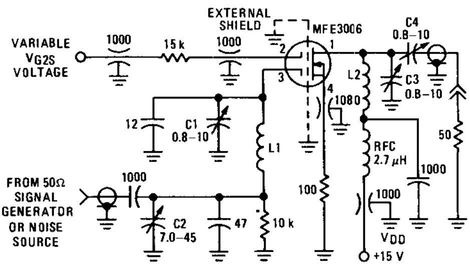
f = 100 MHz

FIGURE 1 – NOISE AND POWER GAIN



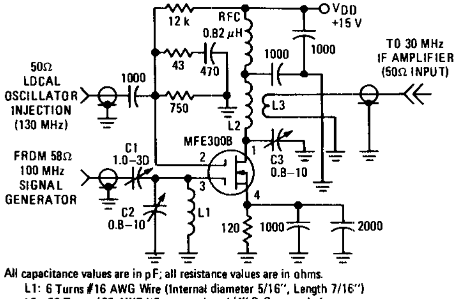
All capacitance values are in pF; all resistance values are in ohms.
C1, C3, C4: Jehanson Type 2951 or equivelent
C2: Centralab Type B25-G.N. or equivalent
L1: 5 Turns #16 AWG Wire (Internal diameter 5/16", Length 5/8")
L2: 5 Turns #16 AWG Wire (Internal diameter 3/8", Length 5/8")
Adjust C1, C2, C3 and C4 for maximum signal output; C1 and C2 for minimum noise figure, before measuring power gain.
Overall bandwidth = 3.0 MHz @ -3.0 dB
4.5 MHz @ -6.0 dB

FIGURE 2 – GAIN REDUCTION



All capacitance values are in pF; all resistance values are in ohms.
C1, C3, C4: Johenson Type 2951 or equivalent
C2: Centralab Type B25-G.N. or equivalent
L1: 5 Turns #16 AWG Wire (Internal diameter 5/16", Length 5/8")
L2: 5 Turns #16 AWG Wire (Internal diameter 3/8", Length 5/8")
Overall bandwidth = 3.0 MHz @ -3.0 dB
4.5 MHz @ -6.0 dB

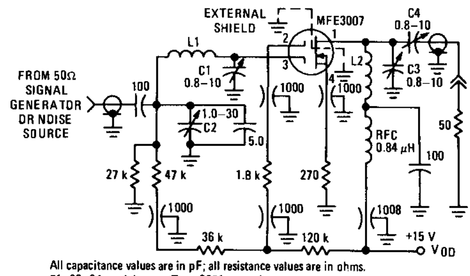
FIGURE 3 – CONVERSION POWER GAIN



All capacitance values are in pF; all resistance values are in ohms.
L1: 6 Turns #16 AWG Wire (Internal diameter 5/16", Length 7/16")
L2: 25 Turns #32 AWG Wire wound on 1/4" O.D. ceramic ferm
L3: 4 Turns #26 AWG Wire wound on top of and at dc supply end of L2
C1: Johanson Capacitor Type 3908 or equivalent
C2, C3: Johanson Capacitor Type 2950 or equivalent

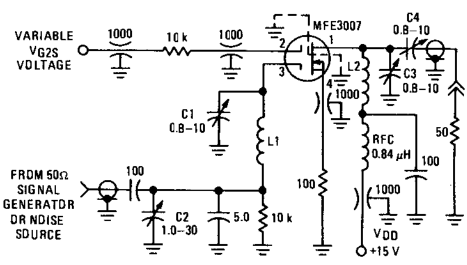
f = 200 MHz

FIGURE 4 – NOISE AND POWER GAIN



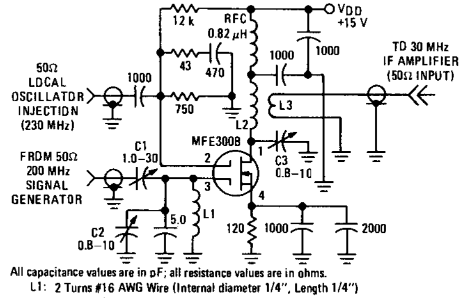
All capacitance values are in pF; all resistance values are in ohms.
C1, C3, C4: Johanson Type 2951 or equivalent
C2: Johanson Type 3988 or equivalent
L1: 4 Turns #16 AWG Wire (Internal diameter 1/4", Length 3/4")
L2: 5 Turns #16 AWG Wire (Internal diameter 1/4", Length 3/4")
Adjust C1, C2, C3 and C4 for maximum signal output; C1 and C2 for minimum noise figure, before measuring power gain.
Overall bandwidth = 9.5 MHz @ -3.0 dB
14 MHz @ -6.0 dB

FIGURE 5 – GAIN REDUCTION



All capacitance values are in pF; all resistance values are in ohms.
C1, C3, C4: Johansen Type 2951 or equivalent
C2: Johanson Type 3908 or equivalent
L1: 4 Turns #16 AWG Wire (Internal diameter 1/4", Length 3/4")
L2: 5 Turns #16 AWG Wire (Internal diameter 1/4", Length 3/4")
Overall bandwidth = 9.5 MHz @ -3.0 dB
14 MHz @ -6.0 dB

FIGURE 6 – CONVERSION POWER GAIN



All capacitance values are in pF; all resistance values are in ohms.
L1: 2 Turns #16 AWG Wire (Internal diameter 1/4", Length 1/4")
L2: 25 Turns #32 AWG Wire wound on 1/4" O.D. ceramic form
L3: 4 Turns #26 AWG Wire wound on top of and at dc supply end of L2
C1: Johanson Capacitor Type 3908 or equivalent
C2, C3: Johanson Capacitor Type 2950 or equivalent

CIRCUIT PERFORMANCE

FIGURE 7 – POWER GAIN versus SOURCE RESISTANCE

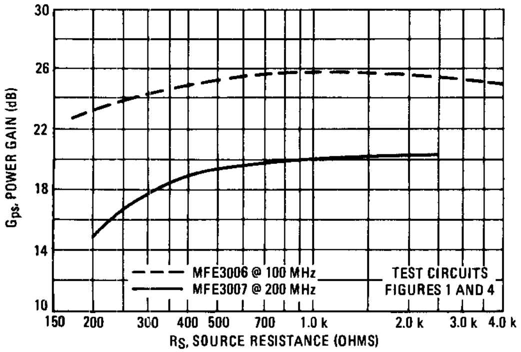


FIGURE 8 – NOISE FIGURE versus SOURCE RESISTANCE

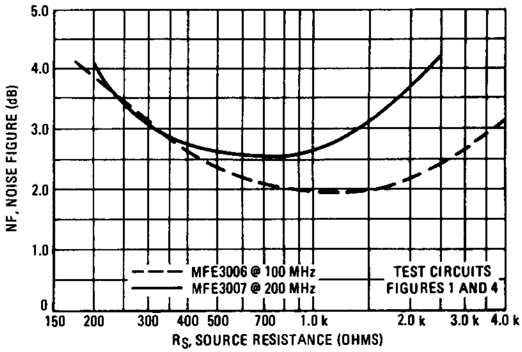


FIGURE 9 – GAIN REDUCTION

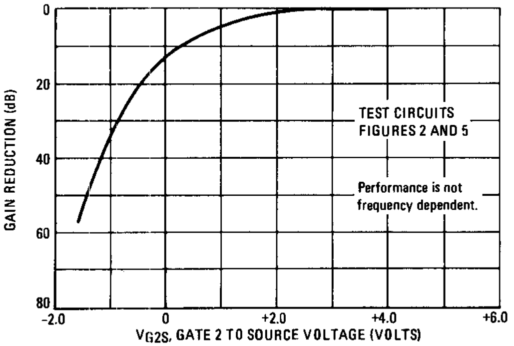


FIGURE 10 – COMMON SOURCE NOISE FIGURE versus GAIN REDUCTION

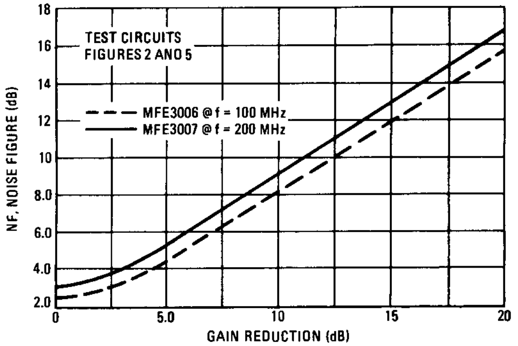


FIGURE 11 – CONVERSION POWER GAIN

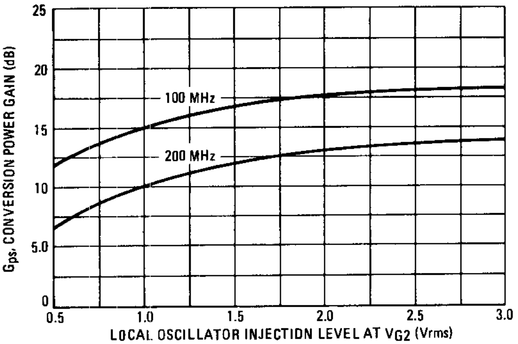
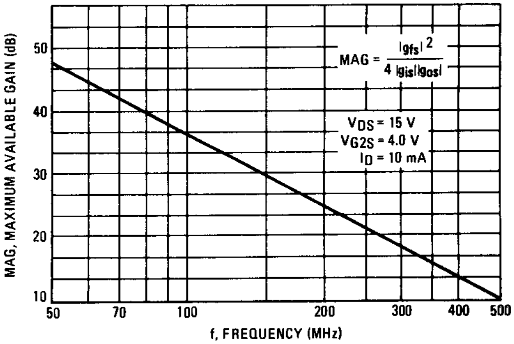


FIGURE 12 – MAXIMUM AVAILABLE POWER GAIN



COMMON-SOURCE ADMITTANCE PARAMETERS

(V_{DS} = 15 Vdc, V_{G2S} = 4.0 Vdc, I_D = 10 mAdc)

FIGURE 13 – INPUT ADMITTANCE

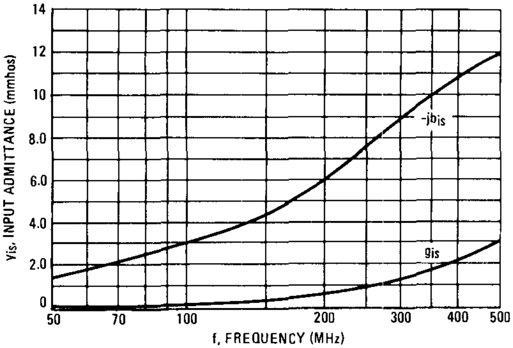


FIGURE 14 – REVERSE TRANSFER ADMITTANCE

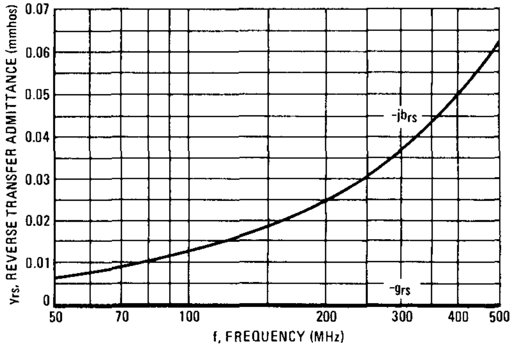


FIGURE 15 – FORWARD TRANSFER ADMITTANCE

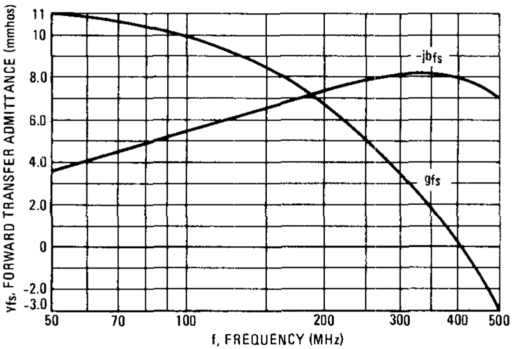
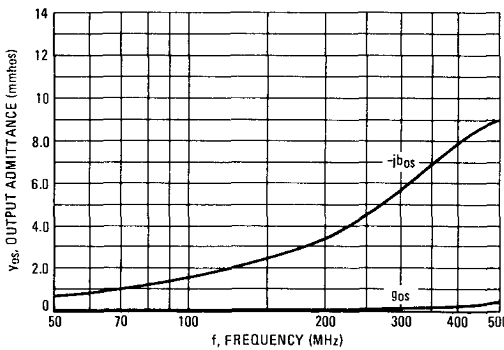


FIGURE 16 – OUTPUT ADMITTANCE



COMMON-SOURCE CIRCUIT DESIGN DATA AS A FUNCTION OF THE STERN "K" FACTOR

(V_{DS} = 15 Vdc, V_{G2S} = 4.0 Vdc, I_D = 10 mAdc)

FIGURE 17 – TRANSDUCER POWER GAIN

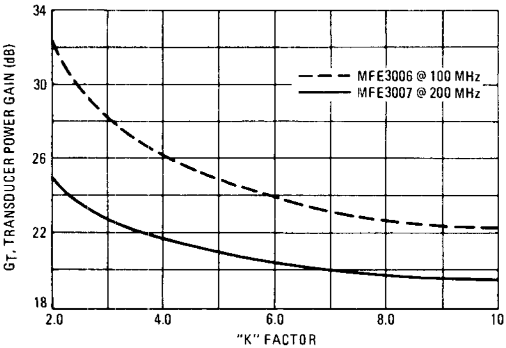


FIGURE 18 – SOURCE ADMITTANCE

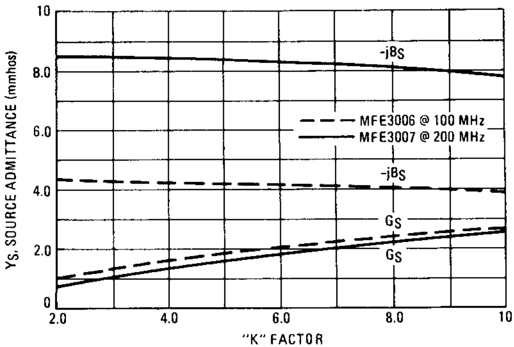
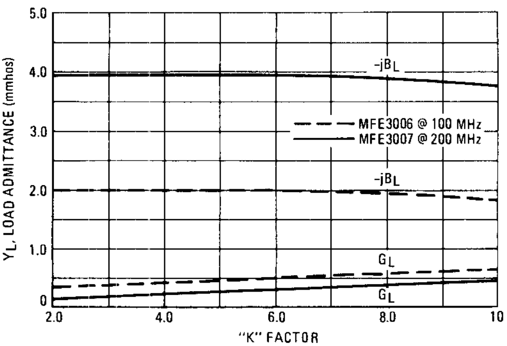


FIGURE 19 – LOAD ADMITTANCE



DESIGN NOTE

Figures 17-19 are included to assist the circuit designer in determining the transducer gain and the proper source and load admittances required for a given stability (Stern "K" factor*).

The Stern "K" factor has been defined to determine the stability of a practical amplifier terminated in finite load and source admittances. If "K" is greater than 1.0, the circuit will be stable. If less than 1.0, the circuit will be unstable. For further details, see Application Note AN-215.

As the C_{rss} of the MFE3006-7 is comparable to the distributed capacitance of the circuit where it is used, a feedback capacitance of 0.1 pF has been used throughout these calculations.

*"Stability and Power Gain of Tuned Transistor Amplifiers," Arthur P. Stern, Proc. I.R.E., March 1967.

MJ500 (SILICON)
MJ501

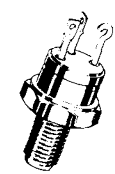
MEDIUM-POWER PNP SILICON TRANSISTORS

. . . designed for switching and wide-band amplifier applications.

- Low Collector Emitter Saturation Voltage — $V_{CE(sat)}$ = 1.2 Vdc (Max) @ I_C = 7.0 Adc
- DC Current Gain Specified to 5 Amperes
- Excellent Safe Operating Area
- Packaged in the Compact, High Dissipation TO-59 Case
- Collector Common to Case

7 AMPERE
POWER TRANSISTORS
PNP SILICON

60-80 VOLTS
60 WATTS

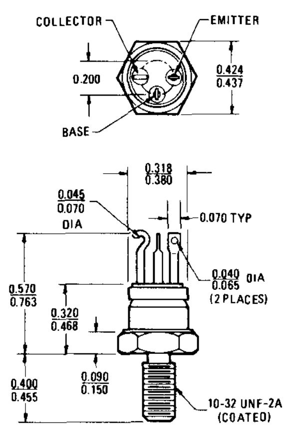


MAXIMUM RATINGS

Rating	Symbol	MJ500	MJ501	Unit
Collector-Emitter Voltage	V_{CEO}	60	80	Vdc
Collector-Base Voltage	V_{CB}	60	80	Vdc
Emitter-Base Voltage	V_{EB}	5.0		Vdc
Collector Current — Continuous	I_C	7.0		Adc
Base Current — Continuous	I_B	1.0		Adc
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	60 343		Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	-65 to +200		°C

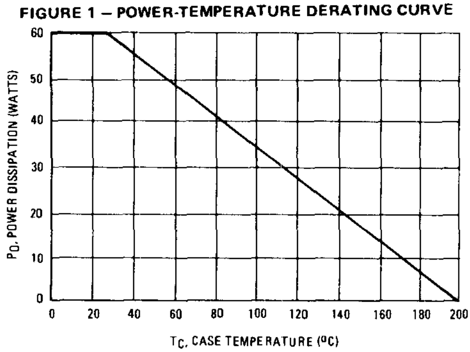
THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	θ_{JC}	2.91	°C/W



CASE 160A
TO-59
Collector Common to Case

FIGURE 1 — POWER-TEMPERATURE DERATING CURVE



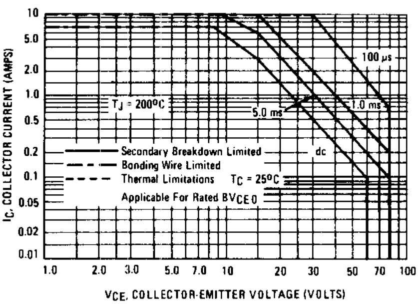
Safe Area Curves are indicated by Figure 2.
All limits are applicable and must be observed.

ELECTRICAL CHARACTERISTICS ($T_C = 25^oC$ unless otherwise noted)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Sustaining Voltage*	$V_{CEO(sus)}$*			Vdc
(I_C = 50 mAdc, I_B = 0) MJ500		60	–	
MJ501		80	–	
Collector Cutoff Current	I_{CEO}			µAdc
(V_{CE} = 55 Vdc, I_B = 0) MJ500		–	100	
(V_{CE} = 75 Vdc, I_B = 0) MJ501		–	100	
Collector Cutoff Current	I_{CEX}			
(V_{CE} = 55 Vdc, $V_{BE(off)}$ = 1.5 Vdc) MJ500		–	10	µAdc
(V_{CE} = 75 Vdc, $V_{BE(off)}$ = 1.5 Vdc) MJ501		–	10	
(V_{CE} = 55 Vdc, $V_{BE(off)}$ = 1.5 Vdc, $T_C = 150^oC$) MJ500		–	1.0	mAdc
(V_{CE} = 75 Vdc, $V_{BE(off)}$ = 1.5 Vdc, $T_C = 150^oC$) MJ501		–	1.0	
Collector Cutoff Current (V_{CB} = Rated V_{CB}, I_C = 0)	I_{CBO}	–	10	µAdc
Emitter Cutoff Current (V_{BE} = 5.0 Vdc, I_C = 0)	I_{EBO}	–	100	µAdc
ON CHARACTERISTICS				
DC Current Gain*	h_{FE}*			–
(I_C = 500 mAdc, V_{CE} = 2.0 Vdc)		25	–	
(I_C = 2.0 Adc, V_{CE} = 2.0 Vdc)		25	180	
(I_C = 5.0 Adc, V_{CE} = 2.0 Vdc)		15	–	
Collector-Emitter Saturation Voltage*	$V_{CE(sat)}$*			Vdc
(I_C = 2.0 Adc, I_B = 0.2 Adc)		–	0.7	
(I_C = 7.0 Adc, I_B = 0.7 Adc)		–	1.2	
Base-Emitter Saturation Voltage*	$V_{BE(sat)}$*			Vdc
(I_C = 2.0 Adc, I_B = 0.2 Adc)		–	1.2	
(I_C = 7.0 Adc, I_B = 0.7 Adc)		–	2.0	
DYNAMIC CHARACTERISTICS				
Current-Gain—Bandwidth Product (I_C = 500 mAdc, V_{CE} = 10 Vdc, f = 10 MHz)	f_T	30	–	MHz
Output Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 100 kHz)	C_{ob}	–	300	pF
Input Capacitance (V_{BE} = 2.0 Vdc, I_C = 0, f = 100 kHz)	C_{ib}	–	1250	pF
SWITCHING CHARACTERISTICS				
Delay Time (V_{CC} = 40 Vdc, $V_{BE(off)}$ = 4.0 Vdc, I_C = 2.0 Adc, I_{B1} = 200 mAdc)	t_d	–	100	ns
Rise Time (V_{CC} = 40 Vdc, $V_{BE(off)}$ = 4.0 Vdc, I_C = 2.0 Adc, I_{B1} = 200 mAdc)	t_r	–	100	ns
Storage Time (V_{CC} = 40 Vdc, I_C = 2.0 Adc, $I_{B1} = I_{B2}$ = 200 mAdc)	t_s	–	1.0	µs
Fall Time (V_{CC} = 40 Vdc, I_C = 2.0 Adc, $I_{B1} = I_{B2}$ = 200 mAdc)	t_f	–	150	ns

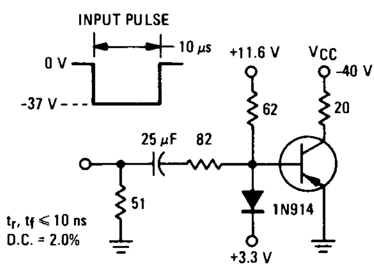
*Pulse Test: Pulse Width = 300 µs, Duty Cycle = 2.0%.

FIGURE 2 – ACTIVE-REGION SAFE OPERATING AREA



The Safe Operating Area Curves indicate I_C–V_{CE} limits below which the device will not enter secondary breakdown. Collector load lines for specific circuits must fall within the applicable Safe Area to avoid causing a catastrophic failure. To insure operation below the maximum T_J, power-temperature derating must be observed for both steady state and pulse power conditions.

FIGURE 3 – SWITCHING TIME TEST CIRCUIT



MJ802 (SILICON)

HIGH-POWER NPN SILICON TRANSISTOR

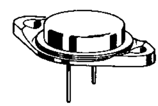
. . . for use as an output device in complementary audio amplifiers to 100-Watts music power per channel.

- High DC Current Gain – h_{FE} = 25–100 @ I_C = 7.5 A
- Excellent Safe Operating Area
- Complement to the PNP MJ4502

30 AMPERE
POWER TRANSISTOR

NPN SILICON

100 VOLTS
200 WATTS



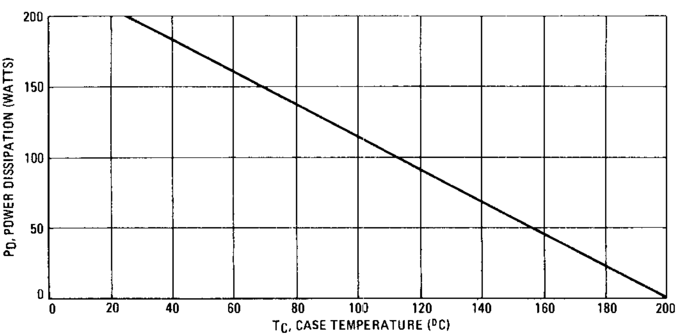
MAXIMUM RATINGS

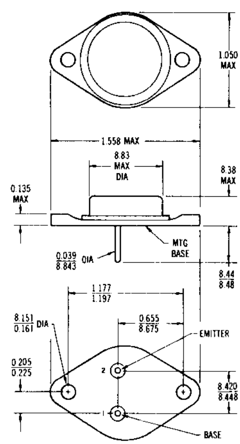
Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CER}	100	Vdc
Collector-Base Voltage	V_{CB}	100	Vdc
Collector-Emitter Voltage	V_{CEO}	90	Vdc
Emitter-Base Voltage	V_{EB}	4.0	Vdc
Collector Current	I_C	30	Adc
Base Current	I_B	7.5	Adc
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	200 1.14	Watts W/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	-65 to +200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	θ_{JC}	0.875	°C/W

FIGURE 1 – POWER-TEMPERATURE DERATING CURVE





CASE 11
(TO-3)
Collector Connected to Case

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage* (I_C = 200 mAdc, R_{BE} = 100 Ohms)	BV_{CER}*	100	–	Vdc
Collector-Emitter Sustaining Voltage* (I_C = 200 mAdc)	$BV_{CEO(sus)}$*	90	–	Vdc
Collector-Base Cutoff Current	I_{CBO}			mAdc
(V_{CB} = 100 Vdc, I_E = 0)		–	1.0	
(V_{CB} = 100 Vdc, I_E = 0, T_C = 150°C)		–	5.0	
Emitter-Base Cutoff Current (V_{BE} = 4.0 Vdc, I_C = 0)	I_{EBO}	–	1.0	mAdc
ON CHARACTERISTICS				
DC Current Gain* (I_C = 7.5 Adc, V_{CE} = 2.0 Vdc)	h_{FE}*	25	100	–
Base-Emitter "On" Voltage* (I_C = 7.5 Adc, V_{CE} = 2.0 Vdc)	$V_{BE(on)}$*	–	1.3	Vdc
Collector-Emitter Saturation Voltage* (I_C = 7.5 Adc, I_B = 0.75 Adc)	$V_{CE(sat)}$*	–	0.8	Vdc
Base-Emitter Saturation Voltage* (I_C = 7.5 Adc, I_B = 0.75 Adc)	$V_{BE(sat)}$*	–	1.3	Vdc
DYNAMIC CHARACTERISTICS				
Current Gain – Bandwidth Product (I_C = 1.0 Adc, V_{CE} = 10 Vdc, f = 1.0 MHz)	f_T	2.0	–	MHz

*Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

FIGURE 2 – DC CURRENT GAIN

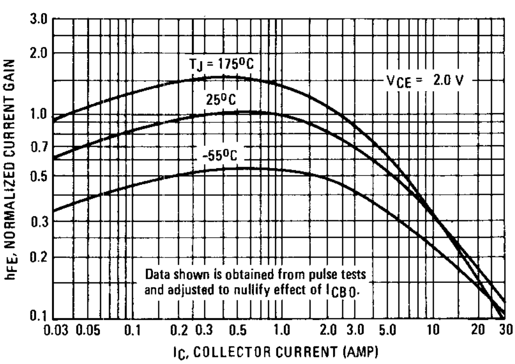


FIGURE 3 – "ON" VOLTAGES

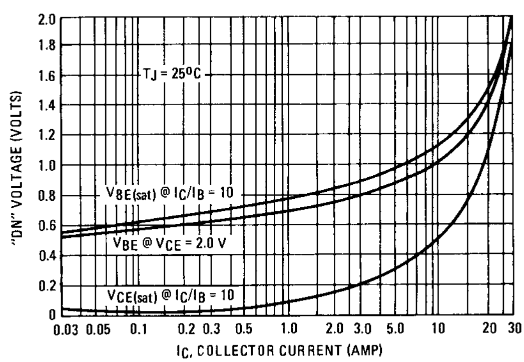
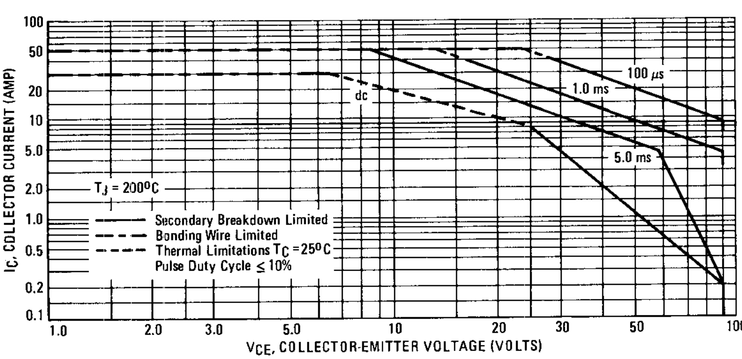


FIGURE 4 – ACTIVE REGION SAFE OPERATING AREA



The Safe Operating Area Curves indicate I_C – V_{CE} limits below which the device will not enter secondary breakdown. Collector load lines for specific circuits must fall within the applicable Safe Area to avoid causing a catastrophic failure. To insure operation below the maximum T_J, power-temperature derating must be observed for both steady state and pulse power conditions.

MJ1800 (SILICON)

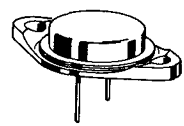
HIGH-VOLTAGE NPN SILICON TRANSISTOR

. . . designed for use in vertical deflection amplifier circuits in television receivers.

- High Collector-Emitter Voltage — V_{CER} = 500 Vdc
- Excellent Gain Linearity

5 AMPERES
POWER TRANSISTOR
NPN SILICON

500 VOLTS
100 WATTS



MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	250	Vdc
Collector-Emitter Voltage	V_{CER}	500	Vdc
Emitter-Base Voltage	V_{EB}	5.0	Vdc
Collector Current — Continuous	I_C	5.0	Adc
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	100 0.8	Watts W/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	-55 to +150	°C

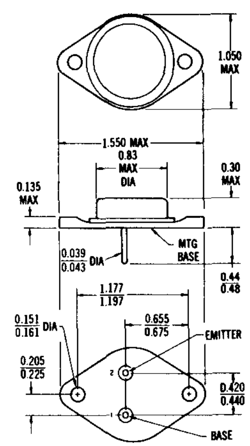
THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	θ_{JC}	1.25	°C/W

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage* (I_C = 0.1 Adc, I_B = 0)	BV_{CEO}*	250	–	Vdc
Collector Cutoff Current (V_{CE} = 500 Vdc, R_{BE} = 1.5 k Ohms)	I_{CER}	–	200	µAdc
Emitter-Base Leakage Current (V_{EB} = 5.0 Vdc, I_C = 0)	I_{EBO}	–	100	µAdc
ON CHARACTERISTICS				
DC Current Gain* (I_C = 0.3 Adc, V_{CE} = 5.0 Vdc)	h_{FE1}*	35	–	–
DC Current Gain* (I_C = 0.4 Adc, V_{CE} = 5.0 Vdc)	h_{FE2}*	40	120	–
Gain Linearity	h_{FE1}/h_{FE2}	0.95	–	–

*Pulse Test: Pulse Width ≤ 500 µs, Duty Cycle ≤ 2.0%.



Collector Connected to Case
CASE 11
TO-3

FIGURE 1 – POWER-TEMPERATURE DERATING CURVE

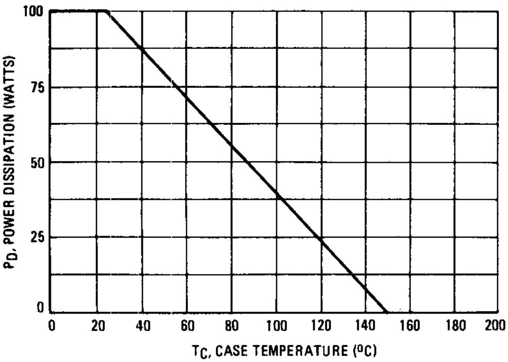


FIGURE 2 – NORMALIZED DC CURRENT GAIN

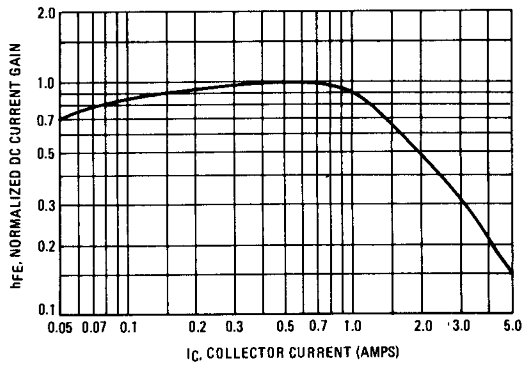
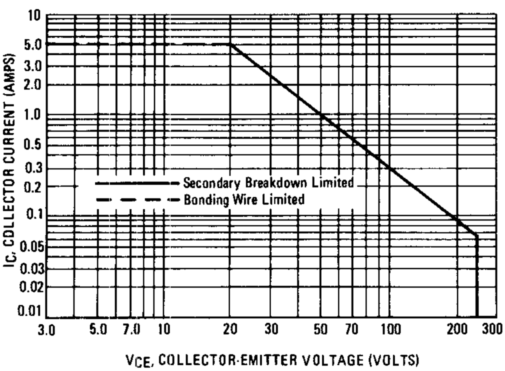


FIGURE 3 – ACTIVE-REGION DC SAFE OPERATING AREA



The Safe Operating Area Curves indicate $I_C - V_{CE}$ limits below which the device will not enter secondary breakdown. Collector load lines for specific circuits must fall within the applicable Safe Area to avoid causing a catastrophic failure. To insure operation below the maximum T_J, power-temperature derating must be observed for both steady state and pulse power conditions.

MJ3771
MJ3772

For Specifications, See 2N3771 Data.

MJ3801 (SILICON)
MJ3802

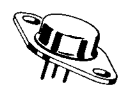
MEDIUM POWER NPN SILICON TRANSISTORS

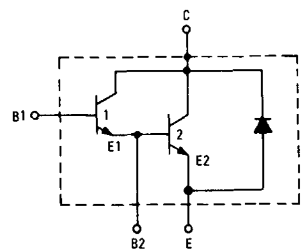
. . . designed for use in industrial and military amplifier and switching systems.

- High DC Current Gain – h_{FE} = 1,000 (Min) @ I_C = 10 Adc
- Low Collector-Emitter Cutoff Current – I_{CE2S} = 10 μAdc (Max) @ V_{CE2} = 80 Vdc
- Darlington Connection

10 AMPERE
POWER TRANSISTORS
NPN SILICON

80 VOLTS
40 WATTS



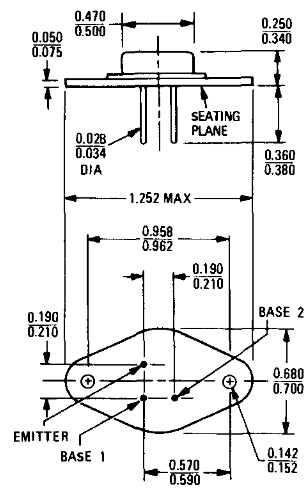


MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CE20}	80	Vdc
Collector-Base Voltage	V_{CB1}	80	Vdc
Collector-Base Voltage	V_{CB2}	80	Vdc
Emitter-Base Voltage	V_{E2B1}	15	Vdc
Emitter-Base Voltage	V_{E2B2}	7.5	Vdc
Emitter-Base Voltage	V_{E1B1}	7.5	Vdc
Collector Current – Continuous Peak	I_C	10 15	Adc
Base Current	I_{B1}	0.5	Adc
Base Current	I_{B2}	2.0	Adc
Commutating-Diode Current	I_D	10	Adc
Total Device Dissipation @ T_C = 25°C Derate linearly from 25°C	P_D	40 0.228	Watts W/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	-65 to +200	°C

THERMAL CHARACTERISTICS

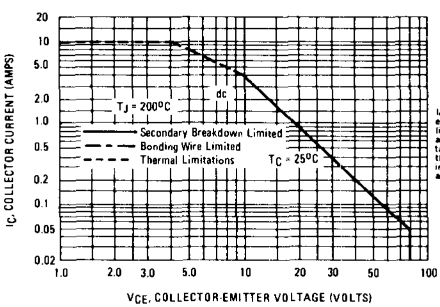
Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	θ_{JC}	4.38	°C/W



CASE 198
(STYLE 2)

(Collector Connected to Case)

FIGURE 1 – DC SAFE OPERATING AREA

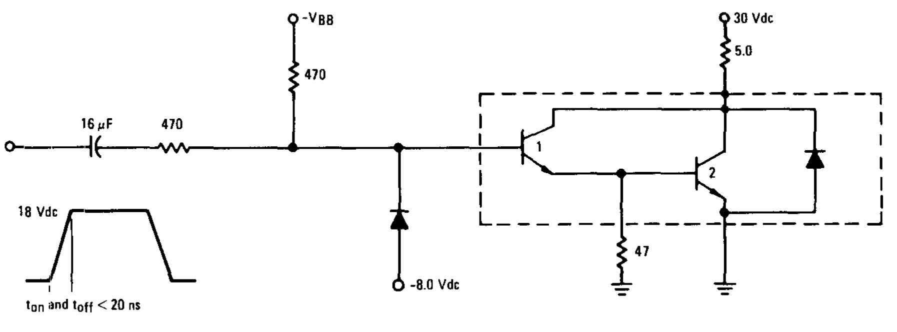


The Safe Operating Area Curves indicate I_C-V_{CE} limits below which the device will not enter secondary breakdown. Collector load lines for specific circuits must fall within the applicable Safe Area to avoid causing a catastrophic failure. To insure operation below the maximum T_J, power-temperature derating must be observed for both steady state and pulse power conditions.

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown (I_C = 25 mAdc, I_{B1} = I_{B2} = 0)		BV_{CEO}	80	–	Vdc
Collector-Base Cutoff Current (V_{CB1} = 80 Vdc, I_{B2} = 0)		I_{CB1O}	–	10	μAdc
Collector-Emitter Cutoff Current		I_{CE2S}			μAdc
(V_{CE} = 80 Vdc, V_{B1E} = 0, V_{B1E} = 0)			–	10	
(V_{CE} = 80 Vdc, V_{B1E} = 0, V_{B1E} = 0, T_C = 150°C)			–	1.0	mAdc
Emitter Cutoff Current (V_{EB1} = 15 Vdc, I_C = 0, I_{B2} = 0)		I_{E2B1O}	–	10	μAdc
ON CHARACTERISTICS					
DC Current Gain		h_{FE}			–
(I_C = 1.0 Adc, V_{CE} = 2.0 Vdc, I_{B2} = 0)	MJ3801		20,000	–	
	MJ3802		2000	–	
(I_C = 6.0 Adc, V_{CE} = 4.0 Vdc, I_{B2} = 0)	MJ3801		10,000	60,000	
	MJ3802		1000	20,000	
(I_C = 10 Adc, V_{CE} = 4.0 Vdc, I_{B2} = 0)	MJ3801		1000	–	
	MJ3802		250	–	
Collector-Emitter Saturation Voltage		$V_{CE2(sat)}$			Vdc
(I_C = 6.0 Adc, I_{B1} = 15 mAdc, I_{B2} = 0)			–	1.5	
(I_C = 10 Adc, I_{B1} = 25 mAdc, I_{B2} = 0)			–	2.0	
(I_C = 10 Adc, I_{B1} = 50 mAdc, I_{B2} = 0)			–	2.0	
Base-Emitter Voltage (I_C = 6.0 Adc, V_{CE} = 2.0 Vdc, I_{B2} = 0)		V_{B1E2}	–	2.0	Vdc
Base-Emitter Saturation Voltage		$V_{B1E2(sat)}$			Vdc
(I_C = 10 Adc, I_{B1} = 25 mAdc, I_{B2} = 0)	MJ3801		–	2.5	
(I_C = 10 Adc, I_{B1} = 50 mAdc, I_{B2} = 0)	MJ3802		–	2.5	
Commutating-Diode Forward Voltage (I_E = 6.0 Adc, I_{B1} = I_{B2} = 0)		V_{E2C}	–	2.0	Vdc
DYNAMIC CHARACTERISTICS					
Current-Gain—Bandwidth Product (V_{CE1} = 10 Vdc, I_C = 1.0 Adc, I_{B2} = 0, f = 1.0 MHz)		f_T	50	–	MHz
Output Capacitance (V_{CB1} = 10 Vdc, I_E = I_{B2} = 0, f = 1.0 MHz)		C_{ob1}	–	75	pF
SWITCHING CHARACTERISTICS					
Delay Time	(I_C = 6.0 Adc, $I_{B1(on)}$ = $I_{B1(off)}$ = 15 mAdc, V_{CC} = 30 Vdc, V_{OB1} = 8.0 Vdc, R_{B2E2} = 47 Ohms)	t_d	–	200	ns
Rise Time		t_r	–	200	ns
Storage Time		t_s	–	3.0	μs
Fall Time		t_f	–	200	ns

FIGURE 2 – THERMAL RESPONSE SWITCHING CIRCUIT



MJ4502 (SILICON)

HIGH-POWER PNP SILICON TRANSISTOR

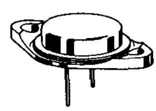
. . . for use as an output device in complementary audio amplifiers to 100-Watts music power per channel.

- High DC Current Gain – h_{FE} = 25–100 @ I_C = 7.5 A
- Excellent Safe Operating Area
- Complement to the NPN MJ802

30 AMPERE
POWER TRANSISTOR

PNP SILICON

100 VOLTS
200 WATTS



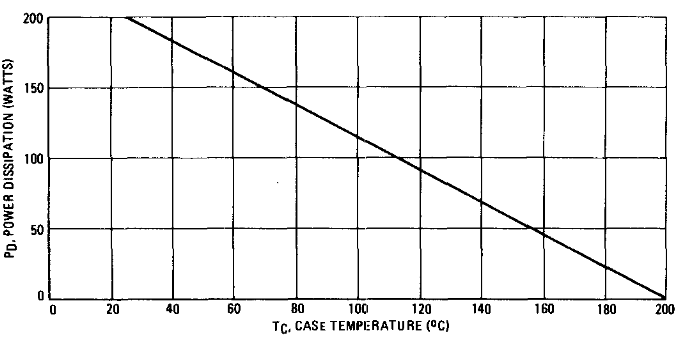
MAXIMUM RATINGS

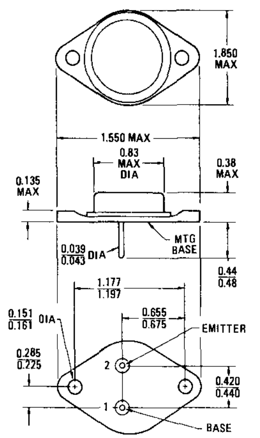
Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CER}	100	Vdc
Collector-Base Voltage	V_{CB}	100	Vdc
Collector-Emitter Voltage	V_{CEO}	90	Vdc
Emitter-Base Voltage	V_{EB}	4.0	Vdc
Collector Current	I_C	30	Adc
Base Current	I_B	7.5	Adc
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	200 1.14	Watts W/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	-65 to +200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	θ_{JC}	0.875	°C/W

FIGURE 1 – POWER-TEMPERATURE DERATING CURVE





CASE 11
(TO-3)

Collector Connected to Case

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage* (I_C = 200 mAdc, R_{BE} = 100 Ohms)	BV_{CER}*	100	–	Vdc
Collector-Emitter Sustaining Voltage* (I_C = 200 mAdc)	$BV_{CEO(sus)}$*	90	–	Vdc
Collector-Base Cutoff Current (V_{CB} = 100 Vdc, I_E = 0) (V_{CB} = 100 Vdc, I_E = 0, T_C = 150°C)	I_{CBO}	– –	1.0 5.0	mAdc
Emitter-Base Cutoff Current (V_{BE} = 4.0 Vdc, I_C = 0)	I_{EBO}	–	1.0	mAdc
ON CHARACTERISTICS				
DC Current Gain* (I_C = 7.5 Adc, V_{CE} = 2.0 Vdc)	h_{FE}*	25	100	–
Base-Emitter "On" Voltage* (I_C = 7.5 Adc, V_{CE} = 2.0 Vdc)	$V_{BE(on)}$*	–	1.3	Vdc
Collector-Emitter Saturation Voltage* (I_C = 7.5 Adc, I_B = 0.75 Adc)	$V_{CE(sat)}$*	–	0.8	Vdc
Base-Emitter Saturation Voltage* (I_C = 7.5 Adc, I_B = 0.75 Adc)	$V_{BE(sat)}$*	–	1.3	Vdc
DYNAMIC CHARACTERISTICS				
Current Gain – Bandwidth Product (I_C = 1.0 Adc, V_{CE} = 10 Vdc, f = 1.0 MHz)	f_T	2.0	–	MHz

*Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

FIGURE 2 – DC CURRENT GAIN

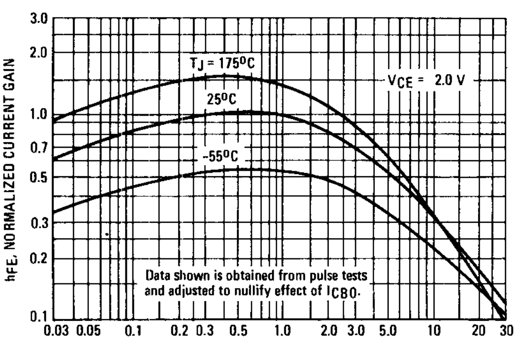


FIGURE 3 – "ON" VOLTAGES

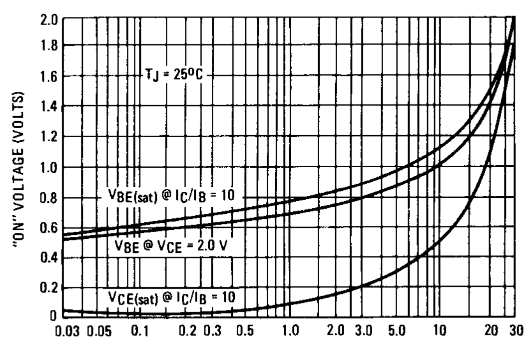
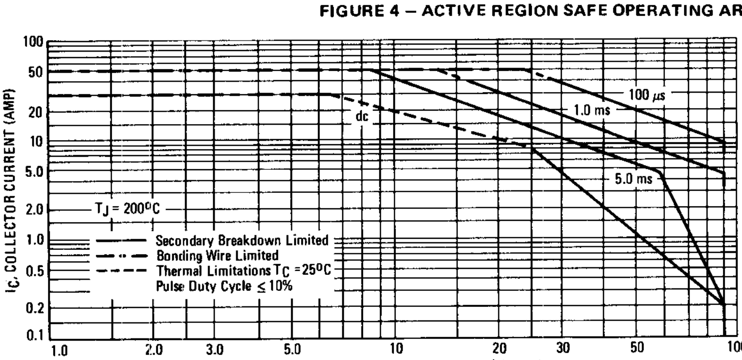


FIGURE 4 – ACTIVE REGION SAFE OPERATING AREA



The Safe Operating Area Curves indicate $I_C - V_{CE}$ limits below which the device will not enter secondary breakdown. Collector load lines for specific circuits must fall within the applicable Safe Area to avoid causing a catastrophic failure. To insure operation below the maximum T_J, power-temperature derating must be observed for both steady state and pulse power conditions.

MJ6700 (SILICON)
MJ6701

MEDIUM-POWER PNP SILICON TRANSISTORS

. . . designed for switching and wide-band amplifier applications.

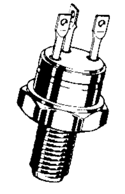
- Low Collector-Emitter Saturation Voltage – $V_{CE(sat)}$ = 1.2 Vdc (Max) @ I_C = 7.0 Adc
- DC Current Gain Specified to 5 Amperes
- Excellent Safe Operating Area
- Packaged in the Compact, High Dissipation TO-59 Case
- Isolated Collector Configuration – 700 V Breakdown

**7 AMPERE
POWER TRANSISTORS
PNP SILICON**

**60-80 VOLTS
60 WATTS**

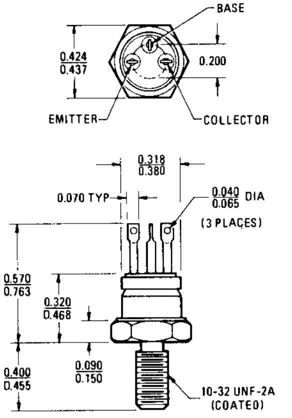
MAXIMUM RATINGS

Rating	Symbol	MJ6700	MJ6701	Unit
Collector-Emitter Voltage	V_{CEO}	60	80	Vdc
Collector-Base Voltage	V_{CB}	60	80	Vdc
Emitter-Base Voltage	V_{EB}	5.0		Vdc
Collector Current – Continuous	I_C	7.0		Adc
Base Current	I_B	1.0		Adc
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	60 343		Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	-65 to +200		°C



THERMAL CHARACTERISTICS

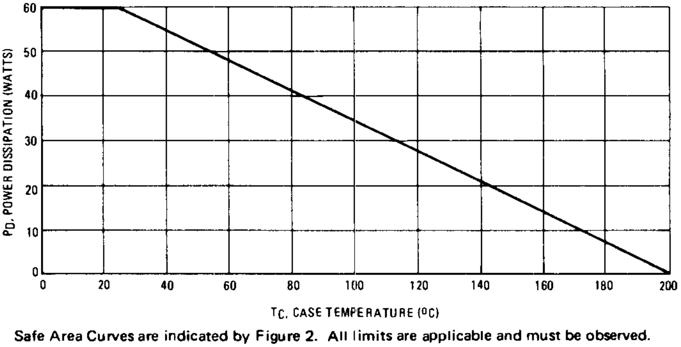
Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	θ_{JC}	2.91	°C/W



Isolated Collector

CASE 160
TO-59

FIGURE 1 – POWER-TEMPERATURE DERATING CURVE



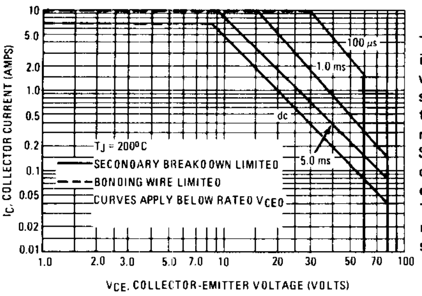
Safe Area Curves are indicated by Figure 2. All limits are applicable and must be observed.

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Sustaining Voltage* (I_C = 50 mAdc, I_B = 0) MJ6700	$BV_{CEO(sus)}$*	60	–	Vdc
MJ6701		80	–	
Collector Cutoff Current (V_{CE} = 55 Vdc, I_B = 0) MJ6700	I_{CEO}	–	100	μAdc
(V_{CE} = 75 Vdc, I_B = 0) MJ6701		–	100	
Collector Cutoff Current (V_{CE} = 55 Vdc, $V_{BE(off)}$ = 1.5 Vdc) MJ6700	I_{CEX}	–	10	μAdc
(V_{CE} = 75 Vdc, $V_{BE(off)}$ = 1.5 Vdc) MJ6701		–	10	
(V_{CE} = 55 Vdc, $V_{BE(off)}$ = 1.5 Vdc, T_C = 150°C) MJ6700		–	1.0	mAdc
(V_{CE} = 75 Vdc, $V_{BE(off)}$ = 1.5 Vdc, T_C = 150°C) MJ6701		–	1.0	
Collector Cutoff Current (V_{CB} = Rated V_{CB}, I_E = 0)	I_{CBO}	–	10	μAdc
Emitter Cutoff Current (V_{EB} = 5.0 Vdc, I_C = 0)	I_{EBO}	–	100	μAdc
ON CHARACTERISTICS				
DC Current Gain* (I_C = 500 mAdc, V_{CE} = 2.0 Vdc)	h_{FE}*	25	–	–
(I_C = 2.0 Adc, V_{CE} = 2.0 Vdc)		25	180	
(I_C = 5.0 Adc, V_{CE} = 2.0 Vdc)		15	–	
Collector-Emitter Saturation Voltage* (I_C = 2.0 Adc, I_B = 0.2 Adc)	$V_{CE(sat)}$*	–	0.7	Vdc
(I_C = 7.0 Adc, I_B = 0.7 Adc)		–	1.2	
Base-Emitter Saturation Voltage* (I_C = 2.0 Adc, I_B = 0.2 Adc)	$V_{BE(sat)}$*	–	1.2	Vdc
(I_C = 7.0 Adc, I_B = 0.7 Adc)		–	2.0	
DYNAMIC CHARACTERISTICS				
Current-Gain-Bandwidth Product (I_C = 500 mAdc, V_{CE} = 10 Vdc, f = 10 MHz)	f_T	30	–	MHz
Output Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 100 kHz)	C_{ob}	–	300	pF
Input Capacitance (V_{BE} = 2.0 Vdc, I_C = 0, f = 100 kHz)	C_{ib}	–	1250	pF
SWITCHING CHARACTERISTICS				
Delay Time (V_{CC} = 40 Vdc, $V_{BE(off)}$ = 4.0 Vdc,	t_d	–	100	ns
Rise Time I_C = 2.0 Adc, I_{B1} = 200 mAdc)	t_r	–	100	ns
Storage Time (V_{CC} = 40 Vdc, I_C = 2.0 Adc,	t_s	–	1.0	μs
Fall Time I_{B1} = I_{B2} = 200 mAdc)	t_f	–	150	ns

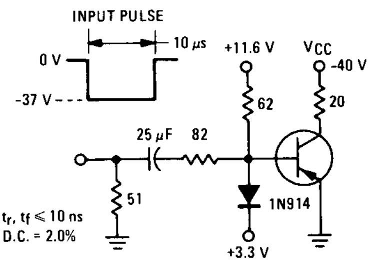
*Pulse Test: Pulse Width = 300 μs, Duty Cycle = 2.0%

FIGURE 2 — ACTIVE-REGION SAFE OPERATING AREA



The Safe Operating Area Curves indicate $I_C - V_{CE}$ limits below which the device will not enter secondary breakdown. Collector load lines for specific circuits must fall within the applicable Safe Area to avoid causing a catastrophic failure. To insure operation below the maximum T_J, power-temperature derating must be observed for both steady state and pulse power conditions.

FIGURE 3 — SWITCHING TIME TEST CIRCUIT



MJ7000 (SILICON)

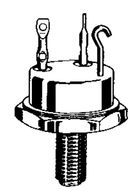
HIGH-POWER NPN SILICON TRANSISTOR

. . . designed for use in industrial power amplifier and switching circuits applications.

- High DC Current Gain —
  h_{FE} = 20-100 @ I_C = 10 Adc
- High Collector-Emitter Sustaining Voltage —
  $V_{CEO(sus)}$ = 100 Vdc (Min) @ I_C = 100 mAdc
- Low Collector-Emitter Saturation Voltage —
  $V_{CE(sat)}$ = 1.7 Vdc (Max) @ I_C = 30 Adc

30 AMPERE
POWER TRANSISTOR
NPN SILICON

100 VOLTS
150 WATTS

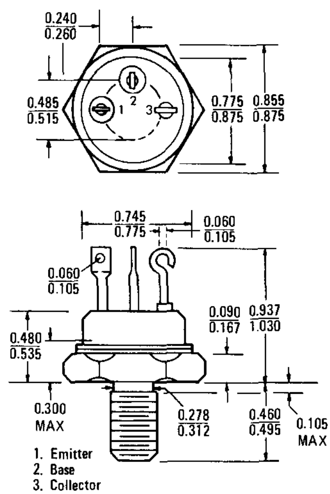


MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	100	Vdc
Collector-Base Voltage	V_{CB}	100	Vdc
Emitter-Base Voltage	V_{EB}	7.0	Vdc
Collector Current — Continuous	I_C	30	Adc
Base Current — Continuous	I_B	10	Adc
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	150 0.855	Watts W/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	-65 to +200	°C

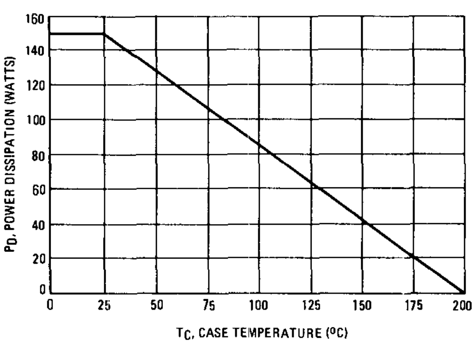
THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	θ_{JC}	1.17	°C/W



CASE 188
TO-63

FIGURE 1 — POWER-TEMPERATURE DERATING CURVE



ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Sustaining Voltage* (I_C = 100 mAdc, I_B = 0)	$V_{CEO(sus)}$*	100	–	Vdc
Collector-Emitter Cutoff Current (V_{CE} = 50 Vdc, I_B = 0)	I_{CEO}	–	10	μAdc
Collector-Emitter Cutoff Current (V_{CE} = 90 Vdc, $V_{EB(off)}$ = 1.5 Vdc)	I_{CEX}	–	5.0	μAdc
Collector-Base Cutoff Current (V_{CB} = 100 Vdc, I_E = 0)	I_{CBO}	–	5.0	μAdc
Emitter-Base Cutoff Current (V_{BE} = 7.0 Vdc, I_C = 0)	I_{EBO}	–	5.0	μAdc
ON CHARACTERISTICS				
OC Current Gain*	h_{FE}*			–
(I_C = 1.0 Adc, V_{CE} = 4.0 Vdc)		20	–	
(I_C = 10 Adc, V_{CE} = 4.0 Vdc)		20	100	
(I_C = 30 Adc, V_{CE} = 4.0 Vdc)		10	–	
Collector-Emitter Saturation Voltage*	$V_{CE(sat)}$*			Vdc
(I_C = 10 Adc, I_B = 1.0 Adc)		–	1.0	
(I_C = 30 Adc, I_B = 4.0 Adc)		–	1.7	
Base-Emitter Saturation Voltage*	$V_{BE(sat)}$*			Vdc
(I_C = 10 Adc, I_B = 1.0 Adc)		–	1.7	
(I_C = 30 Adc, I_B = 4.0 Adc)		–	2.25	
Base-Emitter On Voltage* (I_C = 10 Adc, V_{CE} = 4.0 Vdc)	$V_{BE(on)}$*	–	1.5	Vdc
DYNAMIC CHARACTERISTICS				
Current-Gain—Bandwidth Product (I_C = 1.0 Adc, V_{CE} = 5.0 Vdc, f = 20 MHz)	f_T	30	–	MHz
Output Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 100 kHz)	C_{ob}	–	600	pF

*Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

MJ7200 (SILICON)
MJ7201

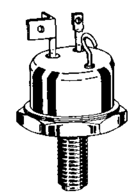
HIGH-POWER NPN SILICON TRANSISTORS

. . . designed for use in high reliability power amplifier and switching circuits applications.

- High DC Current Gain –
  h_{FE} = 20–100 @ I_C = 20 Adc
- High Collector-Emitter Sustaining Voltage –
  $V_{CEO(sus)}$ = 100 Vdc (Min) @ I_C = 200 mAdc – MJ7201
- Low Collector-Emitter Saturation Voltage –
  $V_{CE(sat)}$ = 1.5 Vdc (Max) @ I_C = 40 Adc
- High Current-Gain–Bandwidth Product –
  f_T = 20 MHz (Min) @ I_C = 0.7 Adc

60 AMPERE
POWER TRANSISTORS
NPN SILICON

80–100 VOLTS
300 WATTS



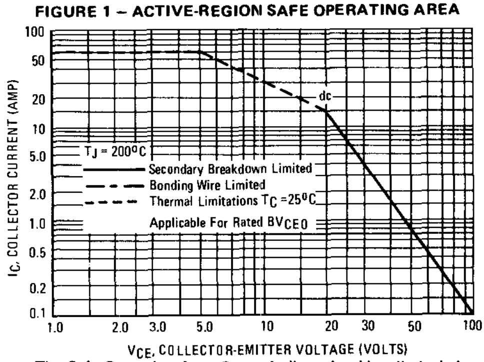
MAXIMUM RATINGS

Rating	Symbol	MJ7200	MJ7201	Unit
Collector-Emitter Voltage	V_{CEO}	80	100	Vdc
Collector-Base Voltage	V_{CB}	100	120	Vdc
Emitter-Base Voltage	V_{EB}	6.0		Vdc
Collector Current – Continuous Peak	I_C	60 90		Adc
Base Current – Continuous	I_B	20		Adc
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	300 1.72		Watts W/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	-65 to +200		°C

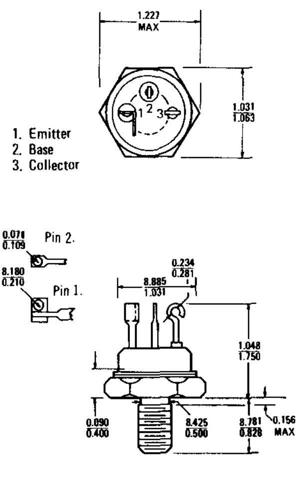
THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	θ_{JC}	0.58	°C/W

FIGURE 1 – ACTIVE-REGION SAFE OPERATING AREA



The Safe Operating Area Curves indicate I_C–V_{CE} limits below which the device will not enter secondary breakdown. Collector load lines for specific circuits must fall within the applicable Safe Area to avoid causing a catastrophic failure. To insure operation below the maximum T_J, power-temperature derating must be observed for both steady state and pulse power conditions.



CASE 177
TO-114

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Sustaining Voltage*		$V_{CEO(sus)}$*			Vdc
(I_C = 100 mAdc, I_B = 0)	MJ7200		80	–	
	MJ7201		100	–	
Collector-Emitter Cutoff Current		I_{CEX}			
(V_{CE} = 80 Vdc, $V_{EB(off)}$ = 1.5 Vdc)	MJ7200		–	100	μAdc
(V_{CE} = 100 Vdc, $V_{EB(off)}$ = 1.5 Vdc)	MJ7201		–	100	
(V_{CE} = 80 Vdc, $V_{EB(off)}$ = 1.5 Vdc, T_C = 150°C)	MJ7200		–	2.0	mAdc
(V_{CE} = 100 Vdc, $V_{EB(off)}$ = 1.5 Vdc, T_C = 150°C)	MJ7201		–	2.0	
Collector-Base Cutoff Current		I_{CBO}			μAdc
(V_{CB} = 100 Vdc, I_E = 0)	MJ7200		–	100	
(V_{CB} = 120 Vdc, I_E = 0)	MJ7201		–	100	
Emitter-Base Cutoff Current (V_{BE} = 6.0 Vdc, I_C = 0)		I_{EBO}	–	1.0	mAdc
Collector-Emitter Cutoff Current		I_{CEO}			mAdc
(V_{CE} = 80 Vdc, I_B = 0)	MJ7200		–	1.0	
(V_{CE} = 100 Vdc, I_B = 0)	MJ7201		–	1.0	
ON CHARACTERISTICS					
DC Current Gain*		h_{FE}*			–
(I_C = 5.0 Adc, V_{CE} = 5.0 Vdc)			15	–	
(I_C = 20 Adc, V_{CE} = 5.0 Vdc)			20	100	
(I_C = 40 Adc, V_{CE} = 5.0 Vdc)			12	75	
(I_C = 60 Adc, V_{CE} = 5.0 Vdc)			10	–	
Collector-Emitter Saturation Voltage*		$V_{CE(sat)}$*			Vdc
(I_C = 20 Adc, I_B = 2.0 Adc)			–	1.0	
(I_C = 40 Adc, I_B = 4.0 Adc)			–	1.5	
(I_C = 60 Adc, I_B = 8.0 Adc)			–	2.5	
Base-Emitter Saturation Voltage* (I_C = 40 Adc, I_B = 4.0 Adc)		$V_{BE(sat)}$*	–	2.5	Vdc
Base-Emitter On Voltage*		$V_{BE(on)}$*			Vdc
(I_C = 20 Adc, V_{CE} = 5.0 Vdc)			–	1.6	
(I_C = 60 Adc, V_{CE} = 5.0 Vdc)			–	3.2	
DYNAMIC CHARACTERISTICS					
Current-Gain—Bandwidth Product (I_C = 0.7 Adc, V_{CE} = 10 Vdc, f = 10 MHz)		f_T	20	–	MHz
Output Capacitance (I_E = 0, V_{CB} = 10 Vdc, f = 100 kHz)		C_{ob}	–	1200	pF

*Pulse Test: Pulse Width ≤300 μs, Duty Cycle ≤ 2.0%.

MJ8100 (SILICON)
MJ8101

MEDIUM-POWER PNP SILICON TRANSISTORS

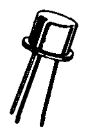
. . . designed for switching and wide band amplifier applications.

- Low Collector-Emitter Saturation Voltage –
  $V_{CE(sat)}$ = 1.2 Vdc (Max) @ I_C = 5.0 Amp
- DC Current Gain Specified to 5 Amperes
- Excellent Safe Operating Area
- Packaged in the Compact TO-39 Case for Critical Space-Limited Applications.

5 AMPERE
POWER TRANSISTORS

PNP SILICON

60 - 80 VOLTS
10 WATTS

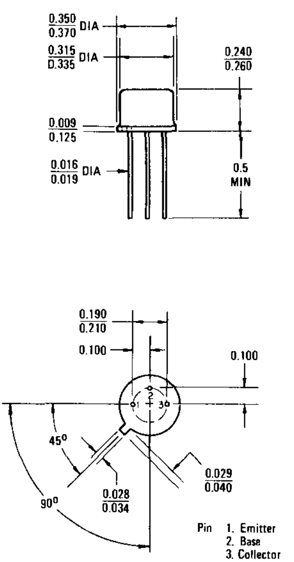


MAXIMUM RATINGS

Rating	Symbol	MJ8100	MJ8101	Unit
Collector-Emitter Voltage	V_{CEO}	60	80	Vdc
Collector-Base Voltage	V_{CB}	60	80	Vdc
Emitter-Base Voltage	V_{EB}	5.0		Vdc
Collector Current – Continuous	I_C	5.0		Adc
Base Current	I_B	1.0		Adc
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	10 57.2		Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	-65 to +200		°C

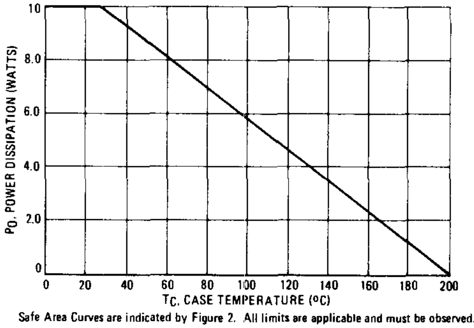
THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	θ_{JC}	17.5	°C/W



CASE 79
TO-39

FIGURE 1 – POWER-TEMPERATURE DERATING CURVE



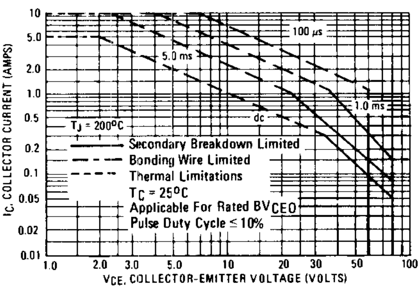
Safe Area Curves are indicated by Figure 2. All limits are applicable and must be observed.

ELECTRICAL CHARACTERISTICS ($T_C = 25^oC$ unless otherwise noted)

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Sustaining Voltage* (I_C = 50 mAdc, I_B = 0)	MJ8100 MJ8101	$BV_{CEO(sus)}$*	60 80	– –	Vdc
Collector Cutoff Current (V_{CE} = 55 Vdc, I_B = 0) (V_{CE} = 75 Vdc, I_B = 0)	MJ8100 MJ8101	I_{CEO}	– –	100 100	μAdc
Collector Cutoff Current (V_{CE} = 55 Vdc, $V_{BE(off)}$ = 1.5 Vdc) (V_{CE} = 75 Vdc, $V_{BE(off)}$ = 1.5 Vdc) (V_{CE} = 55 Vdc, $V_{BE(off)}$ = 1.5 Vdc, $T_C = 150^oC$) (V_{CE} = 75 Vdc, $V_{BE(off)}$ = 1.5 Vdc, $T_C = 150^oC$)	MJ8100 MJ8101 MJ8100 MJ8101	I_{CEX}	– – – –	10 10 1.0 1.0	μAdc mAdc
Collector Cutoff Current (V_{CB} = Rated V_{CB}, I_E = 0)		I_{CBO}	–	10	μAdc
Emitter Cutoff Current (V_{BE} = 5.0 Vdc, I_C = 0)		I_{EBO}	–	100	μAdc
ON CHARACTERISTICS					
DC Current Gain* (I_C = 500 mAdc, V_{CE} = 2.0 Vdc) (I_C = 2.0 Adc, V_{CE} = 2.0 Vdc) (I_C = 5.0 Adc, V_{CE} = 2.0 Vdc)		h_{FE}*	25 25 15	– 180 –	–
Collector-Emitter Saturation Voltage* (I_C = 2.0 Adc, I_B = 0.2 Adc) (I_C = 5.0 Adc, I_B = 0.5 Adc)		$V_{CE(sat)}$*	– –	0.7 1.2	Vdc
Base-Emitter Saturation Voltage* (I_C = 2.0 Adc, I_B = 0.2 Adc) (I_C = 5.0 Adc, I_B = 0.5 Adc)		$V_{BE(sat)}$*	– –	1.2 1.8	Vdc
DYNAMIC CHARACTERISTICS					
Current-Gain — Bandwidth Product (I_C = 0.5 Adc, V_{CE} = 10 Vdc, f = 10 MHz)		f_T	30	–	MHz
Output Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 100 kHz)		C_{ob}	–	300	pF
Input Capacitance (V_{BE} = 2.0 Vdc, I_C = 0, f = 100 kHz)		C_{ib}	–	1250	pF
SWITCHING CHARACTERISTICS					
Delay Time	(V_{CC} = 40 Vdc, $V_{BE(off)}$ = 4.0 Vdc,	t_d	–	100	ns
Rise Time	I_C = 2.0 Adc, I_{B1} = 0.2 Adc)	t_r	–	100	ns
Storage Time	(V_{CC} = 40 Vdc, I_C = 2.0 Adc,	t_s	–	1.0	μs
Fall Time	$I_{B1} = I_{B2}$ = 0.2 Adc)	t_f	–	150	ns

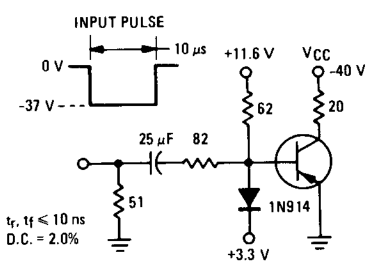
*Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%

FIGURE 2 – ACTIVE-REGION SAFE OPERATING AREA



The Safe Operating Area Curves indicate $I_C - V_{CE}$ limits below which the device will not enter secondary breakdown. Collector load lines for specific circuits must fall within the applicable Safe Area to avoid causing a catastrophic failure. To insure operation below the maximum T_J, power-temperature derating must be observed for both steady state and pulse power conditions.

FIGURE 3 – SWITCHING TIME TEST CIRCUIT



MJ8400 (SILICON)

HIGH-VOLTAGE NPN SILICON TRANSISTOR

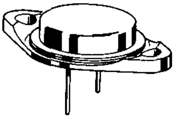
. . . designed for single unit use in horizontal deflection output circuits for line operated color television receivers that use a solid-state rectifier.

- High Breakdown Voltage – V_{CES} = 1400 Vdc
- Fast Fall Time – t_f = 1.1 μs (Max) @ I_C = 3.0 Adc
- Low Collector - Emitter Saturation Voltage – $V_{CE(sat)}$ = 2.0 Vdc @ I_C = 3.0 Adc

4 AMPERE POWER TRANSISTOR

NPN SILICON

1400 VOLTS
125 WATTS



MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	600	Vdc
Collector-Emitter Voltage	V_{CES}	1400	Vdc
Emitter-Base Voltage	V_{EB}	5.0	Vdc
Collector Current – Continuous	I_C	4.0	Adc
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	125 1.0	Watts W/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	-55 to +150	°C

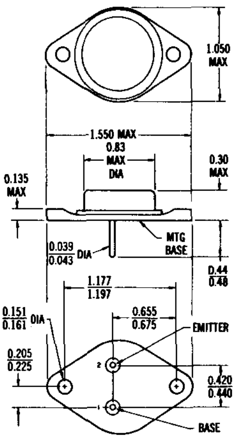
THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	θ_{JC}	1.0	°C/W

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage* (I_C = 100 mAdc, I_B = 0)	BV_{CEO}*	600	–	Vdc
Emitter-Base Breakdown Voltage (I_E = 1.0 mAdc, I_C = 0)	BV_{EBO}	5.0	–	Vdc
Collector Leakage Current (V_{CE} = 600 Vdc, I_B = 0)	I_{CEO}	–	1.0	mAdc
Collector Cutoff Current (V_{CE} = 1400 Vdc, V_{EB} = 0)	I_{CES}	–	1.0	mAdc
ON CHARACTERISTICS				
Collecter-Emitter Saturation Voltage (I_C = 3.0 Adc, I_B = 1.0 Adc)	$V_{CE(sat)}$	–	2.0	Vdc
SWITCHING CHARACTERISTICS				
Fall Time (Figure 3) (V_{CC} = 80 Vdc, I_C = 3.0 Adc, I_{B1} = 1.0 Adc)	t_f	–	1.1	μs

*Pulse Test: Pulse Width ≤ 500 μs, Duty Cycle ≤ 2.0%.

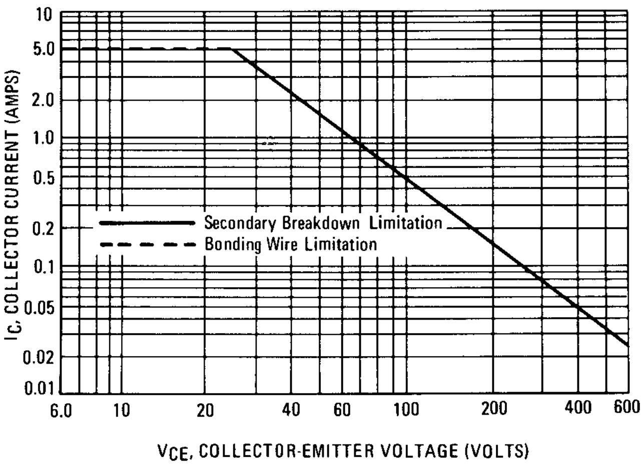


Collector Connected to Case

CASE 11

TO-3

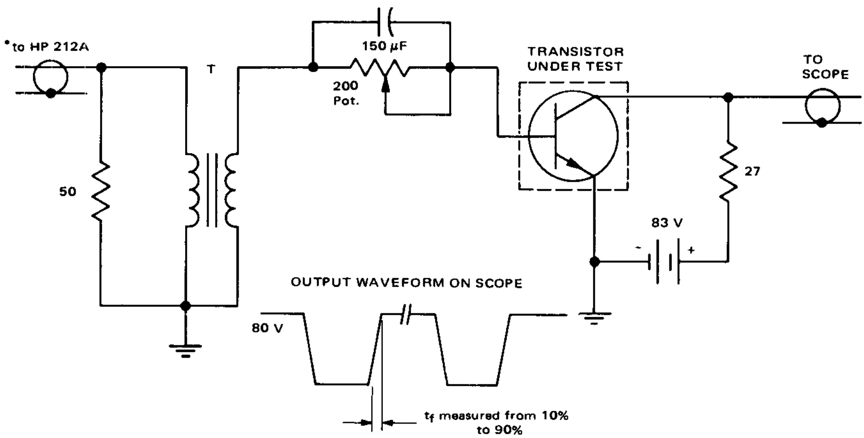
FIGURE 1 – ACTIVE-REGION DC SAFE OPERATING AREA



The Safe Operating Area Curves indicate I_C-V_{CE} limits below which the device will not enter secondary breakdown. Collector load lines for specific circuits must fall within the applicable Safe Area to avoid causing a catastrophic failure. To insure operation below the maximum T_J, power-temperature derating must be observed for both steady state and pulse power conditions.

Transistors should be used with receivers employing solid-state high-voltage rectifiers – as rectifier arcs may destroy the units. Use of a pulse limiter is also highly recommended.

FIGURE 2 – TEST CIRCUIT FOR FALL TIME



*HP 212A: Set for 10 μs wide pulses at 2000 pulses per sec. (500 μs intervals). Adjust for I_{B1} = 1.0 A.
Bias: Adjust to 1.5 V on a VTVM across the 200 Ω Pot.
T: Pulse Transformer: Motorola Part No. 25D68782A01.

MJ9000 (SILICON)

HIGH-VOLTAGE NPN SILICON TRANSISTOR

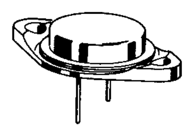
. . . designed for single unit use in color horizontal deflection output circuits in television receivers.

- High Collector-Emitter Voltage – V_{CES} = 700 Vdc
- Fast Fall Time – t_f = 1.1 μs (Max) @ I_C = 6.0 Adc

10 AMPERE
POWER TRANSISTOR

NPN SILICON

700 VOLTS
125 WATTS



MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	325	Vdc
Collector-Emitter Voltage	V_{CES}	700	Vdc
Emitter-Base Voltage	V_{EB}	5.0	Vdc
Collector Current – Continuous	I_C	10	Adc
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	125 1.0	Watts W/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	-55 to +150	°C

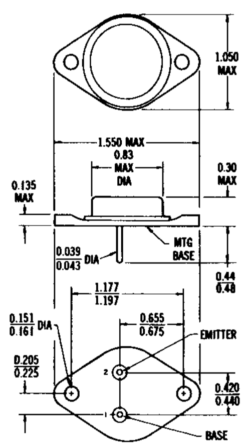
THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	θ_{JC}	1.0	°C/W

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage* (I_C = 0.1 Adc, I_B = 0)	BV_{CEO}*	325	–	Vdc
Collector Cutoff Current (V_{CE} = 700 Vdc, V_{EB} = 0)	I_{CES}	–	1.0	mAdc
ON CHARACTERISTICS				
Collector-Emitter Saturation Voltage (I_C = 6.0 Adc, I_B = 1.6 Adc)	$V_{CE(sat)}$	–	2.0	Vdc
SWITCHING CHARACTERISTICS				
Fall Time (See Figure 3) (V_{CC} = 80 Vdc, I_C = 6.0 Adc, I_{B1} = 1.6 Adc)	t_f	–	1.1	μs

*Pulse Test: Pulse Width ≤ 500 μs, Duty Cycle ≤ 2.0%.

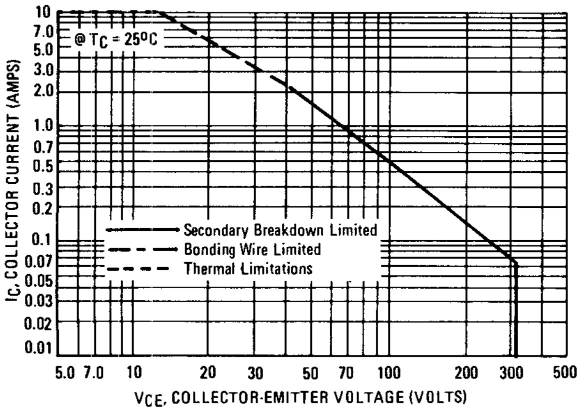


Collector Connected to Case

CASE 11

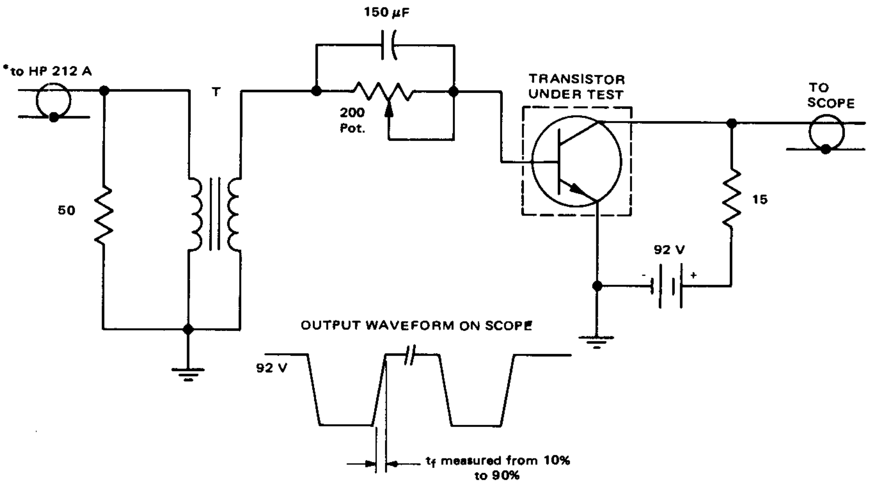
TO-3

FIGURE 1 – ACTIVE-REGION DC SAFE OPERATING AREA



The Safe Operating Area Curves indicate $I_C - V_{CE}$ limits below which the device will not enter secondary breakdown. Collector load lines for specific circuits must fall within the applicable Safe Area to avoid causing a catastrophic failure. To insure operation below the maximum T_J, power-temperature derating must be observed for both steady state and pulse power conditions.

FIGURE 2 – TEST CIRCUIT FOR FALL TIME



*HP 212A: Set for 10 µs wide pulses at 2000 pulses per sec. (500 µs intervals). Adjust for I_{B1} = 1.6 A.
Bias: Adjust to 1.5 V on a VTVM across the 200 Ω Pot.
T: Pulse Transformer: Motorola Part No. 25C68782A01.

MJE340 (SILICON)

PLASTIC MEDIUM POWER NPN SILICON TRANSISTOR

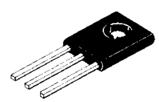
. . . designed for power output stages for television, radio, phonograph and other consumer product applications.

- Suitable for Transformerless, Line-Operated Equipment
- Thermopad Construction Provides High Power Dissipation Rating for High Reliability

0.5 AMPERE
POWER TRANSISTOR

NPN SILICON

300 VOLTS
20.8 WATTS

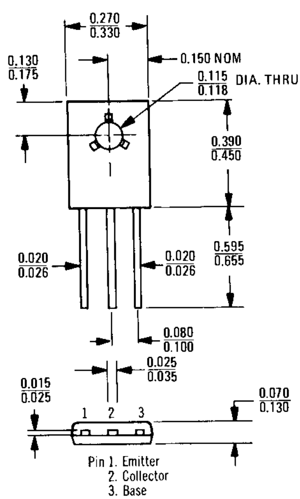


MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	300	Vdc
Emitter-Base Voltage	V_{EB}	3.0	Vdc
Collector Current — Continuous	I_C	500	mAdc
Total Device Dissipation @ $T_C = 25^oC$ Derate above 25^oC	P_D	20.8 0.167	Watts $W/^oC$
Operating and Storage Junction Temperature Range	T_J, T_{stg}	-65 to +150	^oC

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	θ_{JC}	6.0	$^oC/W$



When mounting the device, torque not to exceed 6.0 in.-lb.

If lead bending is required, use suitable clamps or other supports between transistor case and point of bend.

CASE 77-02

ELECTRICAL CHARACTERISTICS ($T_C = 25^oC$ unless otherwise noted)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Sustaining Voltage (I_C = 1.0 mAdc, I_B = 0)	$V_{CEO(sus)}$	300	–	Vdc
Collector Cutoff Current (V_{CB} = 300 Vdc, I_E = 0)	I_{CBO}	–	100	μAdc
Emitter Cutoff Current (V_{EB} = 3.0 Vdc, I_C = 0)	I_{EBO}	–	100	μAdc
ON CHARACTERISTICS				
DC Current Gain (I_C = 50 mAdc, V_{CE} = 10 Vdc)	h_{FE}	30	240	–

FIGURE 1 – POWER TEMPERATURE DERATING CURVE

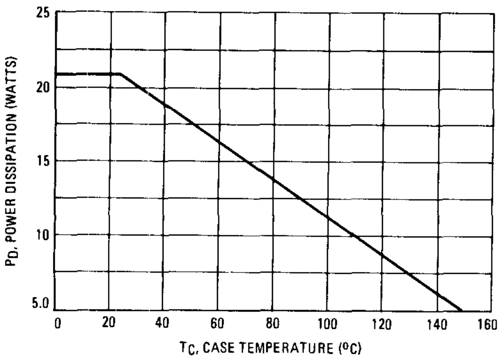


FIGURE 2 – "ON" VOLTAGES

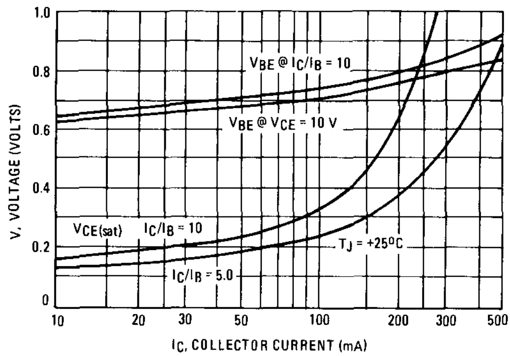
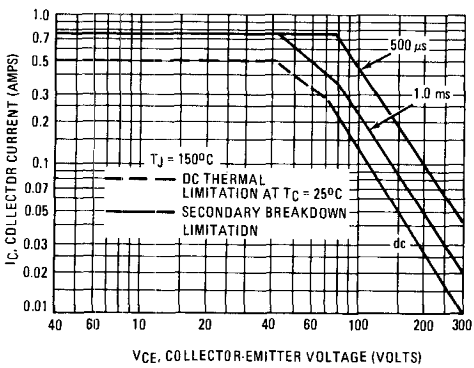
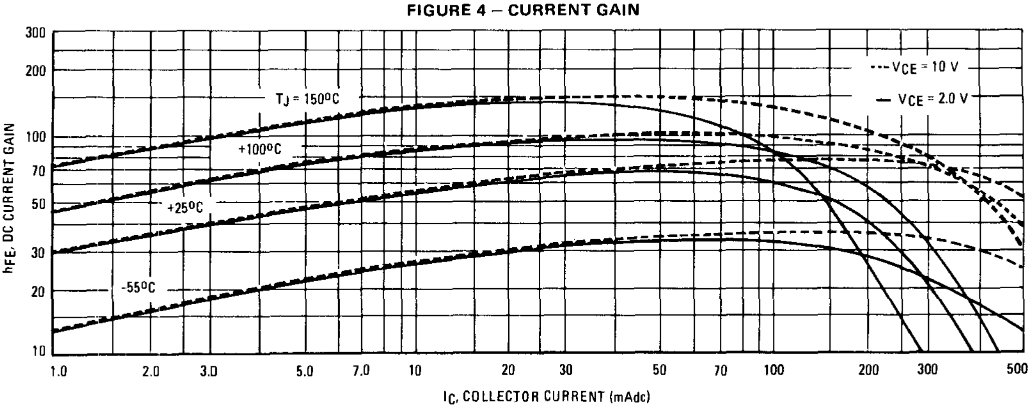


FIGURE 3 – DC SAFE OPERATING AREA



The Safe Operating Area Curves indicate I_C–V_{CE} limits below which the device will not enter secondary breakdown. Collector load lines for specific circuits must fall within the applicable Safe Area to avoid causing a catastrophic failure. To insure operation below the maximum T_J, power-temperature derating must be observed for both steady state and pulse power conditions.

FIGURE 4 – CURRENT GAIN



MJE370 (SILICON)

PLASTIC MEDIUM-POWER PNP SILICON TRANSISTOR

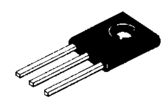
. . . designed for use in 5 to 10 Watt audio amplifiers utilizing complementary symmetry circuitry.

- DC Current Gain — h_{FE} = 25 (Min) @ I_C = 1.0 Adc
- MJE370 is Complementary with NPN MJE520

3 AMPERE POWER TRANSISTOR

PNP SILICON

30 VOLTS
25 WATTS

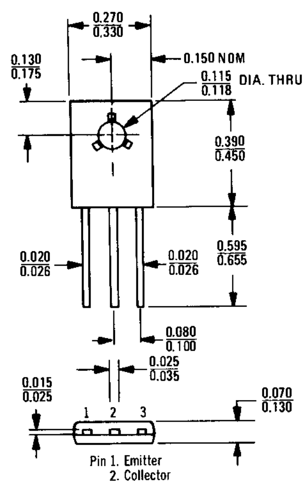


MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	30	Vdc
Collector-Base Voltage	V_{CB}	30	Vdc
Emitter-Base Voltage	V_{EB}	4.0	Vdc
Collector Current — Continuous — Peak	I_C	3.0 4.0	Adc
Base Current — Continuous	I_B	2.0	Adc
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	25 0.2	Watts W/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	-65 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	θ_{JC}	5.0	°C/W



When mounting the device, torque not to exceed 6.0 in.-lb.

If lead bending is required, use suitable clamps or other supports between transistor case and point of bend.

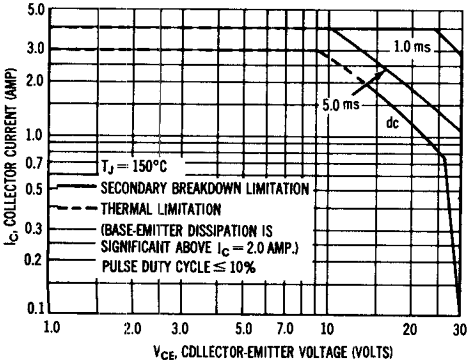
CASE 77-02

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Sustaining Voltage* (I_C = 100 mAdc, I_B = 0)	$V_{CEO(sus)}$*	30	—	Vdc
Collector-Base Cutoff Current (V_{CB} = 30 Vdc, I_E = 0)	I_{CBO}	—	100	µAdc
Emitter-Base Cutoff Current (V_{EB} = 4.0 Vdc, I_C = 0)	I_{EBO}	—	100	µAdc
ON CHARACTERISTICS				
DC Current Gain* (V_{CE} = 1.0 Vdc, I_C = 1.0 Adc)	h_{FE}	25	—	—

*Pulse Test: Pulse Width ≤300 µs, Duty Cycle ≤2.0%.

FIGURE 1 – ACTIVE-REGION SAFE OPERATING AREA



The Safe Operating Area Curves indicate $I_C - V_{CE}$ limits below which the device will not anter secondary breakdown. Collector load lines for specific circuits must fall within the applicable Safe Area to avoid causing a catastrophic failure. To insure operation below the maximum T_J, power-temperature derating must be observed for both steady state and pulse power conditions.

FIGURE 2 – DC CURRENT GAIN

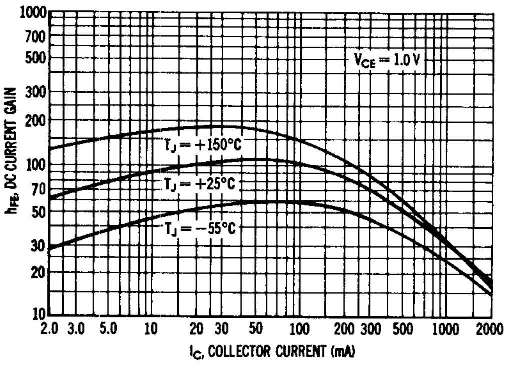


FIGURE 3 – "ON" VOLTAGE

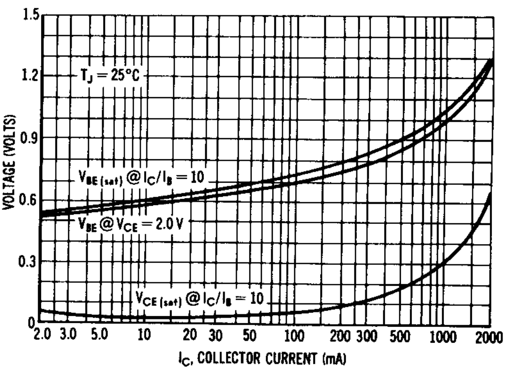
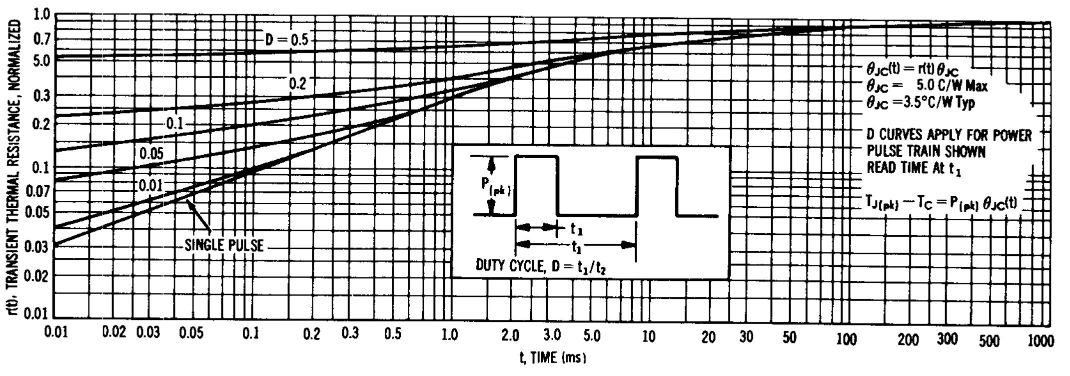


FIGURE 4 – THERMAL RESPONSE



MJE371 (SILICON)

PLASTIC MEDIUM-POWER PNP SILICON TRANSISTOR

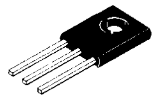
. . . designed for use in 5 to 10 Watt audio amplifiers utilizing complementary symmetry circuitry.

- DC Current Gain — h_{FE} = 40 (Min) @ I_C = 1.0 Adc
- MJE371 is Complementary with NPN MJE521

3 AMPERE POWER TRANSISTOR

PNP SILICON

40 VOLTS
40 WATTS

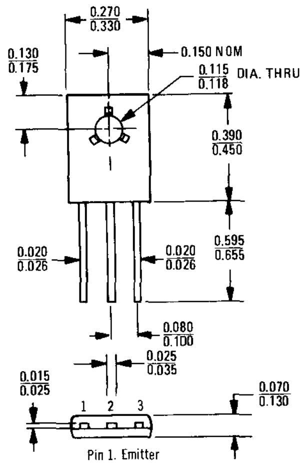


MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	40	Vdc
Collector-Base Voltage	V_{CB}	40	Vdc
Emitter-Base Voltage	V_{EB}	4.0	Vdc
Collector Current — Continuous — Peak	I_C	3.0 4.0	Adc
Base Current — Continuous	I_B	2.0	Adc
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	40 320	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	-65 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	θ_{JC}	3.12	°C/W



Pin 1. Emitter
2. Collector
3. Base

When mounting the device, torque not to exceed 6.0 in.-lb.

If lead bending is required, use suitable clamps or other supports between transistor case and point of bend.

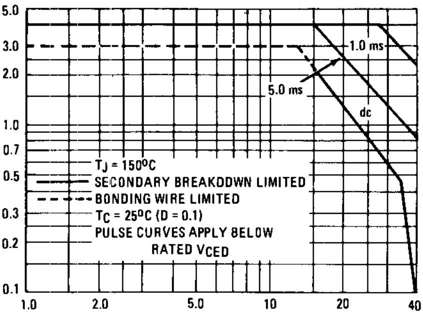
CASE 77-02

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Sustaining Voltage* (I_C = 100 mAdc, I_B = 0)	$V_{CEO(sus)}$	40	—	Vdc
Collector-Base Cutoff Current (V_{CB} = 40 Vdc, I_E = 0)	I_{CBO}	—	100	μAdc
Emitter-Base Cutoff Current (V_{EB} = 4.0 Vdc, I_C = 0)	I_{EBO}	—	100	μAdc
ON CHARACTERISTICS				
DC Current Gain* (V_{CE} = 1.0 Vdc, I_C = 1.0 Adc)	h_{FE}	40	—	—

*Pulse Test: Pulse Width ≤300 μs, Duty Cycle ≤2.0%.

FIGURE 1 – ACTIVE-REGION SAFE OPERATING AREA



The Safe Operating Area Curves indicate $I_C - V_{CE}$ limits below which the device will not enter secondary breakdown. Collector load lines for specific circuits must fall within the applicable Safe Area to avoid causing a catastrophic failure. To insure operation below the maximum T_J, power-temperature derating must be observed for both steady state and pulse power conditions.

FIGURE 2 – NORMALIZED DC CURRENT GAIN

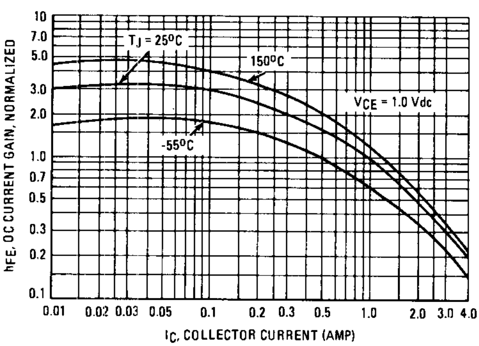


FIGURE 3 – "ON" VOLTAGE

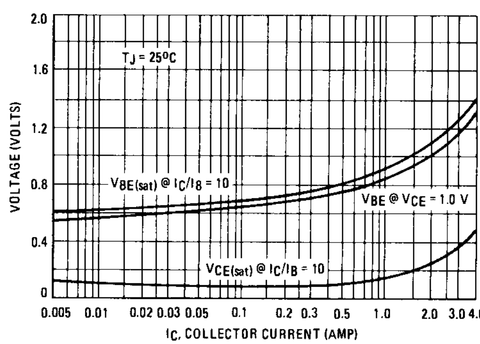
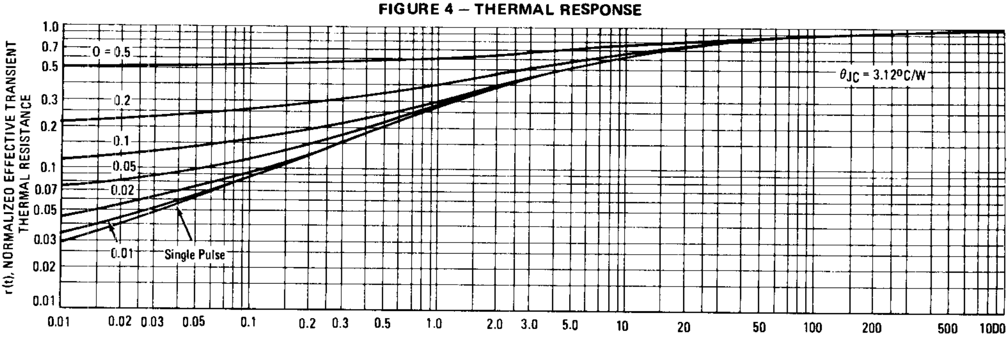


FIGURE 4 – THERMAL RESPONSE



MJE520 (SILICON)

PLASTIC MEDIUM-POWER NPN SILICON TRANSISTOR

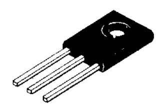
. . . designed for use in 5 to 10 Watt audio amplifiers utilizing complementary symmetry circuitry.

- DC Current Gain – h_{FE} = 25 (Min) @ I_C = 1.0 Adc
- MJE520 is Complementary with PNP MJE370

3 AMPERE POWER TRANSISTOR

NPN SILICON

30 VOLTS
25 WATTS

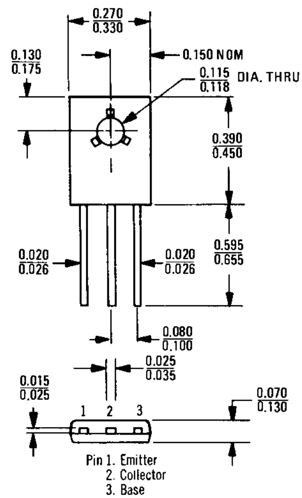


MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	30	Vdc
Collector-Base Voltage	V_{CB}	30	Vdc
Emitter-Base Voltage	V_{EB}	4.0	Vdc
Collector Current – Continuous – Peak	I_C	3.0 4.0	Adc
Base Current – Continuous	I_B	2.0	Adc
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	25 0.2	Watts W/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	-65 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	θ_{JC}	5.0	°C/W



When mounting the device, torque not to exceed 6.0 in.-lb.

If lead bending is required, use suitable clamps or other supports between transistor case and point of bend.

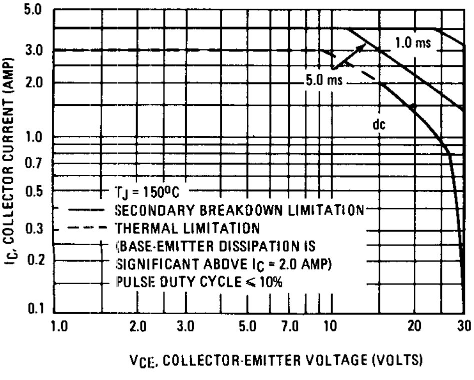
CASE 77-02

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Sustaining Voltage* (I_C = 100 mAdc, I_B = 0)	$V_{CEO(sus)}$*	30	–	Vdc
Collector-Base Cutoff Current (V_{CB} = 30 Vdc, I_E = 0)	I_{CBO}	–	100	μAdc
Emitter-Base Cutoff Current (V_{EB} = 4.0 Vdc, I_C = 0)	I_{EBO}	–	100	μAdc
ON CHARACTERISTICS				
DC Current Gain* (V_{CE} = 1.0 Vdc, I_C = 1.0 Adc)	h_{FE}	25	–	–

*Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

FIGURE 1 – ACTIVE-REGION SAFE OPERATING AREA



The Safe Operating Area Curves indicate I_C–V_{CE} limits below which the device will not enter secondary breakdown. Collector load lines for specific circuits must fall within the applicable Safe Area to avoid causing a catastrophic failure. To insure operation below the maximum T_J, power-temperature derating must be observed for both steady state and pulse power conditions.

FIGURE 2 – DC CURRENT GAIN

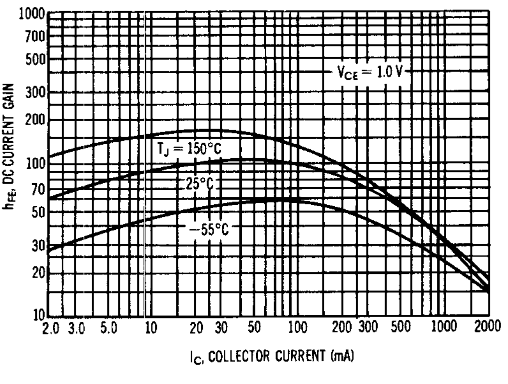


FIGURE 3 – "ON" VOLTAGE

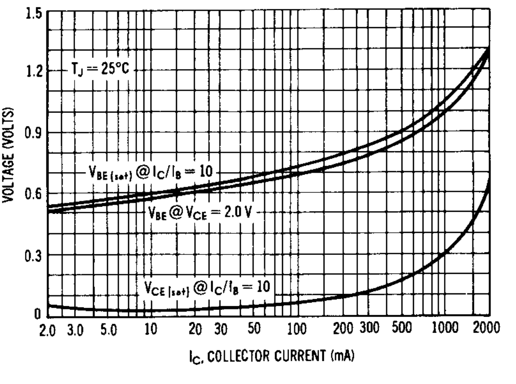
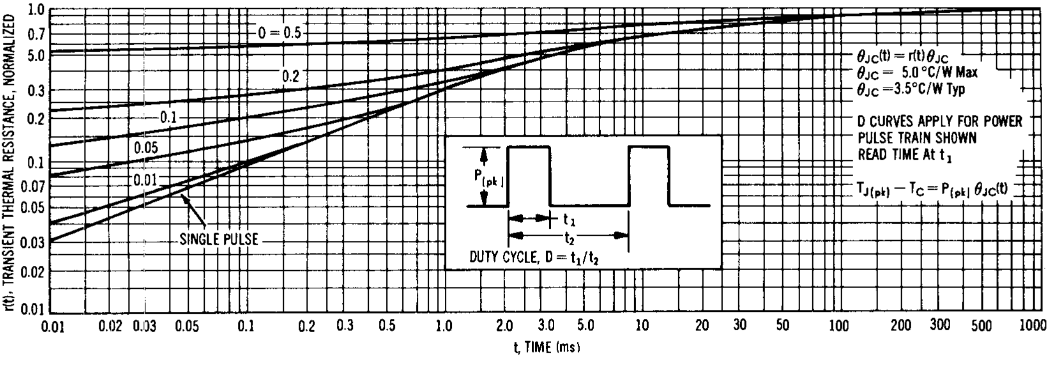


FIGURE 4 – THERMAL RESPONSE



MJE521 (SILICON)

PLASTIC MEDIUM-POWER NPN SILICON TRANSISTOR

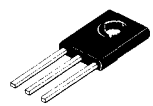
. . . designed for use in 5 to 10 Watt audio amplifiers utilizing complementary symmetry circuitry.

- DC Current Gain — h_{FE} = 40 (Min) @ I_C = 1.0 Adc
- MJE521 is Complementary with PNP MJE371

3 AMPERE POWER TRANSISTOR

NPN SILICON

40 VOLTS
40 WATTS

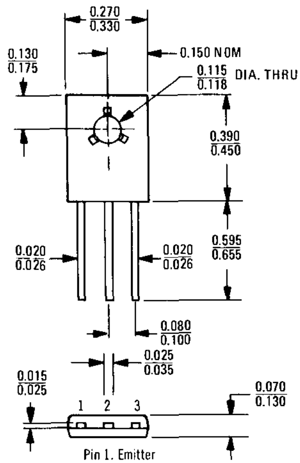


MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	40	Vdc
Collector-Base Voltage	V_{CB}	40	Vdc
Emitter-Base Voltage	V_{EB}	4.0	Vdc
Collector Current — Continuous — Peak	I_C	3.0 4.0	Adc
Base Current — Continuous	I_B	2.0	Adc
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	40 320	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	-65 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	θ_{JC}	3.12	°C/W



Pin 1. Emitter
2. Collector
3. Base

When mounting the device, torque not to exceed 6.0 in.-lb.

If lead bending is required, use suitable clamps or other supports between transistor case and point of bend.

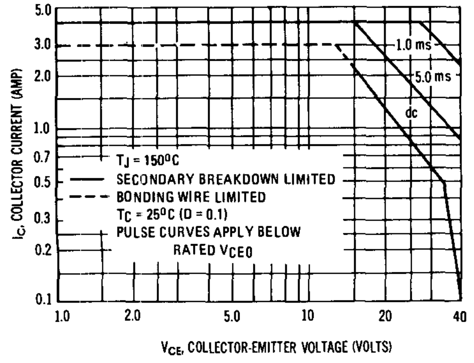
CASE 77-02

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Sustaining Voltage* (I_C = 100 mAdc, I_B = 0)	$V_{CEO(sus)}$*	40	—	Vdc
Collector-Base Cutoff Current (V_{CB} = 40 Vdc, I_E = 0)	I_{CBO}	—	100	μAdc
Emitter-Base Cutoff Current (V_{EB} = 4.0 Vdc, I_C = 0)	I_{EBO}	—	100	μAdc
ON CHARACTERISTICS				
DC Current Gain* (V_{CE} = 1.0 Vdc, I_C = 1.0 Adc)	h_{FE}*	40	—	—

*Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

FIGURE 1 – ACTIVE-REGION SAFE OPERATING AREA



The Safe Operating Area Curves indicate $I_C - V_{CE}$ limits below which the device will not enter secondary breakdown. Collector load lines for specific circuits must fall within the applicable Safe Area to avoid causing a catastrophic failure. To insure operation below the maximum T_J, power-temperature derating must be observed for both steady state and pulse power conditions.

FIGURE 2 – NORMALIZED DC CURRENT GAIN

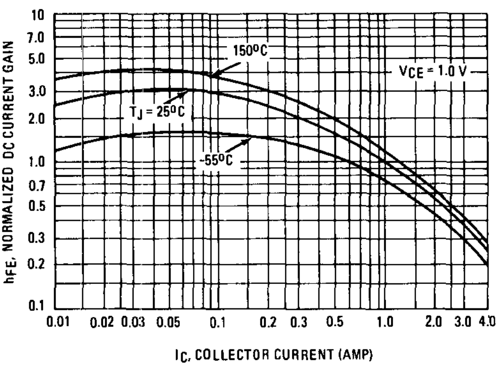


FIGURE 3 – "ON" VOLTAGE

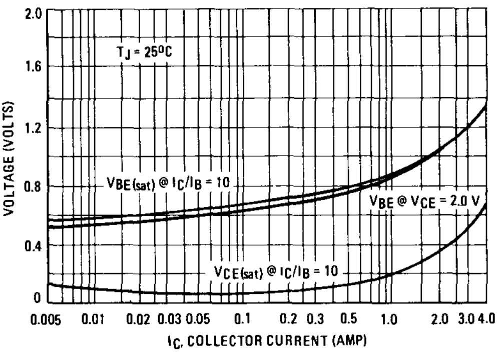
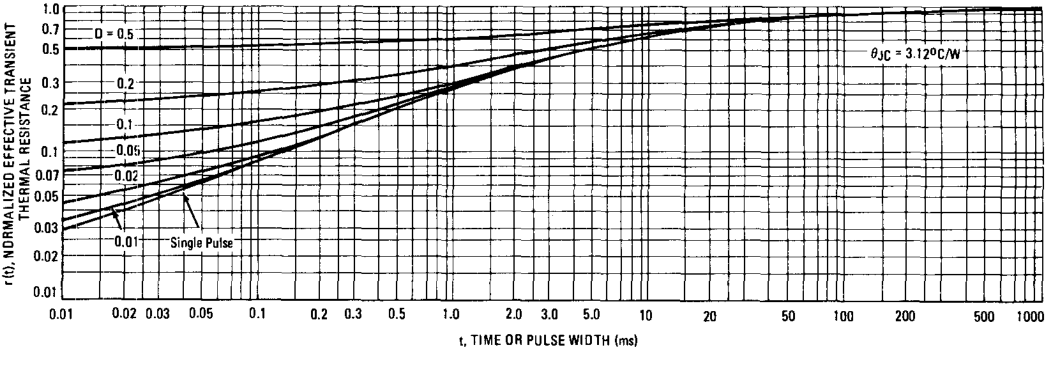


FIGURE 4 – THERMAL RESPONSE



MM3903 (SILICON)
MM3904

NPN SILICON ANNULAR TRANSISTORS

. . . designed for general purpose switching and amplifier applications. Direct replacement for plastic 2N3903 and 2N3904.

- Hermetic Low Profile TO-52 Metal Package for High Reliability
- High Voltage Ratings – BV_{CEO} = 40 Volts (Min)
- Current Gain Specified from 100 μA to 100 mA
- Complete Switching and Amplifier Specifications

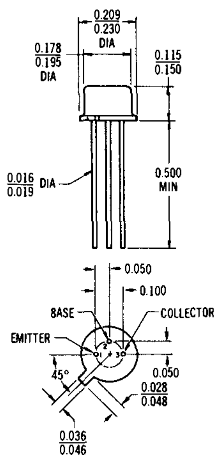
NPN SILICON SWITCHING AND AMPLIFIER TRANSISTORS

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	40	Vdc
Collector-Base Voltage	V_{CB}	60	Vdc
Emitter-Base Voltage	V_{EB}	6.0	Vdc
Collector Current	I_C	200	mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	360 2.06	mW mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	-55 to +200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	θ_{JA}	0.49	°C/mW



CASE 27
(TO-52)

MM3903, MM3904 (continued)

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Fig. No.	Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector-Base Breakdown Voltage (I_C = 10 µAdc, I_E = 0)	-	BV_{CBO}	60	-	Vdc
Collector-Emitter Breakdown Voltage* (I_C = 1.0 mAdc, I_B = 0)	-	BV_{CEO}*	40	-	Vdc
Emitter-Base Breakdown Voltage (I_E = 10 µAdc, I_C = 0)	-	BV_{EBO}	6.0	-	Vdc
Collector Cutoff Current (V_{CE} = 30 Vdc, $V_{EB(off)}$ = 3.0 Vdc)	-	I_{CEX}	-	50	nAdc
Base Cutoff Current (V_{CE} = 30 Vdc, $V_{EB(off)}$ = 3.0 Vdc)	-	I_{BL}	-	50	nAdc
ON CHARACTERISTICS					
DC Current Gain* (I_C = 0.1 mAdc, V_{CE} = 1.0 Vdc) MM3903 MM3904	15	h_{FE}*	20 40	- -	-
(I_C = 1.0 mAdc, V_{CE} = 1.0 Vdc) MM3903 MM3904			35 70	- -	
(I_C = 10 mAdc, V_{CE} = 1.0 Vdc) MM3903 MM3904			50 100	150 300	
(I_C = 50 mAdc, V_{CE} = 1.0 Vdc) MM3903 MM3904			30 60	- -	
(I_C = 100 mAdc, V_{CE} = 1.0 Vdc) MM3903 MM3904			10 15	- -	
Collector-Emitter Saturation Voltage* (I_C = 10 mAdc, I_B = 1.0 mAdc) (I_C = 50 mAdc, I_B = 5.0 mAdc)	16, 17	$V_{CE(sat)}$*	- -	0.2 0.3	Vdc
Base-Emitter Saturation Voltage* (I_C = 10 mAdc, I_B = 1.0 mAdc) (I_C = 50 mAdc, I_B = 5.0 mAdc)	17	$V_{BE(sat)}$*	0.65 -	0.85 0.95	Vdc
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain—Bandwidth Product (I_C = 10 mAdc, V_{CE} = 20 Vdc, f = 100 MHz) MM3903 MM3904	-	f_T	250 300	- -	MHz
Output Capacitance (V_{CB} = 5.0 Vdc, I_E = 0, f = 100 kHz)	3	C_{ob}	-	5.0	pF
Input Capacitance (V_{BE} = 0.5 Vdc, I_C = 0, f = 100 kHz)	3	C_{ib}	-	10	pF
Input Impedance (I_C = 1.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz) MM3903 MM3904	13	h_{ie}	0.5 1.0	8.0 10	k ohms
Voltage Feedback Ratio (I_C = 1.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz) MM3903 MM3904	14	h_{re}	0.1×10^{-4} 0.5×10^{-4}	5×10^{-4} 8×10^{-4}	-
Small-Signal Current Gain (I_C = 1.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz) MM3903 MM3904	11	h_{fe}	50 100	200 400	-
Output Admittance (I_C = 1.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)	12	h_{oe}	1.0	40	µmhos
Noise Figure (I_C = 100 µAdc, V_{CE} = 5.0 Vdc, R_S = 1.0 k ohms, f = 10 Hz to 15.7 kHz) MM3903 MM3904	9, 10	NF	- -	6.0 5.0	dB
SWITCHING CHARACTERISTICS					
Delay Time (V_{CC} = 3.0 Vdc, $V_{BE(off)}$ = 0.5 Vdc, I_C = 10 mAdc, I_{B1} = 1.0 mAdc)	1, 5	t_d	-	35	ns
Rise Time (V_{CC} = 3.0 Vdc, $V_{BE(off)}$ = 0.5 Vdc, I_C = 10 mAdc, I_{B1} = 1.0 mAdc)	1, 5, 6	t_r	-	35	ns
Storage Time (V_{CC} = 3.0 Vdc, I_C = 10 mAdc, $I_{B1} = I_{B2}$ = 1.0 mAdc) MM3903 MM3904	2, 7	t_s	- -	175 200	ns
Fall Time (V_{CC} = 3.0 Vdc, I_C = 10 mAdc, $I_{B1} = I_{B2}$ = 1.0 mAdc)	2, 8	t_f	-	50	ns

* Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 2.0%.

FIGURE 1 — DELAY AND RISE TIME EQUIVALENT TEST CIRCUIT

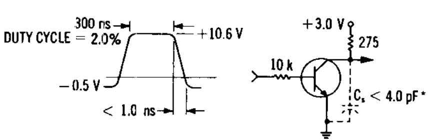
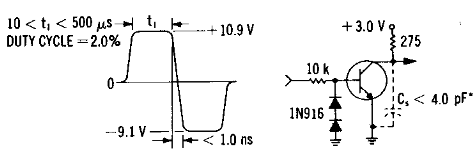


FIGURE 2 — STORAGE AND FALL TIME EQUIVALENT TEST CIRCUIT



*Total shunt capacitance of test jig and connectors

TRANSIENT CHARACTERISTICS

——— $T_J = 25^oC$ - - - - - $T_J = 125^oC$

FIGURE 3 – CAPACITANCE

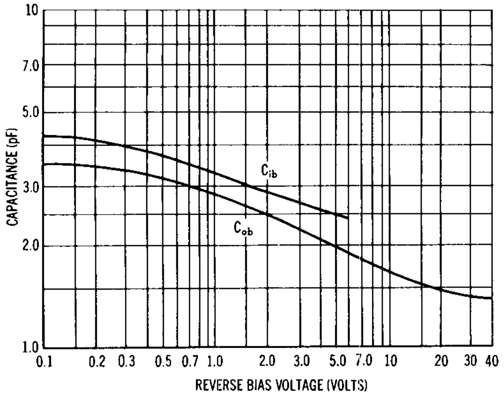


FIGURE 4 – CHARGE DATA

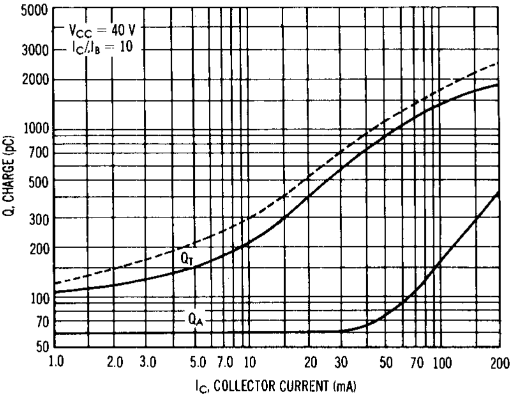


FIGURE 5 – TURN-ON TIME

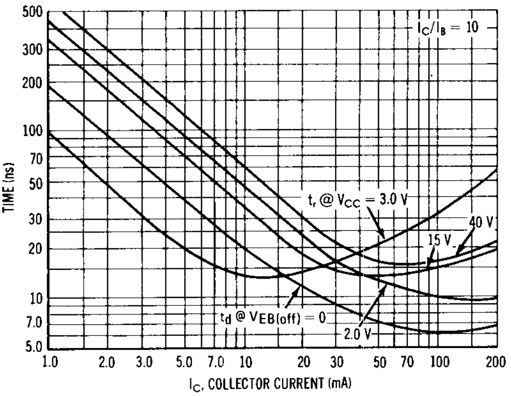


FIGURE 6 – RISE TIME

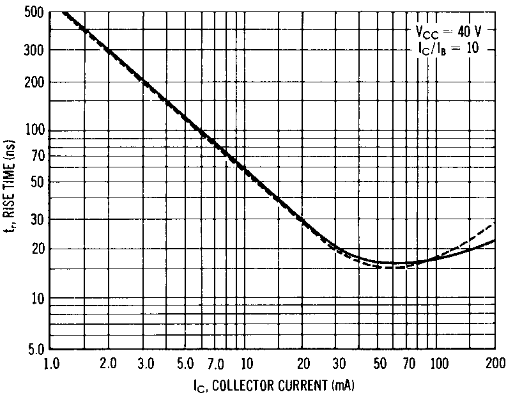


FIGURE 7 – STORAGE TIME

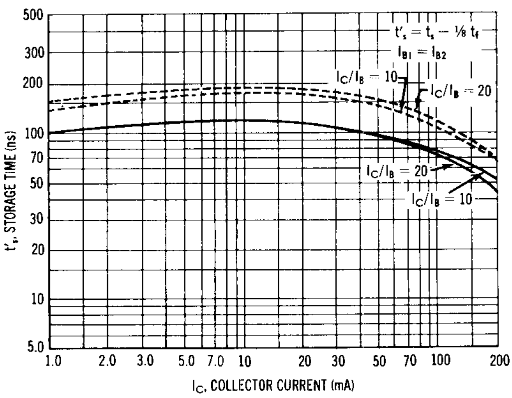
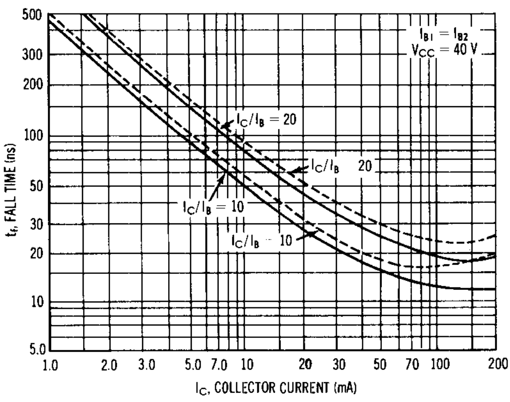


FIGURE 8 – FALL TIME



AUDIO SMALL SIGNAL CHARACTERISTICS

NOISE FIGURE VARIATIONS

V_{CE} = 5.0 Vdc, T_A = 25°C

FIGURE 9

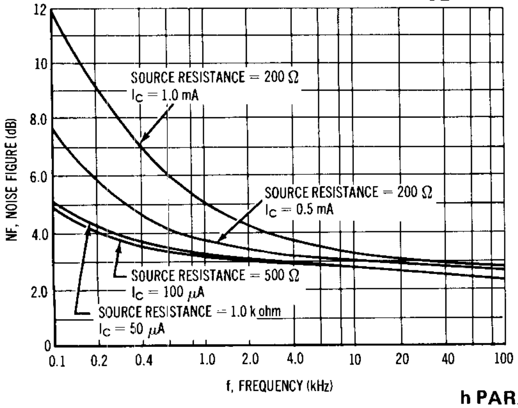
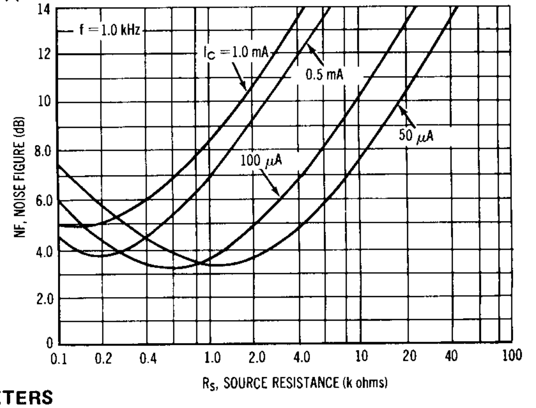


FIGURE 10



h PARAMETERS

V_{CE} = 10 Vdc, f = 1.0 kHz, T_A = 25°C

FIGURE 11 — CURRENT GAIN

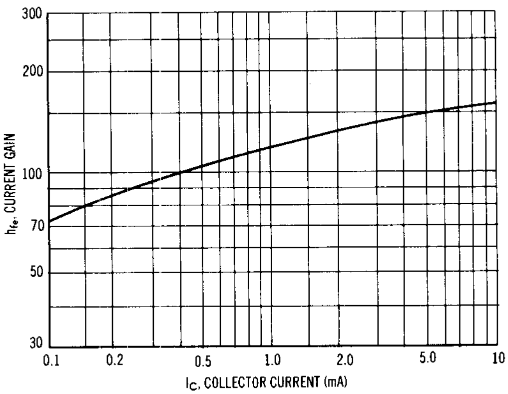


FIGURE 12 — OUTPUT ADMITTANCE

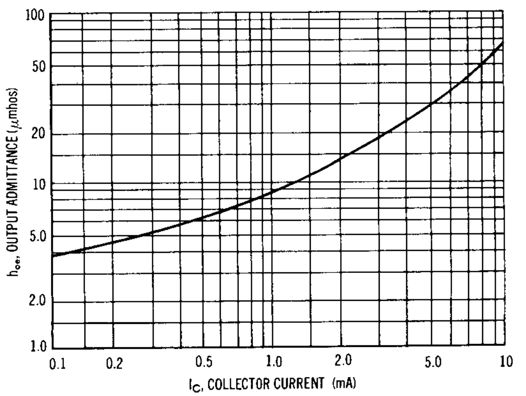


FIGURE 13 — INPUT IMPEDANCE

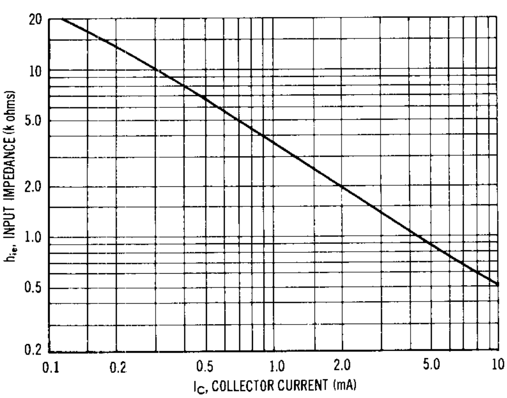
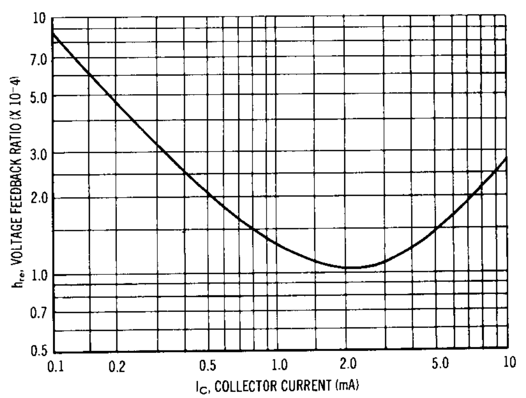


FIGURE 14 — VOLTAGE FEEDBACK RATIO



STATIC CHARACTERISTICS

FIGURE 15 – NORMALIZED CURRENT GAIN

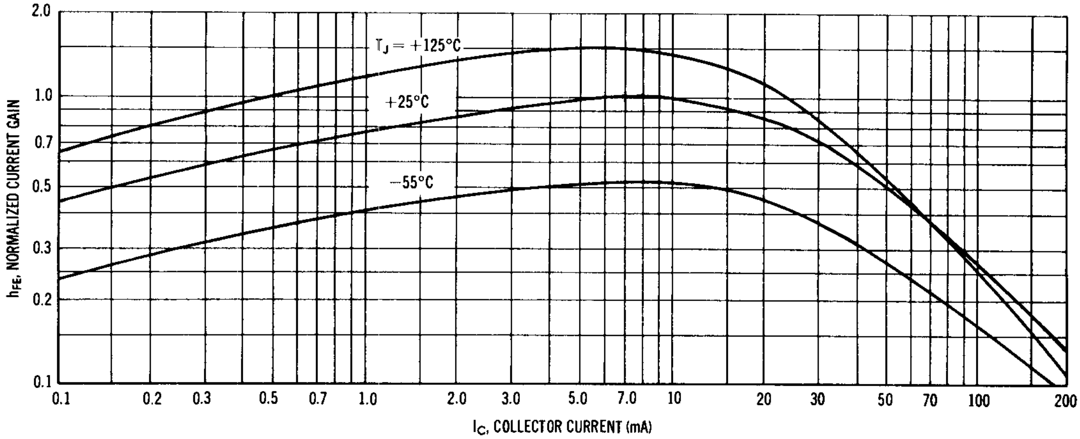


FIGURE 16 – COLLECTOR SATURATION REGION

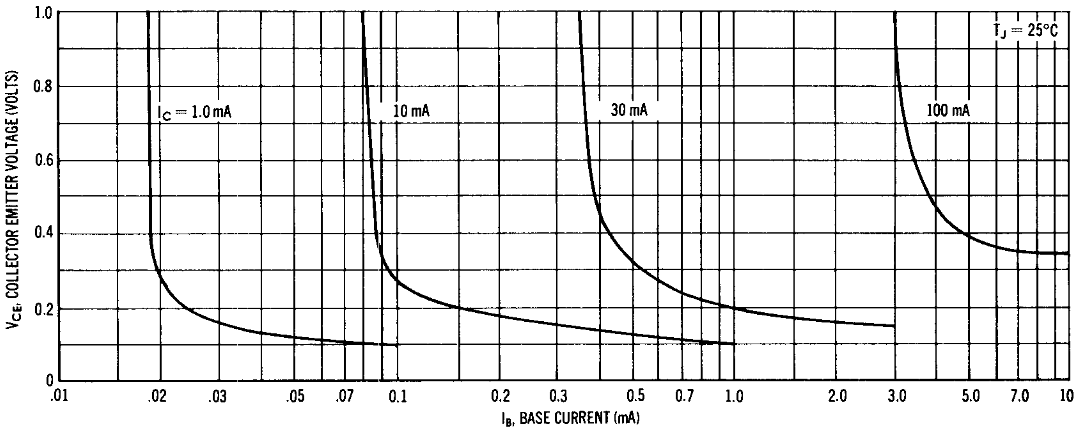


FIGURE 17 – "ON" VOLTAGES

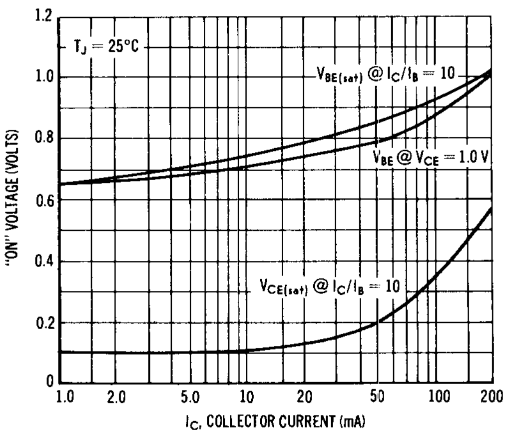
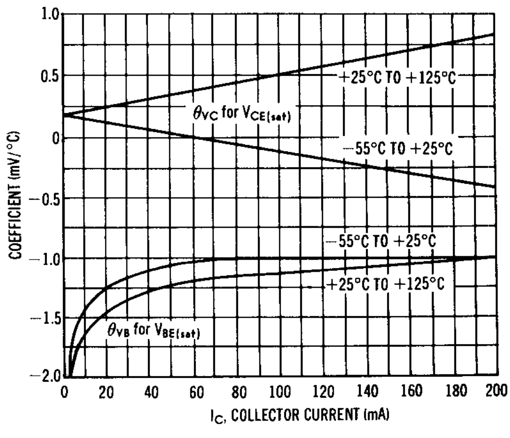


FIGURE 18 – TEMPERATURE COEFFICIENTS



MM3905 (SILICON)
MM3906

PNP SILICON ANNULAR TRANSISTORS

. . . designed for general purpose switching and amplifier applications. Direct replacement for plastic 2N3905 and 2N3906.

- Hermetic Low Profile TO-52 Metal Package for High Reliability
- High Voltage Ratings – BV_{CEO} = 40 Volts (Min)
- Current Gain Specified from 100 μA to 100 mA
- Complete Switching and Amplifier Specifications

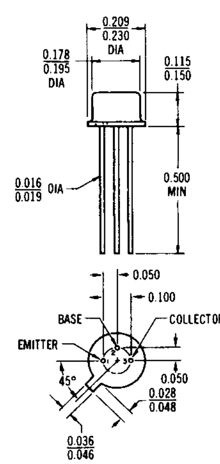
PNP SILICON SWITCHING AND AMPLIFIER TRANSISTORS

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	40	Vdc
Collector-Base Voltage	V_{CB}	40	Vdc
Emitter-Base Voltage	V_{EB}	5.0	Vdc
Collector Current	I_C	200	mAdc
Total Device Dissipation @ $T_A = 25^oC$ Derate above 25°C	P_D	360 2.06	mW mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	-55 to +200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	θ_{JA}	0.49	°C/mW



CASE 27
(TO-52)

MM3905, MM3906 (continued)

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic		Fig. No.	Symbol	Min	Max	Unit
OFF CHARACTERISTICS						
Collector-Base Breakdown Voltage (I_C = 10 μAdc, I_E = 0)		-	BV_{CBO}	40	-	Vdc
Collector-Emitter Breakdown Voltage* (I_C = 1.0 mAdc, I_B = 0)		-	BV_{CEO}*	40	-	Vdc
Emitter-Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)		-	BV_{EBO}	5.0	-	Vdc
Collector Cutoff Current (V_{CE} = 30 Vdc, $V_{BE(off)}$ = 3.0 Vdc)		-	I_{CEX}	-	50	nAdc
Base Cutoff Current (V_{CE} = 30 Vdc, $V_{BE(off)}$ = 3.0 Vdc)		-	I_{BL}	-	50	nAdc
ON CHARACTERISTICS						
DC Current Gain* (I_C = 0.1 mAdc, V_{CE} = 1.0 Vdc)	MM3905 MM3906	15	h_{FE}*	30 60	- -	-
(I_C = 1.0 mAdc, V_{CE} = 1.0 Vdc)	MM3905 MM3906			40 80	- -	
(I_C = 10 mAdc, V_{CE} = 1.0 Vdc)	MM3905 MM3906			50 100	150 300	
(I_C = 50 mAdc, V_{CE} = 1.0 Vdc)	MM3905 MM3906			30 60	- -	
(I_C = 100 mAdc, V_{CE} = 1.0 Vdc)	MM3905 MM3906			10 15	- -	
Collector-Emitter Saturation Voltage* (I_C = 10 mAdc, I_B = 1.0 mAdc) (I_C = 50 mAdc, I_B = 5.0 mAdc)		16, 17	$V_{CE(sat)}$*	- -	0.25 0.4	Vdc
Base-Emitter Saturation Voltage* (I_C = 10 mAdc, I_B = 1.0 mAdc) (I_C = 50 mAdc, I_B = 5.0 mAdc)		17	$V_{BE(sat)}$*	0.65 -	0.85 0.95	Vdc
SMALL-SIGNAL CHARACTERISTICS						
Current-Gain—Bandwidth Product (I_C = 10 mAdc, V_{CE} = 20 Vdc, f = 100 MHz)	MM3905 MM3906	-	f_T	200 250	- -	MHz
Output Capacitance (V_{CB} = 5.0 Vdc, I_E = 0, f = 100 kHz)		3	C_{ob}	-	5.0	pF
Input Capacitance (V_{BE} = 0.5 Vdc, I_C = 0, f = 100 kHz)		3	C_{ib}	-	10	pF
Input Impedance (I_C = 1.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)	MM3905 MM3906	13	h_{ie}	0.5 2.0	8.0 12	k ohms
Voltage Feedback Ratio (I_C = 1.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)	MM3905 MM3906	14	h_{re}	0.1×10^{-4} 1×10^{-4}	5×10^{-4} 10×10^{-4}	-
Small-Signal Current Gain (I_C = 1.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)	MM3905 MM3906	11	h_{fe}	50 100	200 400	-
Output Admittance (I_C = 1.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)	MM3905 MM3906	12	h_{oe}	1.0 3.0	40 60	μmhos
Noise Figure (I_C = 100 μAdc, V_{CE} = 5.0 Vdc, R_S = 1.0 k ohm, f = 10 Hz to 15.7 kHz)	MM3905 MM3906	9, 10	NF	- -	5.0 4.0	dB
SWITCHING CHARACTERISTICS						
Delay Time (V_{CC} = 3.0 Vdc, $V_{BE(off)}$ = 0.5 Vdc, I_C = 10 mAdc, I_{B1} = 1.0 mAdc)		1, 5	t_d	-	35	ns
Rise Time (V_{CC} = 3.0 Vdc, $V_{BE(off)}$ = 0.5 Vdc, I_C = 10 mAdc, I_{B1} = 1.0 mAdc)		1, 5, 6	t_r	-	35	ns
Storage Time (V_{CC} = 3.0 Vdc, I_C = 10 mAdc, I_{B1} = I_{B2} = 1.0 mAdc)	MM3905 MM3906	2, 7	t_s	- -	200 225	ns
Fall Time (V_{CC} = 3.0 Vdc, I_C = 10 mAdc, I_{B1} = I_{B2} = 1.0 mAdc)	MM3905 MM3906	2, 8	t_f	- -	60 75	ns

* Pulse Test: Pulse Width = 300 μs, Duty Cycle = 2.0%.

FIGURE 1 – DELAY AND RISE TIME EQUIVALENT TEST CIRCUIT

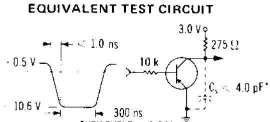
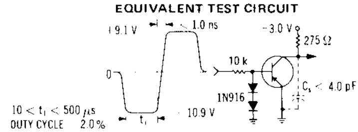


FIGURE 2 – STORAGE AND FALL TIME EQUIVALENT TEST CIRCUIT



*Total shunt capacitance of test jig and connectors

TRANSIENT CHARACTERISTICS

—T_J = 25°C --T_J = 125°C

FIGURE 3 – CAPACITANCE

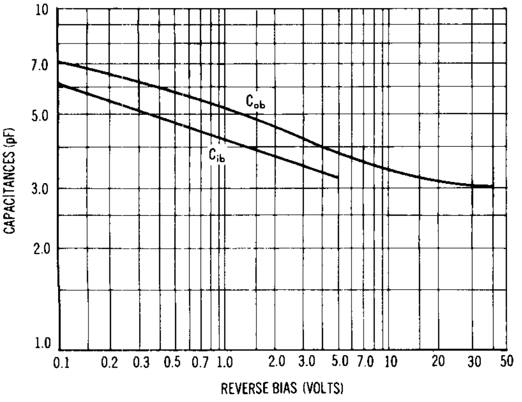


FIGURE 4 – CHARGE DATA

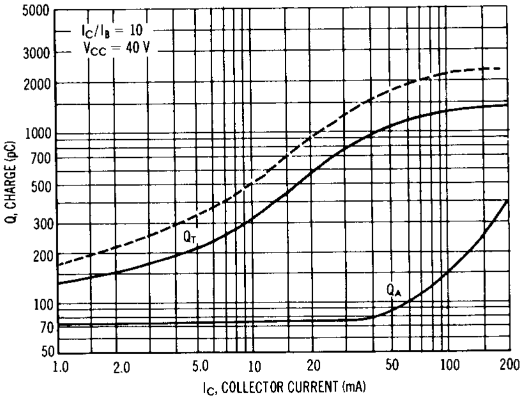


FIGURE 5 – TURN-ON TIME

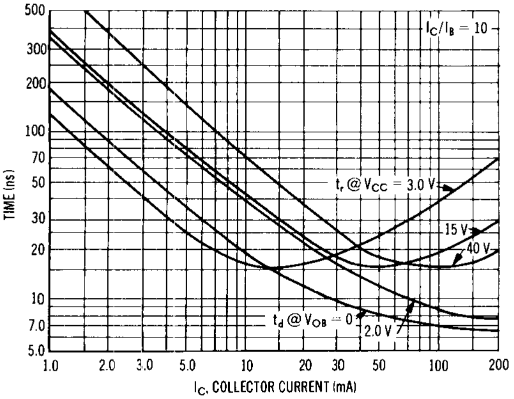


FIGURE 6 – RISE TIME

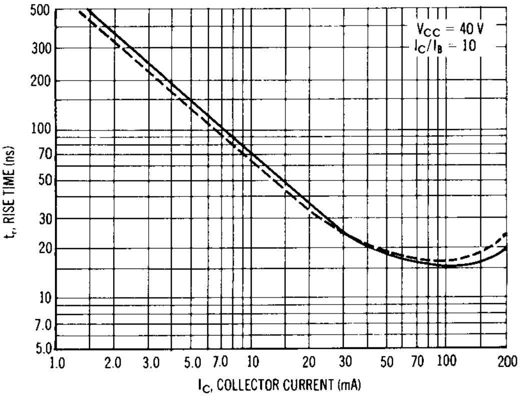


FIGURE 7 – STORAGE TIME

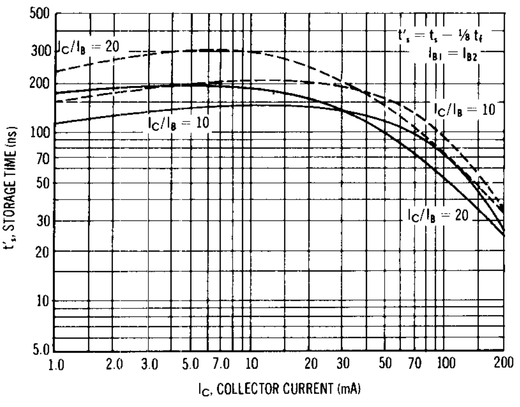
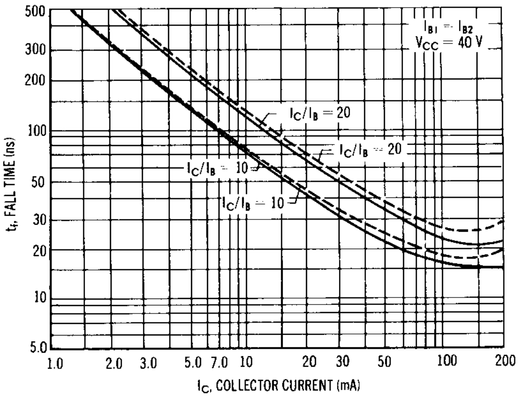


FIGURE 8 – FALL TIME



AUDIO SMALL SIGNAL CHARACTERISTICS

NOISE FIGURE VARIATIONS

V_{CE} = 5.0 Vdc, T_A = 25°C

FIGURE 9

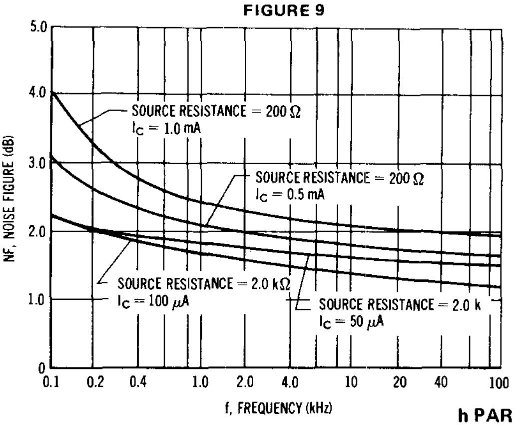
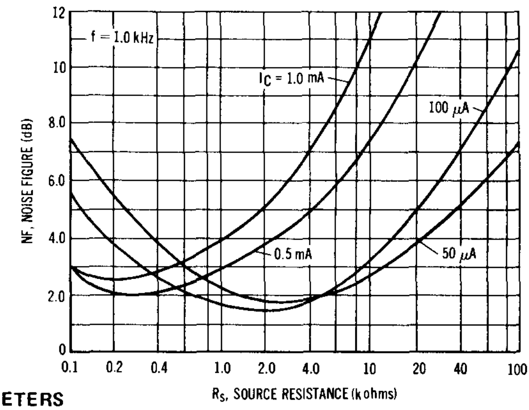


FIGURE 10



h PARAMETERS

(V_{CE} = 10 Vdc, f = 1.0 kHz, T_A = 25°C

FIGURE 11 – CURRENT GAIN

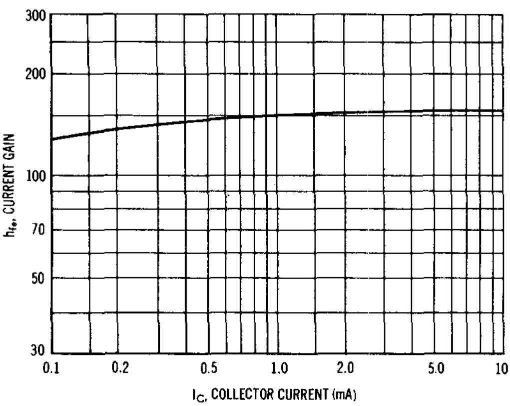


FIGURE 12 – OUTPUT ADMITTANCE

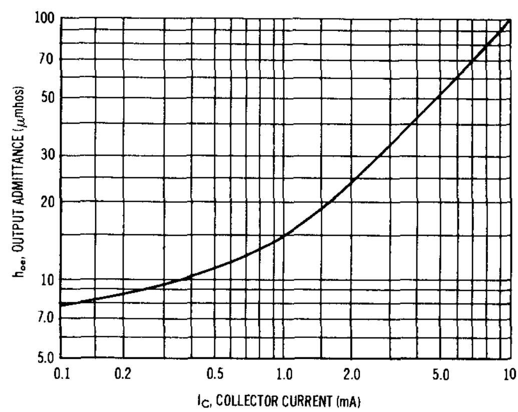


FIGURE 13 – INPUT IMPEDANCE

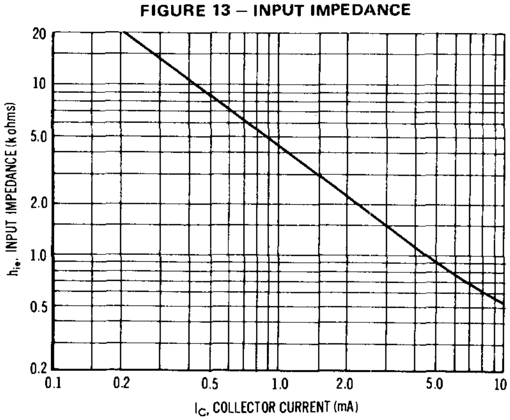
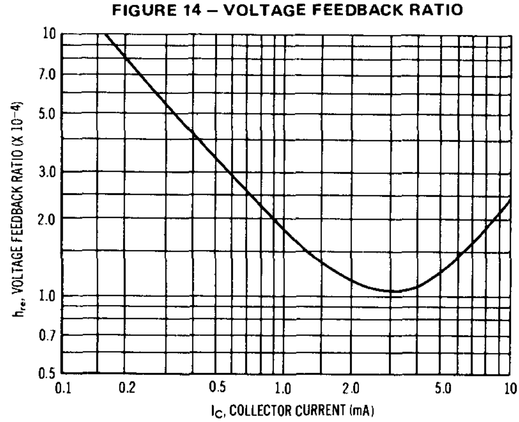


FIGURE 14 – VOLTAGE FEEDBACK RATIO



STATIC CHARACTERISTICS

FIGURE 15 – NORMALIZED CURRENT GAIN

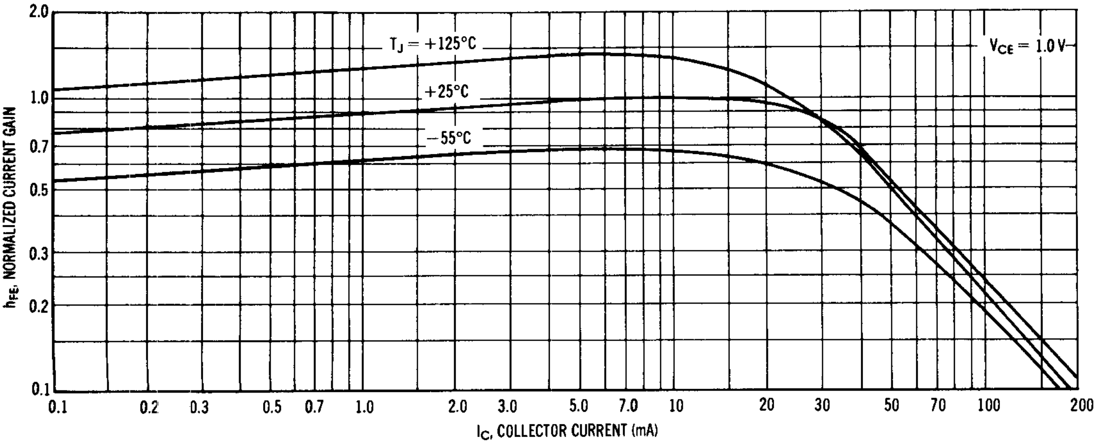


FIGURE 16 – COLLECTOR SATURATION REGION

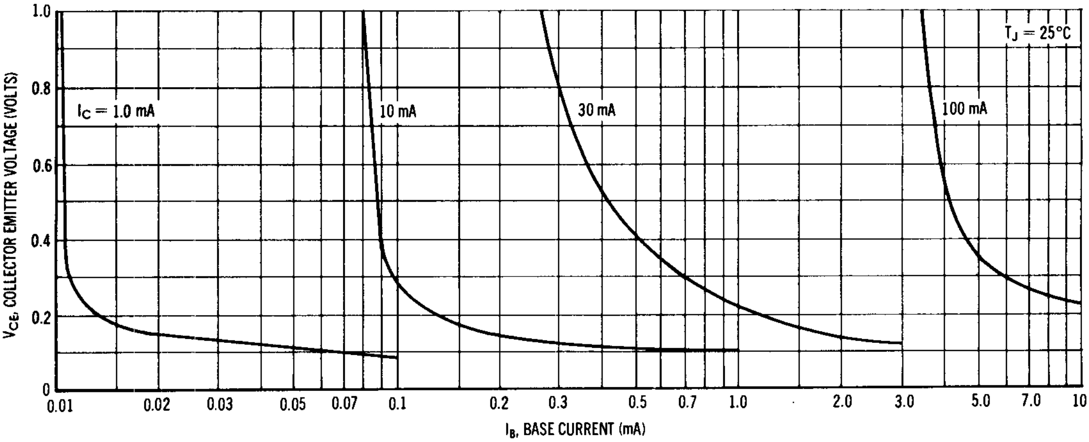


FIGURE 17 – "ON" VOLTAGES

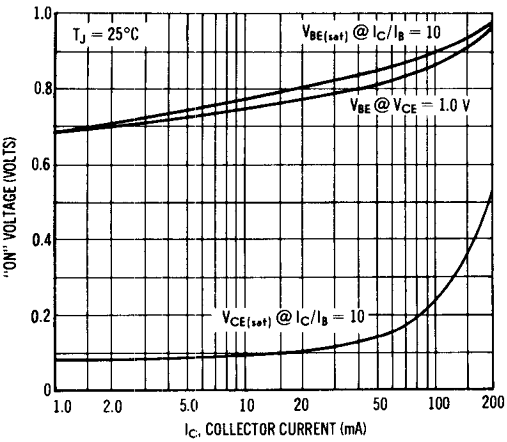
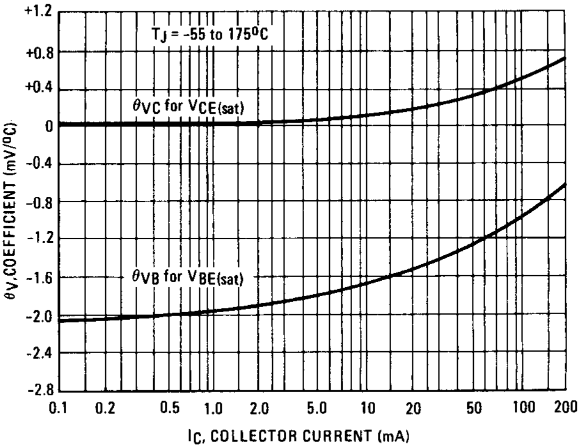


FIGURE 18 – TEMPERATURE COEFFICIENTS



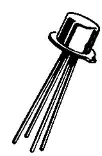
MM4049 (SILICON)

PNP SILICON ANNULAR TRANSISTOR

. . . designed for use as a high-frequency current mode switch. Because of the extremely high Current-Gain–Bandwidth this transistor also makes an excellent RF amplifier and oscillator.

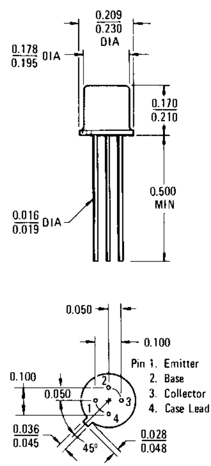
- High Current-Gain–Bandwidth Product –
  f_T = 4.0 GHz (Min) @ I_C = 12 mAdc
- Low Output Capacitance –
  C_{ob} = 0.8 pF (Typ) @ V_{CB} = 5.0 Vdc

PNP SILICON SWITCHING TRANSISTOR



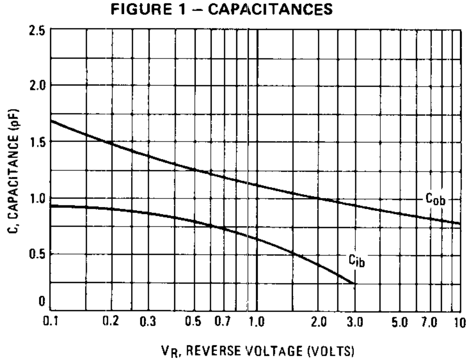
MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	10	Vdc
Collector-Base Voltage	V_{CB}	15	Vdc
Emitter-Base Voltage	V_{EB}	4.5	Vdc
Collector Current – Continuous	I_C	30	mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	200 1.14	mW mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	-65 to +200	°C



CASE 20 (10)
TO–72

FIGURE 1 – CAPACITANCES



ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage (I_C = 2.0 mAdc, I_B = 0)	BV_{CEO}	10	–	Vdc
Collector-Base Breakdown Voltage (I_C = 100 μAdc, I_E = 0)	BV_{CBO}	15	–	Vdc
Emitter-Base Breakdown Voltage (I_E = 100 μAdc, I_C = 0)	BV_{EBO}	4.5	–	Vdc
Collector Cutoff Current (V_{CB} = 10 Vdc, I_E = 0)	I_{CBO}	–	10	nAdc
ON CHARACTERISTICS				
DC Current Gain (I_C = 25 mAdc, V_{CE} = 2.0 Vdc)	h_{FE}	20	80	–
DYNAMIC CHARACTERISTICS				
Current-Gain—Bandwidth Product (Figure 2) (I_C = 20 mAdc, V_{CE} = 5.0 Vdc, f = 500 MHz)	f_T	4.0	–	GHz
Output Capacitance (Figure 1) (V_{CB} = 5.0 Vdc, I_E = 0, f = 100 kHz)	C_{ob}	–	1.25	pF
Input Capacitance (Figure 1) (V_{BE} = 0.5 Vdc, I_C = 0, f = 100 kHz)	C_{ib}	–	1.25	pF
Collector-Base Time Constant (Figure 3) (I_E = 15 mAdc, V_{CB} = 5.0 Vdc, f = 63.6 Hz)	$r_b'C_c$	–	15	ps

FIGURE 2 — CURRENT-GAIN—BANDWIDTH PRODUCT

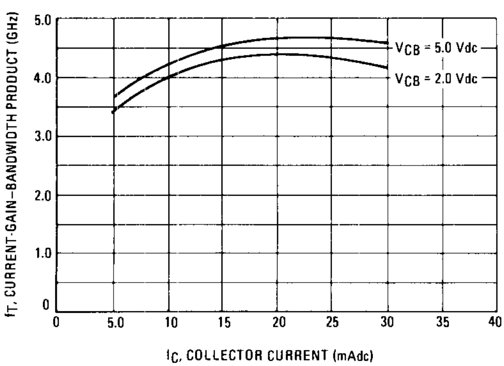
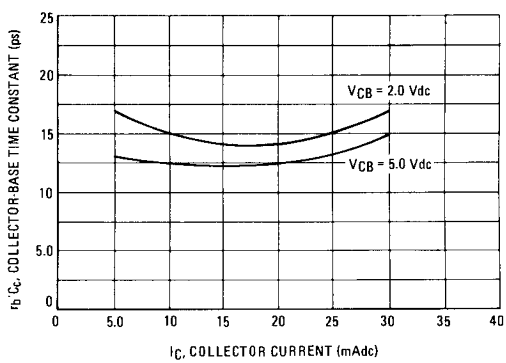


FIGURE 3 — COLLECTOR-BASE TIME CONSTANT



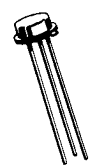
MM4052 (SILICON)

PNP SILICON ANNULAR TRANSISTOR

. . . designed for bilateral switching and high-level chopper applications such as servo-loop circuitry and control amplifiers for motor drive systems. These transistors can also be used as replacement devices for alloy-type transistors where high BV_{EBO} is required.

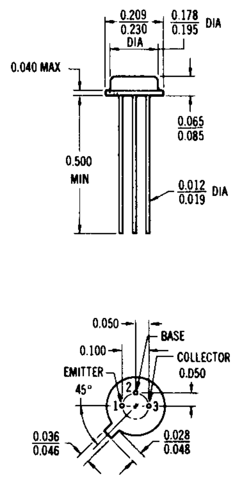
- High Emitter—Base Breakdown Voltage —
  BV_{EBO} = 30 Vdc (Min) @ I_E = 100 μAdc
- Inverted DC Current Gain — 3.0 (Min) @ I_C = 150 mAdc
- Low Emitter-Collector Offset Voltage —
  $V_{EC(ofs)}$ = 2.0 mVdc (Max) @ I_B = 1.0 mAdc
- Low "ON" Series Resistance —
  $r_{ec(ON)}$ = 2.0 Ohms (Max) @ I_B = 10 mAdc

PNP SILICON
CHOPPER AND SWITCHING
TRANSISTOR



MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	30	Vdc
Emitter-Collector Voltage	V_{EC}	30	Vdc
Collector-Base Voltage	V_{CB}	30	Vdc
Emitter-Base Voltage	V_{EB}	30	Vdc
Collector Current – Continuous	I_C	500	mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	0.5 2.8	Watt mW/°C
Total Device Dissipation @ T_C = 25 C Derate above 25 C	P_D	1.75 10	Watts mW/ C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	-65 to +200	°C



CASE 26
TO–46 PACKAGE

ELECTRICAL CHARACTERISTICS ($T_A = 25^\circ$ C unless otherwise noted)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage* (I_C = 10 mAdc, I_B = 0)	BV_{CEO}*	30	–	Vdc
Emitter-Collector Breakdown Voltage* (I_E = 10 mAdc, I_B = 0)	BV_{ECO}*	30	–	Vdc
Collector-Base Breakdown Voltage (I_C = 100 μAdc, I_E = 0)	BV_{CBO}	30	–	Vdc
Emitter-Base Breakdown Voltage (I_E = 100 μAdc, I_C = 0)	BV_{EBO}	30	–	Vdc
Collector Cutoff Current (V_{CB} = 15 Vdc, I_E = 0)	I_{CBO}	–	0.5	nAdc
Emitter Cutoff Current (V_{EB} = 15 Vdc, I_C = 0)	I_{EBO}	–	0.5	nAdc
ON CHARACTERISTICS				
DC Current Gain*	h_{FE}*			–
(I_C = 10 mAdc, V_{CE} = 1.0 Vdc)		20	–	
(I_C = 150 mAdc, V_{CE} = 1.0 Vdc)		15	–	
(I_C = 150 mAdc, V_{CE} = 1.0 Vdc) (Inverted)		3.0	–	
Offset Voltage (I_B = 1.0 mAdc, I_E = 0)	$V_{EC(ofs)}$	–	2.0	mVdc
SMALL-SIGNAL CHARACTERISTICS				
Output Capacitance (V_{CB} = 10 Vdc, I_E = 0, 100 kHz ≤ f ≤ 1.0 MHz)	C_{ob}	–	10	pF
Input Capacitance (V_{EB} = 10 Vdc, I_C = 0, 100 kHz ≤ f ≤ 1.0 MHz)	C_{ib}	–	5.0	pF
Small-Signal Current Gain	h_{fe}			–
(I_C = 10 mAdc, V_{CE} = 1.0 Vdc, f = 1.0 kHz)		20	–	–
(I_C = 10 mAdc, V_{CE} - 1.0 Vdc, f = 4.0 MHz)		3.0	–	–
"ON" Series Resistance (I_B = 10 mAdc, f = 1.0 kHz)	$r_{ec(ON)}$	–	2.0	Ohms

*Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 20%

[redacted]

MM4261H (SILICON)

High Reliability Products

PNP SILICON ANNULAR TRANSISTOR

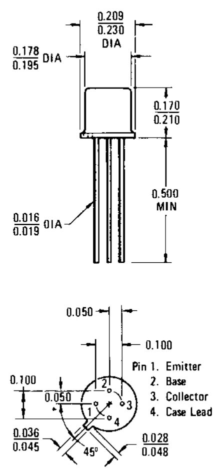
. . . designed for high reliability, low-level switching applications and general usage for radiation resistant requirements.

- Off-the-Shelf Availability of Extensive High Reliability Processing
- High Tolerance to Neutron Radiation @ I_C = 10 mA, h_{FE} Degradation Typically Less Than 50% after 5×10^{14} Neutrons/cm^2 (Figure 13)
- High Current-Gain—Bandwidth Product — f_T = 3500 MHz (Typ) @ I_C = 10 mA
- Low Input and Output Capacitance — C_{ib} and C_{ob} = 2.5 pF (Max)
- Excellent Current-Mode Performance — t_r = 0.5 ns (Typ) @ I_C = 10 mA
  1.1 ns (Typ) @ I_C = 30 mA

PNP SILICON SWITCHING TRANSISTOR

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	15	Vdc
Collector-Base Voltage	V_{CB}	15	Vdc
Emitter-Base Voltage	V_{EB}	4.5	Vdc
Collector Current — Continuous	I_C	30	mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	200 1.14	mW mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	-65 to +200	°C



CASE 20 (10)
TO-72

HIGH RELIABILITY PROCESSING SEQUENCE

The lot is 100% inspected in the sequence shown below

INTERNAL VISUAL INSPECTION
Note 1

SCREEN ELECTRICAL PARAMETERS
Table I
G,R

HIGH TEMPERATURE STORAGE
$T_A \geq 200^oC$, $t \geq 24$ hours

TEMPERATURE CYCLING
MIL-STD-202, Method 102, Condition C
10 cycles, t (extreme) ≥15 minutes

CONSTANT ACCELERATION
MIL-STD-750, Method 2006
Y1 axis 20,000 G

FINE LEAK
MIL-STD-202, Method 112, Procedure IIIa
Condition C, P = 50 psig, t = 4 hours
Leak rate $\leq 1 \times 10^{-8}$ atm. cc/sec
R

GROSS LEAK
MIL-STD-202, Method 112, Condition A
Ethylene Glycol, $T = 100^oC$, $t \geq 15$ sec.
R

MARK DEVICES
Motorola Symbol, MM4261H, seal date code

ELECTRICAL TEST Table II (initial)
RR,R

BURN-IN $T_A = 25^oC$, t = 168 hours
$P_D = 200$ mW, $V_{CB} \leq 5.0$ V

ELECTRICAL TEST Table II (end points)
$P_{DA} = 10$
RR,R

Option 1
Burn-In Data with Delta Calculations
(see Option Data Provisions)

Samples are randomly selected from the lot for Group A, Group B, and Group C inspection. Sample size for each Subgroup shall be determined from Sampling Plan Table and shall meet the specified LTPD or lambda requirements.

GROUP A INSPECTION

SAMPLE INSPECT ELECTRICAL PARAMETERS per TABLE I
summary data provided

SUBGROUP 1
LTPD = 5

VISUAL and MECHANICAL
MIL-STD-750
Method 2071
R

SUBGROUP 2
LTPD = 2

ELECTRICAL TEST
Table I
G,R

SUBGROUP 3
LTPD = 3

ELECTRICAL TEST
Table I
G,R

SUBGROUP 4
LTPD = 5

ELECTRICAL TEST
Table I
G,R

SUBGROUP 5
LTPD = 5

ELECTRICAL TEST
Table I
G,R

SUBGROUP 6
LTPD = 7

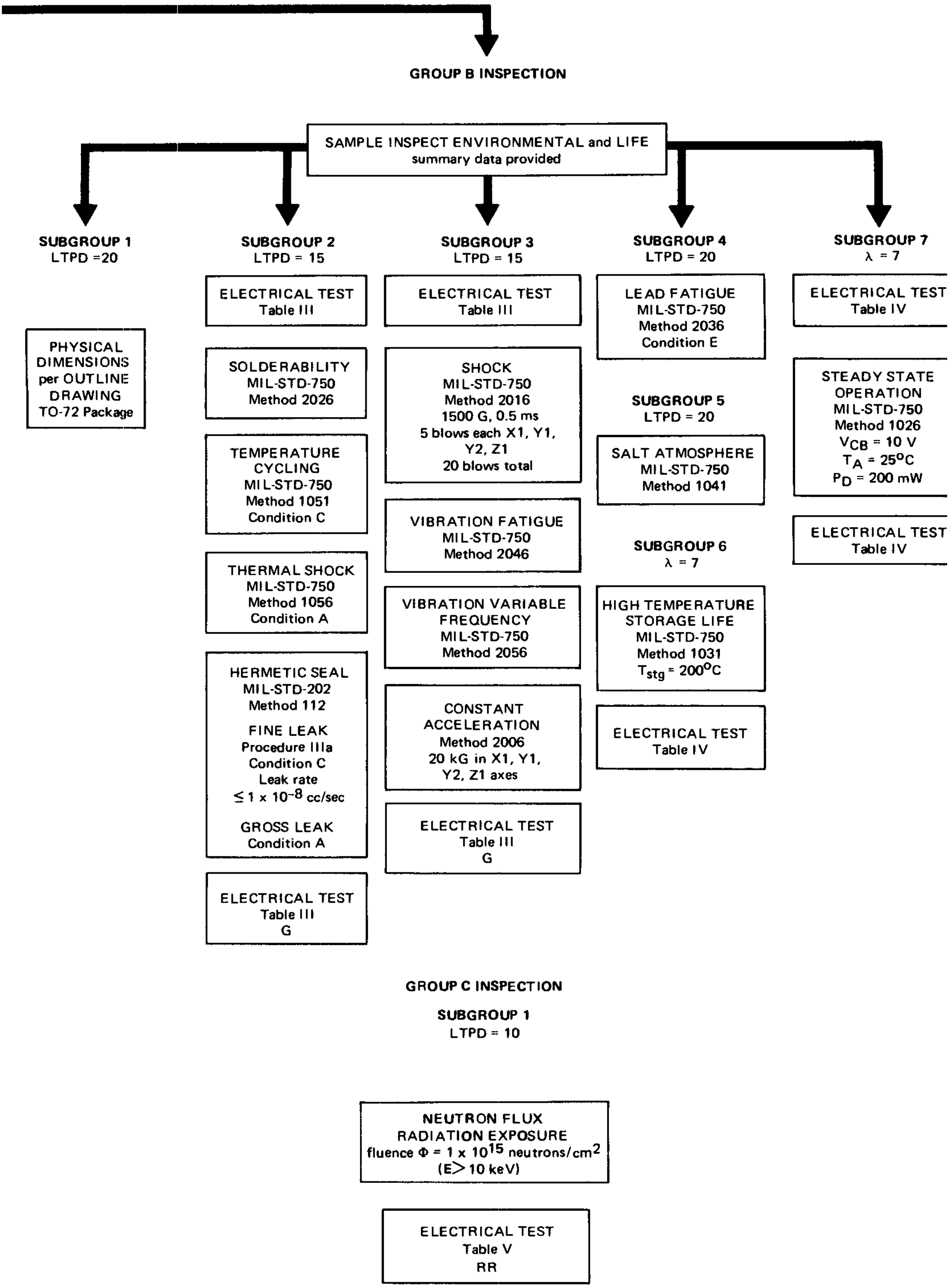
ELECTRICAL TEST
Table I
G,R

SUBGROUP 7
LTPD = 7

ELECTRICAL TEST
Table I
G,R

R — Remove Rejects
G — Go-No-Go
RR — Read and Record

NOTE 1: Internal Visual Inspection
Each device will be inspected under magnification for defects in material and workmanship which do not comply with Motorola's visual inspection procedures.



G — Go-No-Go

RR — Read and Record

TABLE I: GROUP A INSPECTION (T_A = 25°C unless otherwise noted)

Examination or Test	MIL-STD-750 Method	Symbol	Min	Max	Unit	LTPD
SUBGROUP 1						
Visual and Mechanical Examination	2071	–	–	–	–	5
SUBGROUP 2						2
Collector-Base Cutoff Current (V_{CB} = 10 Vdc, I_E = 0)	3036D	I_{CBO1}	–	5.0	nAdc	
Collector-Cutoff Current (V_{CE} = 10 Vdc, $V_{BE(off)}$ = 2.0 Vdc)	3041A	I_{CEX1}	–	5.0	nAdc	
Collector-Cutoff Current (V_{CE} = 10 Vdc, $V_{EB(on)}$ = 0.4 Vdc)	3041A	I_{CEX2}	–	50	nAdc	
Emitter-Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)	3026D	BV_{EBO}	4.5	–	Vdc	
Collector-Base Breakdown Voltage (I_C = 10 μAdc, I_E = 0)	3001D	BV_{CBO}	15	–	Vdc	
Collector-Emitter Breakdown Voltage* (I_C = 10 mAdc, I_B = 0)	3011D	BV_{CEO}*	15	–	Vdc	
SUBGROUP 3						3
Base-Emitter On Voltage (I_C = 1.0 mAdc, V_{CE} = 1.0 Vdc)	3066B	$V_{BE(on)1}$	–	0.8	Vdc	
Base-Emitter On Voltage (I_C = 10 mAdc, V_{CE} = 1.0 Vdc)	3066B	$V_{BE(on)2}$	–	1.0	Vdc	
Collector-Emitter Saturation Voltage (I_C = 1.0 mAdc, I_B = 0.1 mAdc)	3071	$V_{CE(sat)1}$	–	0.15	Vdc	
Collector-Emitter Saturation Voltage (I_C = 10 mAdc, I_B = 1.0 mAdc)	3071	$V_{CE(sat)2}$	–	0.35	Vdc	
DC Current Gain (I_C = 1.0 mAdc, V_{CE} = 1.0 Vdc)	3076	h_{FE1}	25	–	–	
DC Current Gain (I_C = 10 mAdc, V_{CE} = 1.0 Vdc)	3076	h_{FE2}	30	150	–	
DC Current Gain (I_C = 30 mAdc, V_{CE} = 2.0 Vdc)	3076	h_{FE3}	20	–	–	
SUBGROUP 4						5
Current-Gain–Bandwidth Product (I_C = 5.0 mAdc, V_{CE} = 4.0 Vdc, f = 100 MHz)		f_{T1}	1500	–	MHz	
Current-Gain–Bandwidth Product (I_C = 10 mAdc, V_{CE} = 10 Vdc, f = 100 MHz)		f_{T2}	2000	–	MHz	
Output Capacitance (V_{CB} = 4.0 Vdc, I_E = 0, 100 kHz ≤ f ≤ 1.0 MHz)	3236	C_{ob}	–	2.5	pF	
Input Capacitance (V_{EB} = 0.5 Vdc, I_C = 0, 100 kHz ≤ f ≤ 1.0 MHz)	3240	C_{ib}	–	2.5	pF	
SUBGROUP 5 (See Figure 1)						5
Collector-Base Time Constant (I_C = 5.0 mAdc, V_{CE} = 4.0 Vdc)		$r_b'C_{c1}$	–	60	ps	
Collector-Base Time Constant (I_C = 10 mAdc, V_{CE} = 10 Vdc)		$r_b'C_{c2}$	–	50	ps	
SUBGROUP 6						7
OC Current Gain (I_C = 1.0 mAdc, V_{CE} = 1.0 Vdc, T_A = -55°C)		h_{FE4}	15	–	–	
DC Current Gain (I_C = 10 mAdc, V_{CE} = 1.0 Vdc, T_A = -55°C)		h_{FE5}	15	–	–	
Collector-Base Cutoff Current (V_{CB} = 10 Vdc, I_E = 0, T_A = 150°C)		I_{CBO2}	–	5.0	μAdc	
SUBGROUP 7 (See Figure 2)						7
Turn-On Time		t_{on}	–	5.0	ns	
Turn-Off Time		t_{off}	–	5.0	ns	

*Pulse Test: Pulse Width ≤ 300 μs, Outy Cycle ≤ 2.0%.

TABLE II: ELECTRICAL INSPECTION (T_A = 25°C unless otherwise noted)

Examination or Test	MIL-STD-750 Method	Symbol	Min	Max	Unit
Collector-Base Cutoff Current (V_{CB} = 10 Vdc, I_E = 0)	3036D	I_{CBO1}	–	5.0	nAdc
DC Current Gain* (I_C = 10 mAdc, V_{CE} = 1.0 Vdc)	3076	h_{FE2}*	30	150	–
Collector-Base Cutoff Current 100% or 5.0 nAdc whichever is greater		ΔI_{CBO1}	–	–	–
DC Current Gain		Δh_{FE2}	–	±20%	–

TABLE III: ELECTRICAL INSPECTION (T_A = 25°C unless otherwise noted)

Examination or Test	MIL-STD-750 Method	Symbol	Min	Max	Unit
Collector-Base Cutoff Current (V_{CB} = 10 Vdc, I_E = 0)	3036D	I_{CBO1}	–	5.0	nAdc
DC Current Gain* (I_C = 10 mAdc, V_{CE} = 1.0 Vdc)	3076	h_{FE2}*	30	150	–

TABLE IV: ELECTRICAL INSPECTION (T_A = 25°C unless otherwise noted)

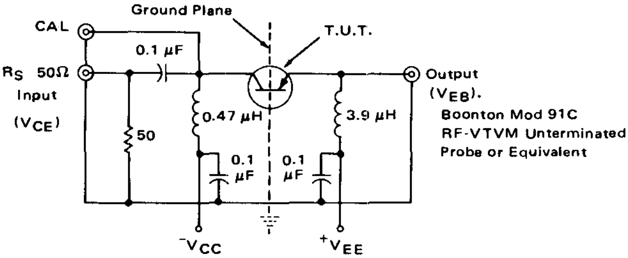
Examination or Test		MIL-STD-750 Method	Symbol	Min	Max	Unit
Collector-Base Cutoff Current (V_{CB} = 10 Vdc, I_E = 0)		3036D	I_{CBO1}			nAdc
	Initial			–	5.0	
	End Point			–	10	
DC Current Gain* (I_C = 10 mAdc, V_{CE} = 1.0 Vdc)		3076	h_{FE2}*			–
	Initial			30	150	
	End Point			20	180	
Collector-Base Cutoff Current 100% or 5.0 nAdc whichever is greater			ΔI_{CBO1}	–	–	–
DC Current Gain			Δh_{FE2}	–	±20%	–

TABLE V: ELECTRICAL INSPECTION (T_A = 25°C unless otherwise noted)

Examination or Test	MIL-STD-750 Method	Symbol	Min	Max	Unit
Collector-Base Cutoff Current (V_{CB} = 10 Vdc, I_E = 0)	3036D	I_{CBO1}	–	10	μAdc
Collector-Emitter Saturation Voltage (I_C = 10 mAdc, I_B = 1.0 mAdc)	3071	$V_{CE(sat)2}$*	–	0.5	Vdc
DC Current Gain (I_C = 10 mAdc, V_{CE} = 1.0 Vdc)	3076	h_{FE2}*	12	–	–

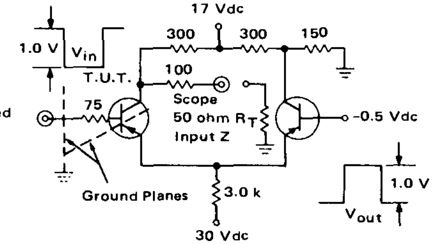
*Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

FIGURE 1 – COLLECTOR-BASE TIME CONSTANT TEST CIRCUIT



1. With transistor under test removed from socket, set input level at "CAL" jack to 500 mV at 31.8 MHz. Insert transistor in socket.
2. After putting VTVM probe on "OUT" jack, adjust bias on transistor under test.
3. Reading on VTVB in millivolts multiplied by 10 equals $r_b'C_c$

FIGURE 2 – TURN-ON TIME AND TURN-OFF TIME TEST CIRCUIT



The test circuit is designed to simulate a series of cascaded identical circuits with input Z equal to output Z.

FIGURE 3 – DC CURRENT GAIN

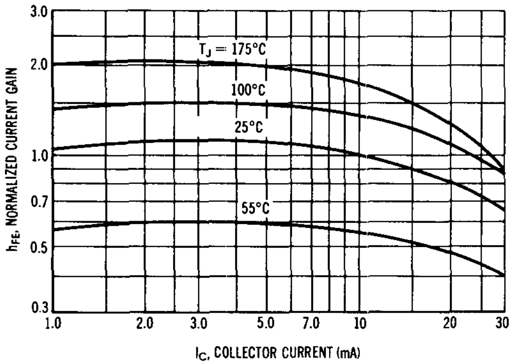


FIGURE 4 – COLLECTOR SATURATION REGION

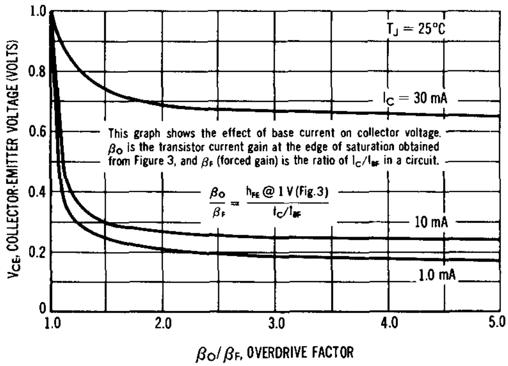


FIGURE 5 – "ON" VOLTAGES

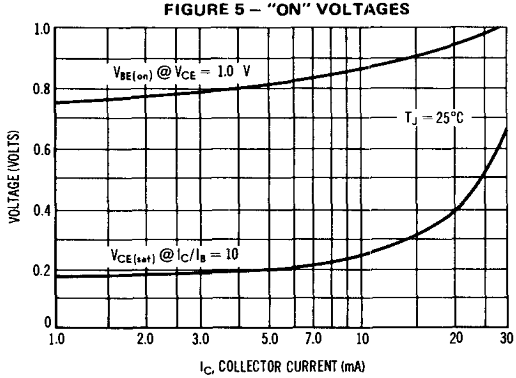


FIGURE 6 – TEMPERATURE COEFFICIENTS

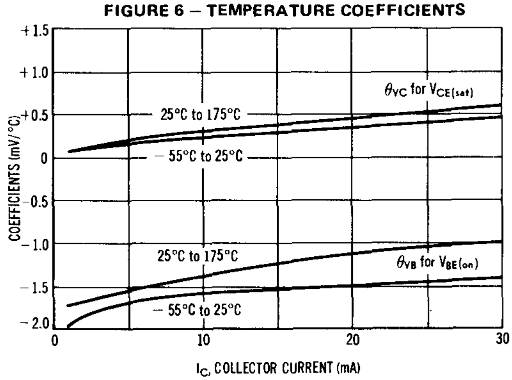


FIGURE 7 – CURRENT-GAIN–BANDWIDTH PRODUCT

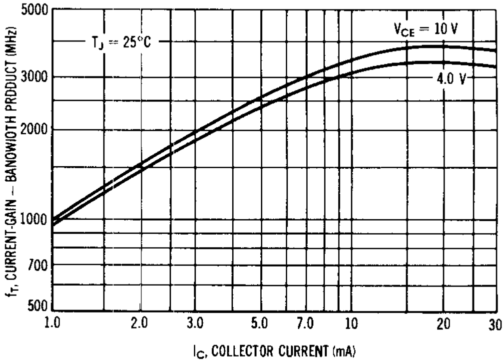


FIGURE 8 – COLLECTOR-BASE TIME CONSTANT

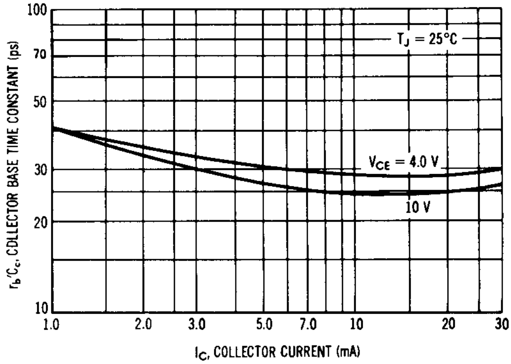


FIGURE 9 – CAPACITANCE

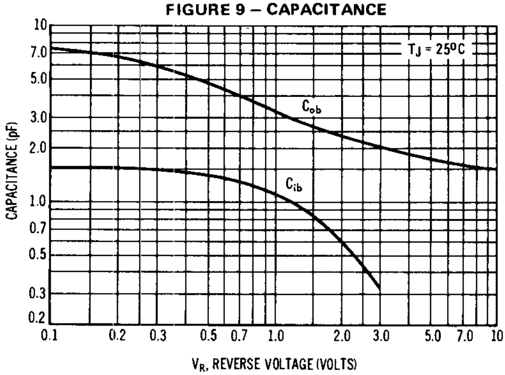


FIGURE 10 – SWITCHING TIMES

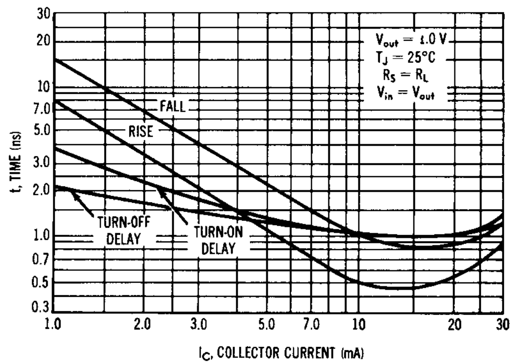
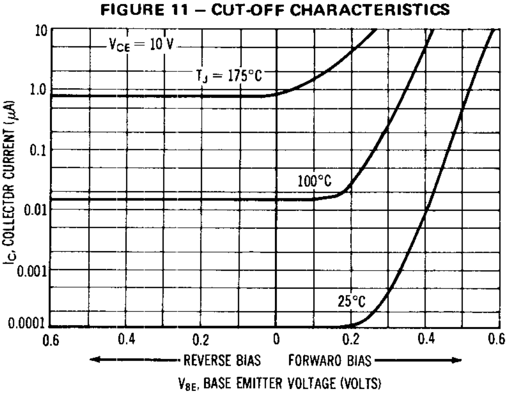


FIGURE 11 – CUT-OFF CHARACTERISTICS



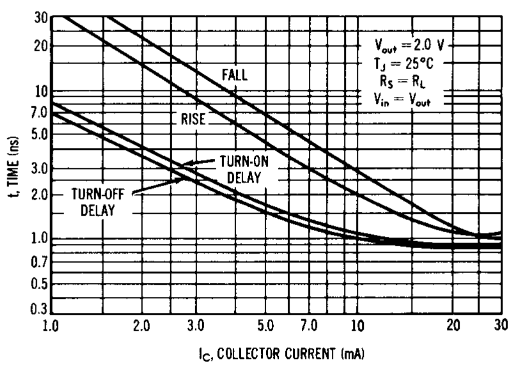


FIGURE 12 – NORMALIZED DC CURRENT GAIN versus FAST NEUTRON DOSAGE

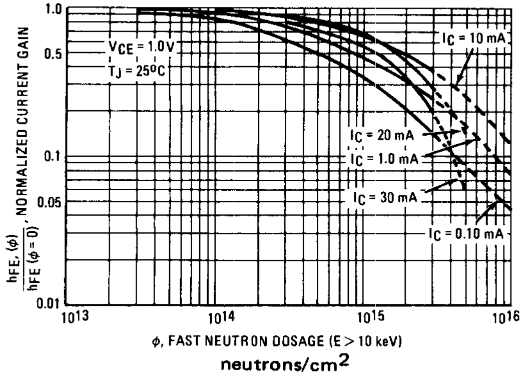
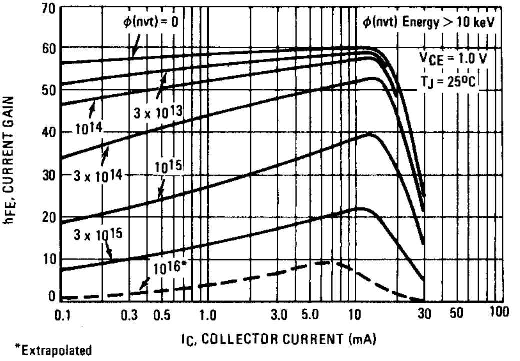


FIGURE 13 – TYPICAL DC CURRENT GAIN versus FAST NEUTRON DOSAGE



*Extrapolated

FIGURE 14 – COLLECTOR-BASE LEAKAGE CURRENT versus FAST NEUTRON DOSAGE

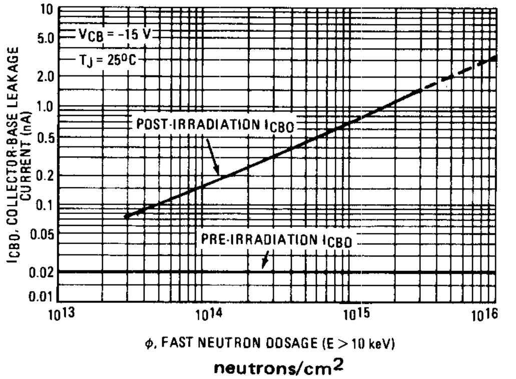
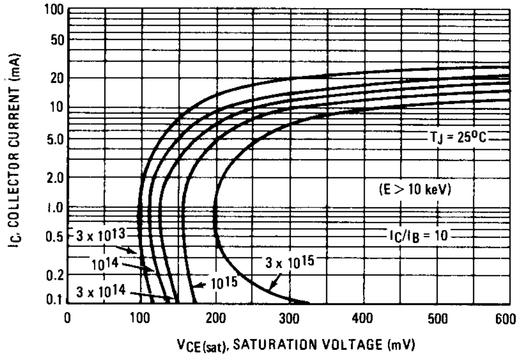


FIGURE 15 – TYPICAL COLLECTOR-EMITTER SATURATION VOLTAGE versus FAST NEUTRON DOSAGE



Devices Stocked in Motorola Bonded Warehouse

STANDARD DATA PROVISIONS

1. Motorola will keep on file 1 copy of all associated data for a minimum of 3 years from date of purchase order.
2. One copy of Summary data shall accompany each shipment of devices from following steps.
   a. Burn-In Test per Table II
   b. Group A Inspection per Table I
   c. Group B Inspection per Tables III and IV
   d. Group C Inspection per Table V

   Foam Tray Packaging per MIL-S-19491

Option 2
100% Radiographic Inspection per MIL-STD-202, Method 209 (see Option Data Provisions)

OPTION DATA PROVISIONS

1. Motorola will provide burn-in delta data on control parameters for the lot as well as for Group B, Subgroup 6 and 7, and Group C, Subgroup 1.
2. Motorola will X-ray the serialized devices prior to shipping and provide films only if this is required by purchase order.

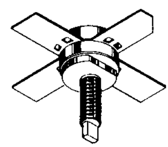
MM4429 (SILICON)

NPN SILICON RF POWER TRANSISTOR

. . . designed primarily for use in large signal VHF, UHF and microwave frequency amplifier output stages in military and industrial communications applications.

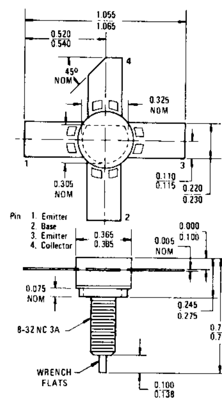
- High Power Output – P_{out} = 1.0 W with 5.2 dB Gain @ f = 1.0 GHz
- Multiple Emitter Construction for Excellent High Frequency Performance
- Low Profile Ceramic Stripline Package for Low Lead Inductance and Ease in Design

NPN SILICON RF POWER TRANSISTOR



MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	35	Vdc
Collector-Base Voltage	V_{CB}	55	Vdc
Emitter-Base Voltage	V_{EB}	3.5	Vdc
Collector Current – Continuous	I_C	250	mAdc
Total Device Dissipation @ $T_C = 25^oC$ Derate above 25^oC	P_D	5.0 28.6	Watts $mW/^oC$
Operating and Storage Junction Temperature Range	T_J, T_{stg}	-65 to +200	^oC



CASE 145A-01

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 10 mAdc, I_B = 0)	BV_{CEO}	35	–	–	Vdc
Collector-Base Breakdown Voltage (I_C = 1.0 mAdc, I_E = 0)	BV_{CBO}	55	–	–	Vdc
Emitter-Base Breakdown Voltage (I_E = 100 μAdc, I_C = 0)	BV_{EBO}	3.5	–	–	Vdc
Collector Cutoff Current (V_{CE} = 30 Vdc, I_B = 0)	I_{CEO}	–	–	1.0	mAdc
Collector Cutoff Current (V_{CB} = 55 Vdc, I_E = 0)	I_{CBO}	–	–	100	μAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 50 mAdc, V_{CE} = 15 Vdc)	h_{FE}	20	–	200	–
Collector-Emitter Saturation Voltage (I_C = 100 mAdc, I_B = 10 mAdc)	$V_{CE(sat)}$	–	–	0.25	Vdc
DYNAMIC CHARACTERISTICS					
Current-Gain—Bandwidth Product (I_C = 100 mAdc, V_{CE} = 15 Vdc, f = 100 MHz)	f_T	600	800	–	MHz
Output Capacitance (V_{CB} = 30 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	–	2.9	3.5	pF
FUNCTIONAL TEST					
Power Output (Figure 1) (P_{in} = 300 mW, V_{CE} = 28 Vdc, f = 1.0 GHz)	P_{out}	1.0	1.3	–	Watt
Collector Efficiency (P_{out} = 1.0 W, V_{CE} = 28 Vdc, f = 1.0 GHz)	η	–	45	–	%

FIGURE 1 — 1.0 GHz TEST SET UP

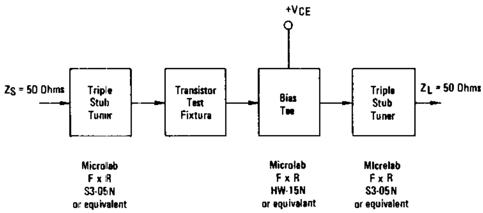


FIGURE 2 — CURRENT-GAIN—BANDWIDTH PRODUCT

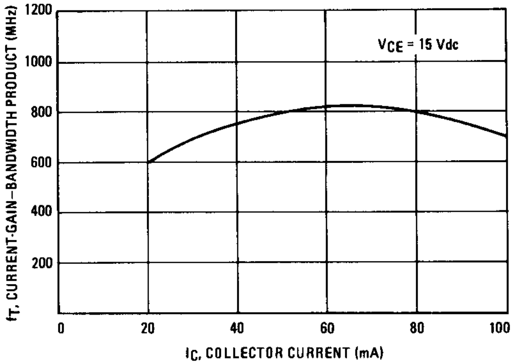


FIGURE 3 — OUTPUT CAPACITANCE versus VOLTAGE

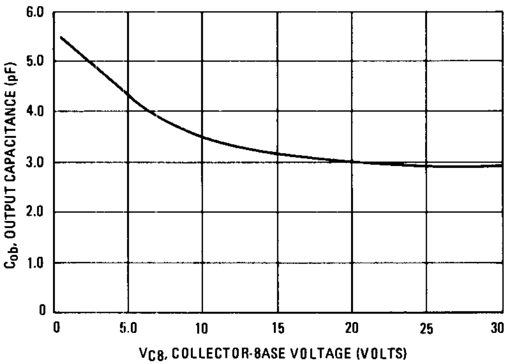


FIGURE 4 — POWER OUTPUT versus VOLTAGE

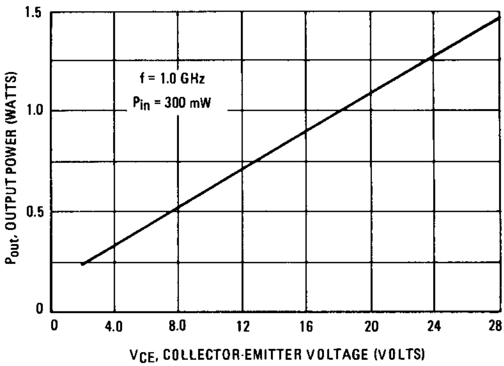


FIGURE 5 — POWER OUTPUT versus POWER INPUT

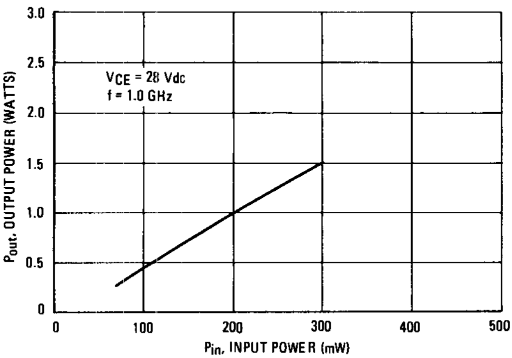
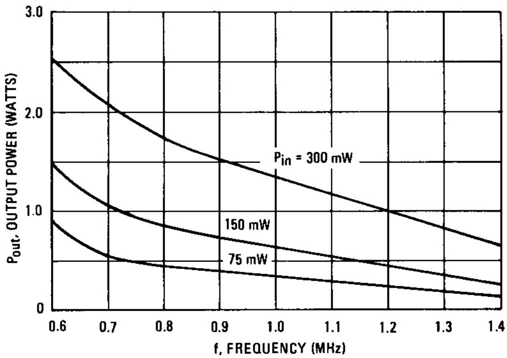


FIGURE 6 — POWER OUTPUT versus FREQUENCY



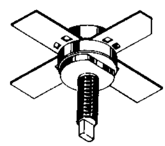
MM4430 (SILICON)

NPN SILICON RF POWER TRANSISTOR

. . . designed primarily for use in large signal VHF, UHF and microwave frequency amplifier output stages in military and industrial communications applications.

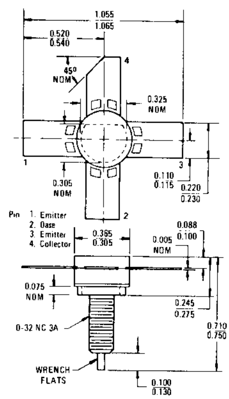
- High Power Output — P_{out} = 2.5 W with 5 dB Gain @ f = 1.0 GHz
- Multiple Emitter Construction for Excellent High Frequency Performance
- Low Profile Ceramic Stripline Package for Low Lead Inductance and Ease in Design

NPN SILICON RF POWER TRANSISTOR



MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	35	Vdc
Collector-Base Voltage	V_{CB}	55	Vdc
Emitter-Base Voltage	V_{EB}	3.5	Vdc
Collector Current — Continuous	I_C	250	mAdc
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	5.0 28.6	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	-65 to +200	°C



CASE 145A-01

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 10 mAdc, I_B = 0)	BV_{CEO}	35	–	–	Vdc
Collector-Base Breakdown Voltage (I_C = 1.0 mAdc, I_E = 0)	BV_{CBO}	55	–	–	Vdc
Emitter-Base Breakdown Voltage (I_E = 100 μAdc, I_C = 0)	BV_{EBO}	3.5	–	–	Vdc
Collector Cutoff Current (V_{CE} = 30 Vdc, I_B = 0)	I_{CEO}	–	–	1.0	mAdc
Collector Cutoff Current (V_{CB} = 55 Vdc, I_E = 0)	I_{CBO}	–	–	100	μAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 50 mAdc, V_{CE} = 15 Vdc)	h_{FE}	20	–	200	–
Collector-Emitter Saturation Voltage (I_C = 100 mAdc, I_B = 10 mAdc)	$V_{CE(sat)}$	–	–	0.25	Vdc
DYNAMIC CHARACTERISTICS					
Current-Gain–Bandwidth Product (I_C = 100 mAdc, V_{CE} = 15 Vdc, f = 100 MHz)	f_T	600	–	–	MHz
Output Capacitance (V_{CB} = 30 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	–	2.8	3.5	pF
FUNCTIONAL TEST					
Power Output (Figure 1) (P_{in} = 750 mW, V_{CE} = 28 Vdc, f = 1.0 GHz)	P_{out}	2.5	2.8	–	Watt
Collector Efficiency (Figure 1) (P_{out} = 2.5 W, V_{CE} = 28 Vdc, f = 1.0 GHz)	η	–	45	–	%

FIGURE 1 – 1.0 GHz TEST SET UP

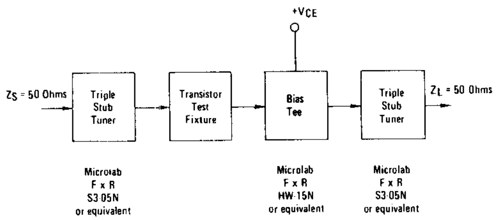
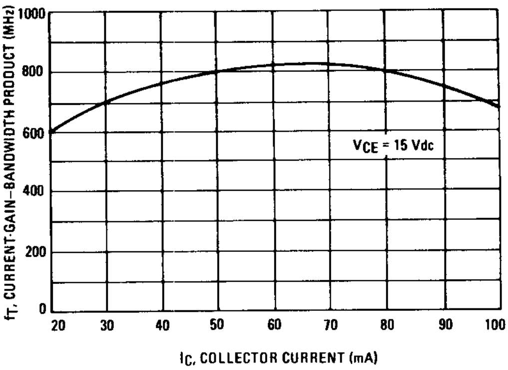


FIGURE 2 – CURRENT-GAIN–BANDWIDTH PRODUCT



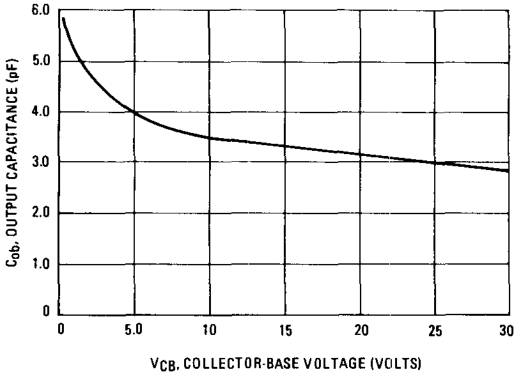


FIGURE 3 – OUTPUT CAPACITANCE versus VOLTAGE

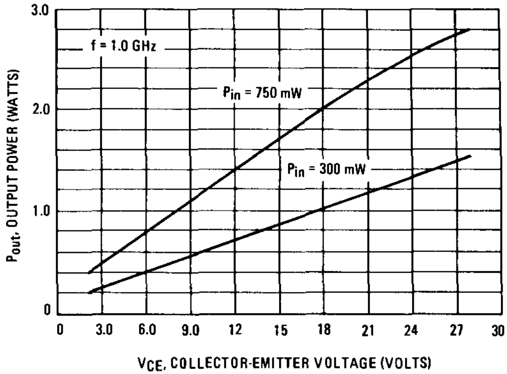


FIGURE 4 – POWER OUTPUT versus VOLTAGE

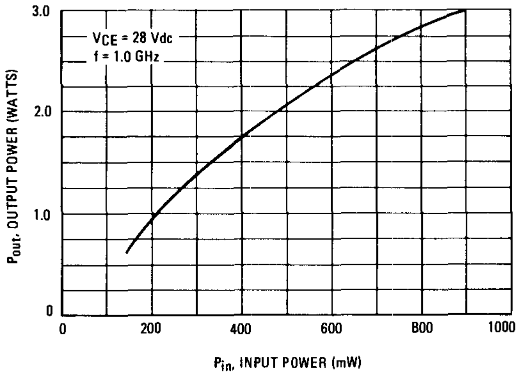


FIGURE 5 – POWER OUTPUT versus POWER INPUT

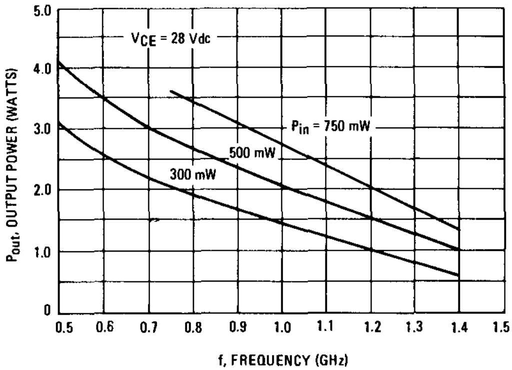


FIGURE 6 – POWER OUTPUT versus FREQUENCY

MM8006 (SILICON)
MM8007

NPN SILICON RF SMALL-SIGNAL TRANSISTORS

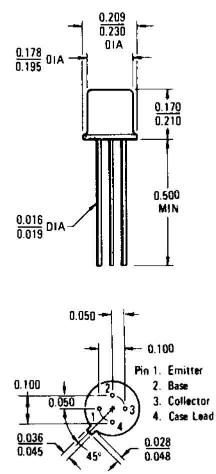
. . . designed primarily for use in high-gain, low-noise, small-signal amplifiers in military and industrial equipment. Suitable for use in video wideband and general high-frequency amplifier applications of 50 to 1000 MHz.

- Low Noise Figure –
  NF = 2.2 dB (Typ) @ f = 200 MHz – MM8006
- High Power Gain –
  G_{pe} = 25 dB (Typ) @ f = 200 MHz – MM8006
- High Current-Gain–Bandwidth Product –
  f_T = 1000 MHz (Min) @ I_C = 5.0 mAdc

NPN SILICON RF SMALL-SIGNAL TRANSISTORS

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	10	Vdc
Collector-Base Voltage	V_{CB}	15	Vdc
Emitter-Base Voltage	V_{EB}	3.0	Vdc
Collector Current – Continuous	I_C	20	mAdc
Total Device Dissipation @ T_A = 25°C	P_D	200	mW
Derate above 25°C		1.14	mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	-65 to +200	°C



CASE 20 (10)
TO-72 PACKAGE

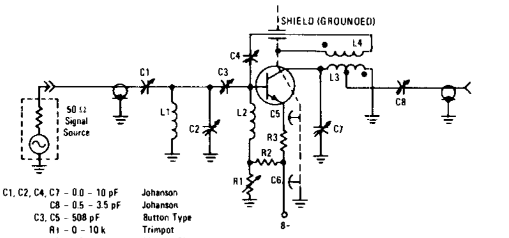
MM8006, MM8007 (continued)

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Collector-Emitter Breakdown Voltage (I_C = 1.0 mAdc, I_B = 0)		BV_{CEO}	10	–	–	Vdc
Collector-Base Breakdown Voltage (I_C = 0.01 mAdc, I_E = 0)		BV_{CBO}	15	–	–	Vdc
Emitter-Base Breakdown Voltage (I_E = 0.01 mAdc, I_C = 0)		BV_{EBO}	3.0	–	–	Vdc
Collector Cutoff Current (V_{CB} = 6.0 Vdc, I_E = 0)		I_{CBO}	–	1.0	10	nAdc
ON CHARACTERISTICS						
DC Current Gain (I_C = 1.0 mAdc, V_{CE} = 6.0 Vdc)		h_{FE}	25	–	–	–
DYNAMIC CHARACTERISTICS						
Current-Gain–Bandwidth Product (I_C = 5.0 mAdc, V_{CE} = 6.0 Vdc, f = 100 MHz)		f_T	1000	–	3500	MHz
Collector-Base Capacitance (V_{CE} = 6.0 Vdc, I_E = 0, f = 0.1 MHz)		C_{cb}	–	1.1	1.5	pF
Collector-Base Time Constant (I_C = 10 mAdc, V_{CE} = 6.0 Vdc, f = 31.8 MHz)		$r_b'C_c$	–	5.0	–	ps
Noise Figure		NF				dB
(I_C = 1.0 mAdc, V_{CE} = 6.0 Vdc, f = 60 MHz)	MMB006		–	1.5	–	
	MM8007		–	1.9	–	
(I_C = 1.0 mAdc, V_{CE} = 6.0 Vdc, f = 200 MHz)	MM8006		–	2.2	–	
	MM8007		–	2.7	–	
†(I_C = 1.0 mAdc, V_{CE} = 6.0 Vdc, f = 450 MHz)	MM8006		–	–	3.8	
	MM8007		–	–	5.0	
FUNCTIONAL TEST						
†Common-Emitter Amplifier Power Gain		G_{pe}				dB
(I_C = 1.0 mAdc, V_{CE} = 6.0 Vdc, f = 60 MHz)	Both Types		–	30	–	
(I_C = 1.0 mAdc, V_{CE} = 6.0 Vdc, f = 200 MHz)	MM8006		–	25	–	
	MM8007		–	20	–	
(I_C = 1.0 mAdc, V_{CE} = 6.0 Vdc, f = 450 MHz)	MM8006		14	–	–	
	MM8007		12	–	–	

† Tuned for minimum noise.

FIGURE 1 – POWER GAIN AND NOISE FIGURE TEST CIRCUIT



C1, C2, C4, C7 – 0.0 – 10 pF Johanson
C8 – 0.5 – 3.5 pF Johanson
C3, C5 – 508 pF Button Type
R1 – 0 – 10 k Trimpot
R2 – 2.7 k 1/4 watt 5%
R3 – 1.8 k 1/4 watt 5%
L1 – 1/4" Brass Rod, Solder Plated, 1-1/8" long. Placed 5/8" from the socket and in parallel with the shield, which bisects the socket. The ungrounded side is soldered directly to the ungrounded side of C2.
L2 – 0.22 μH
L3 – 1/4" Brass Rod, Solder Plated, 1-1/2" long. Placed 1/2" from the socket and in parallel with shield, which bisects the socket. The ungrounded side is soldered directly to the ungrounded side of C7. Output tap is 15/16" from ground.
L4 – 1/2 Turn #16, 5/16" above L3 and 5/8" long, (over L3).

FIGURE 2 – COLLECTOR-BASE CAPACITANCE versus VOLTAGE

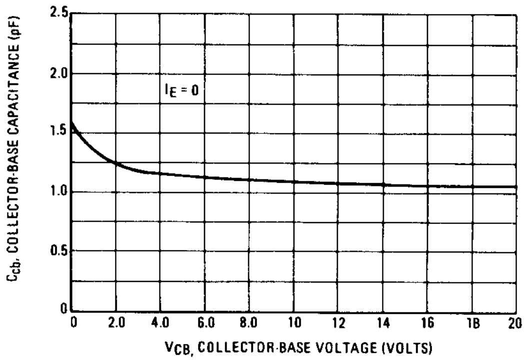


FIGURE 3 — CURRENT-GAIN—BANDWIDTH PRODUCT

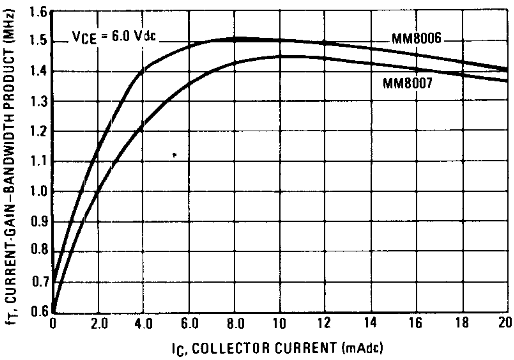


FIGURE 4 — S_{11} AND S_{22}

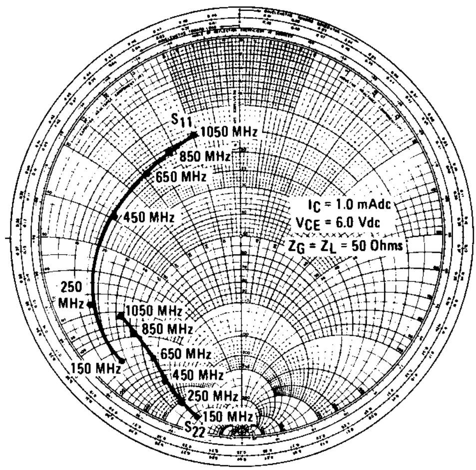


FIGURE 5 — S_{12}

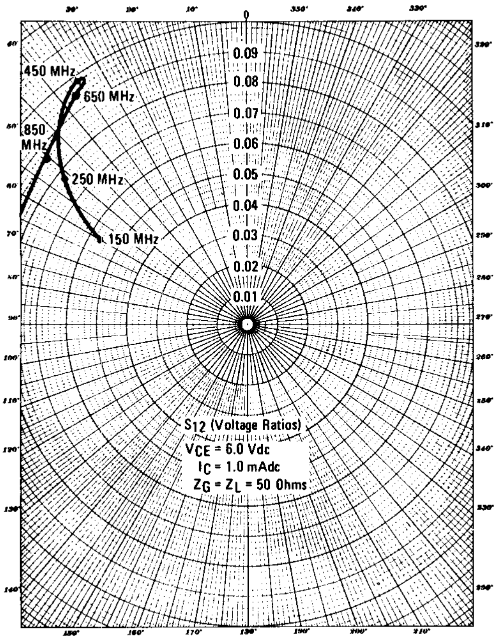


FIGURE 6 — S_{21}

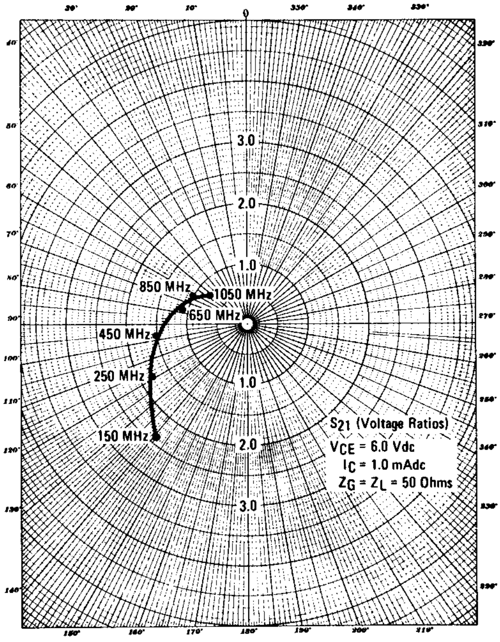


FIGURE 7 – NOISE FIGURE versus FREQUENCY

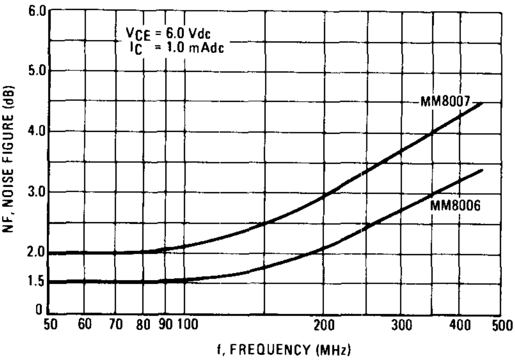


FIGURE 8 – POWER GAIN versus FREQUENCY

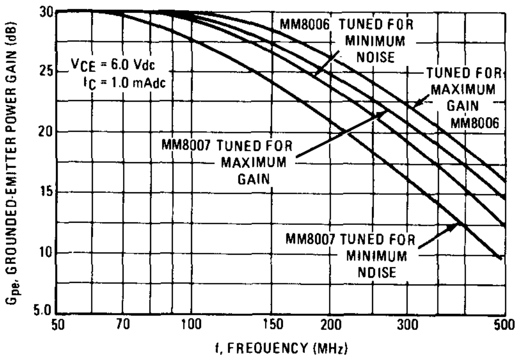


FIGURE 9 – INPUT ADMITTANCE versus FREQUENCY

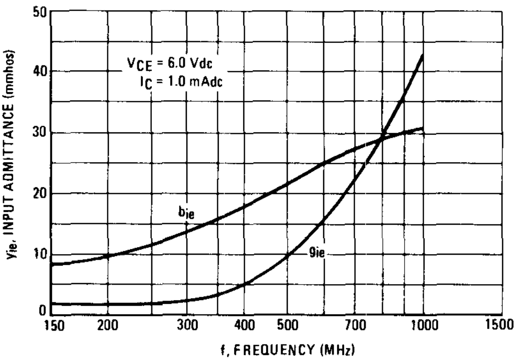


FIGURE 10 – OUTPUT ADMITTANCE versus FREQUENCY

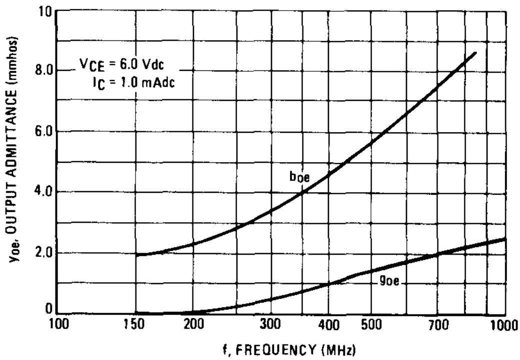


FIGURE 11 – FORWARD TRANSFER ADMITTANCE versus FREQUENCY

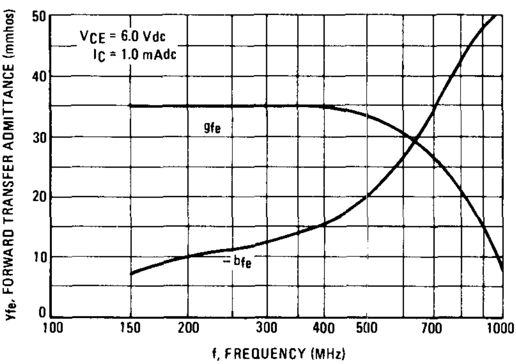
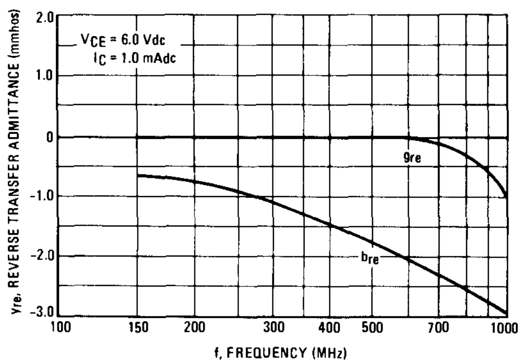


FIGURE 12 – REVERSE TRANSFER ADMITTANCE versus FREQUENCY



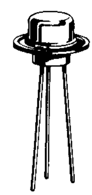
MM8008 (SILICON)
MM8010
MM8011

NPN SILICON RF POWER TRANSISTORS

. . . designed primarily for oscillator, frequency multiplier, and UHF amplifier applications in military and industrial equipment.

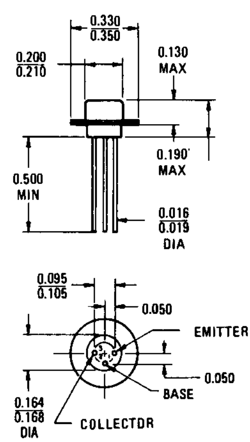
- High Power Output (Oscillator) —
  P_{out} = 300 mW (Min) @ f = 2.0 GHz (MM8008)
  200 mW (Min) @ f = 2.0 GHz (MM8010)
  100 mW (Min) @ f = 2.0 GHz (MM8011)
- High Current-Gain—Bandwidth Product —
  f_T = 1000 MHz (Typ) @ I_C = 50 mAdc
- Ideal for Radio Sonde Applications —
  P_{out} (Oscillator) = 550 mW (Typ) @ f = 1.68 GHz (MM8008)
  450 mW (Typ) @ f = 1.68 GHz (MM8010)
  300 mW (Typ) @ f = 1.68 GHz (MM8011)
- Wide Flange Case for Easy Mounting in Cavity Circuits
- Multiple Emitter Construction for Excellent High-Frequency Performance

NPN SILICON RF POWER TRANSISTORS



MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	30	Vdc
Collector-Base Voltage	V_{CB}	35	Vdc
Emitter-Base Voltage	V_{EB}	3.0	Vdc
Collector Current — Continuous	I_C	100	mAdc
Total Device Dissipation @ $T_C = 25^oC$ Derate above 25^oC	P_D	3.5 20	Watts $mW/^oC$
Operating and Storage Junction Temperature Range	T_J, T_{stg}	-65 to +200	^oC



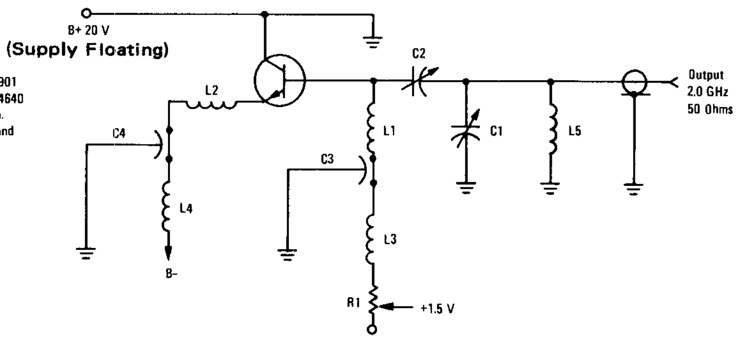
CASE 23
TO-107

Collector Electrically Connected to Case

ELECTRICAL CHARACTERISTICS ($T_C = 25^oC$ unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 5.0 mAdc, I_B = 0)	BV_{CEO}	30	–	–	Vdc
Collector-Base Breakdown Voltage (I_C = 100 μAdc, I_E = 0)	BV_{CBO}	35	–	–	Vdc
Emitter-Base Breakdown Voltage (I_E = 100 μAdc, I_C = 0)	BV_{EBO}	3.0	–	–	Vdc
Collector Cutoff Current (V_{CE} = 20 Vdc, I_B = 0)	I_{CEO}	–	–	100	μAdc
ON CHARACTERISTICS					
Collector-Emitter Saturation Voltage (I_C = 100 mAdc, I_B = 10 mAdc)	$V_{CE(sat)}$	–	–	0.3	Vdc
DYNAMIC CHARACTERISTICS					
Current-Gain–Bandwidth Product (I_C = 50 mAdc, V_{CE} = 15 Vdc, f = 100 MHz)	f_T	–	1100	–	MHz
Output Capacitance (V_{CB} = 30 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	–	1.3	3.0	pF
FUNCTIONAL TEST					
Oscillator Power Output (Figure 1) (I_C = 100 mAdc, V_{CE} = 20 Vdc, f = 2.0 GHz) MM8008	P_{out}	0.3	–	–	Watt
MM8010		0.2	–	–	
MM8011		0.1	–	–	

FIGURE 1 – 2.0 GHz OSCILLATOR TEST CIRCUIT



C1 – 1.0-10 pF Johanson Cap. #3901
C2 – 4.0-6.0 pF Johanson Cap. # 4640
C3, C4 – 500 pF Button Feedthru Cap.
L1, L2 – Microstrip Line 1.03" Long and 0.073" Wide
L3, L4 – 0.68 μH RF Choke
L5 – Microstrip 0.620" Long and 0.078" Wide
R1 – 2.0 k ohms Pot (Miniature)
1/16" Microstrip Board

FIGURE 2 – TOP VIEW – 2.0 GHz OSCILLATOR TEST CIRCUIT

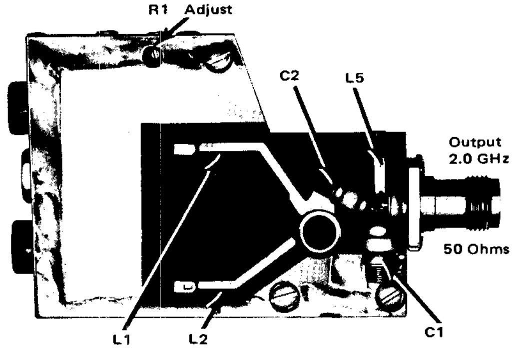


FIGURE 3 – SIDE VIEW – 2.0 GHz OSCILLATOR TEST CIRCUIT

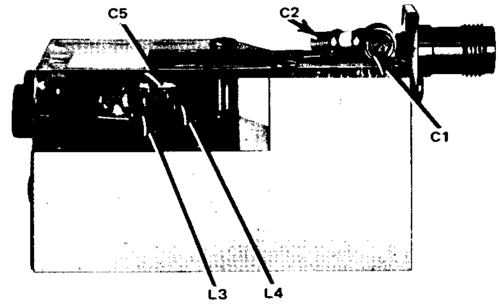


FIGURE 4 – CURRENT-GAIN–BANDWIDTH PRODUCT

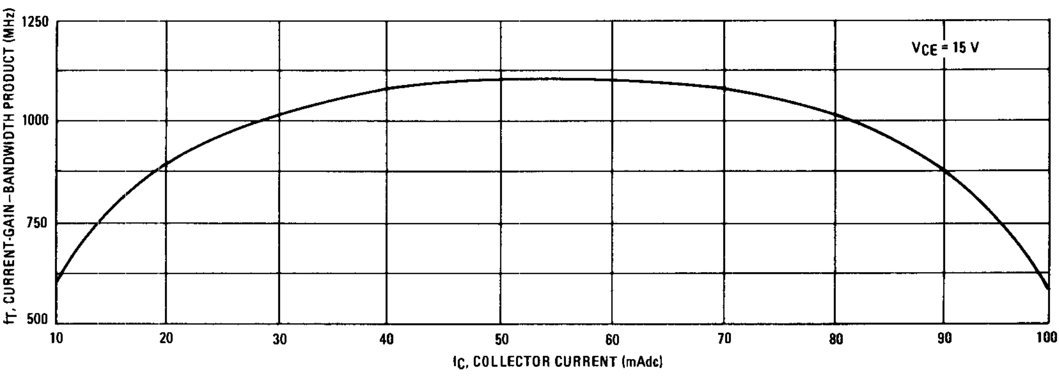
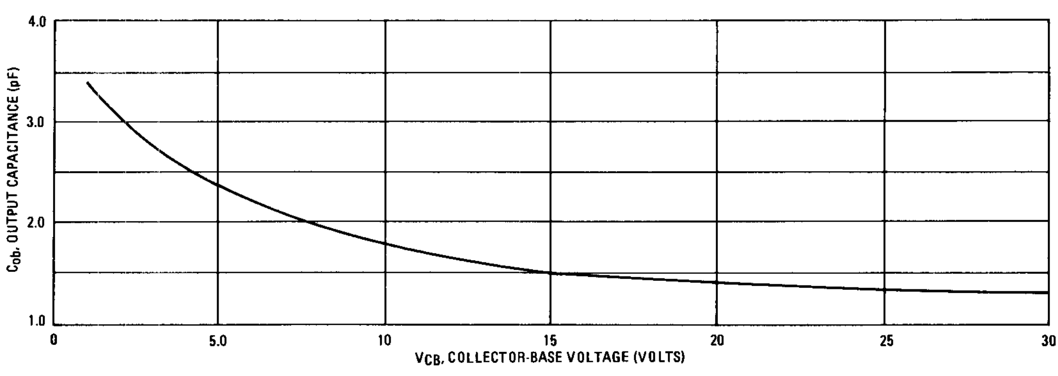


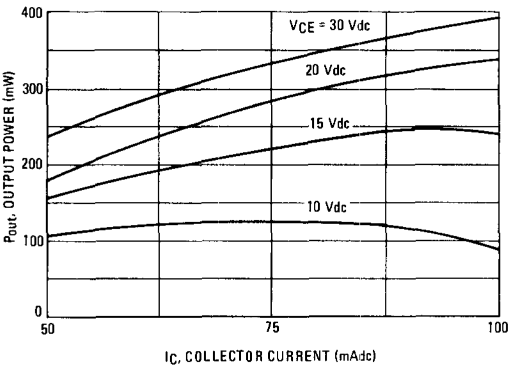
FIGURE 5 – OUTPUT CAPACITANCE versus VOLTAGE



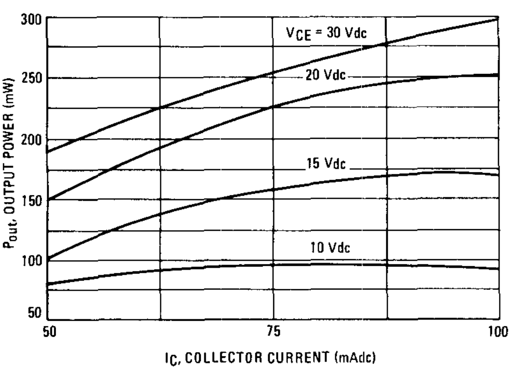
OSCILLATOR OUTPUT POWER versus CURRENT
(SEE FIGURE 1 FOR TEST CIRCUIT)

FIGURE 6 – f = 2.0 GHz

MM8008



MM8010



MM8011

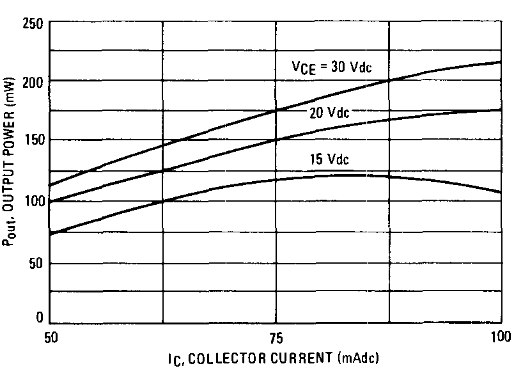
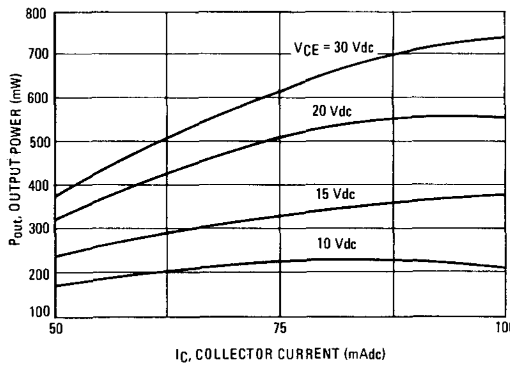
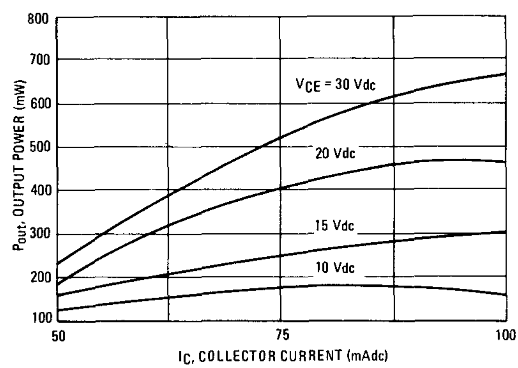


FIGURE 7 – f = 1.68 GHz

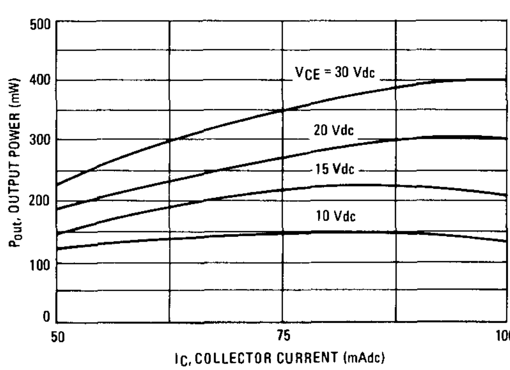
MM8008



MM8010



MM8011



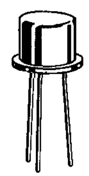
MM8009 (SILICON)

NPN SILICON RF POWER TRANSISTOR

. . . designed for amplifier, frequency multiplier, or oscillator applications in military and industrial equipment. Suitable for use as output, driver, or pre-driver stages in UHF equipment and as a fundamental frequency oscillator at 1.68 GHz.

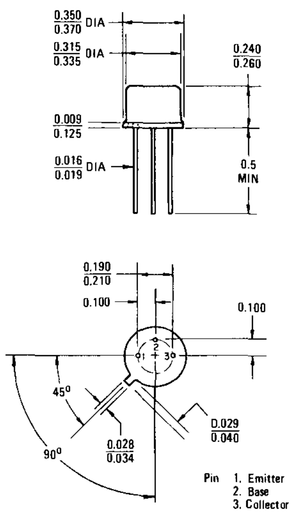
- High Output Power – P_{out} = 0.9 Watt (Min) @ f = 1.0 GHz
- High Current-Gain–Bandwidth Product – f_T = 1000 MHz (Min) @ I_C = 50 mAdc
- Ideal for Radio Sonde Applications – P_{out} (Oscillator) = 300 mW (Typ) @ f = 1.68 GHz

NPN SILICON RF POWER TRANSISTOR



MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	50	Vdc
Collector-Base Voltage	V_{CB}	55	Vdc
Emitter-Base Voltage	V_{EB}	3.0	Vdc
Collector Current – Continuous	I_C	400	mAdc
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	3.5 20	Watt mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	-65 to +200	°C



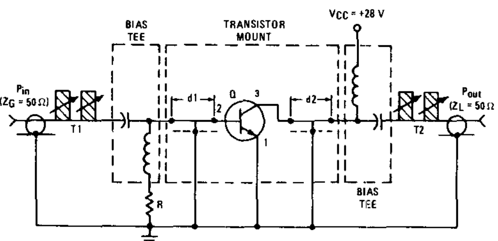
CASE 79 (1)

TO-39

ELECTRICAL CHARACTERISTICS ($T_C = 25^oC$ unless otherwise noted)

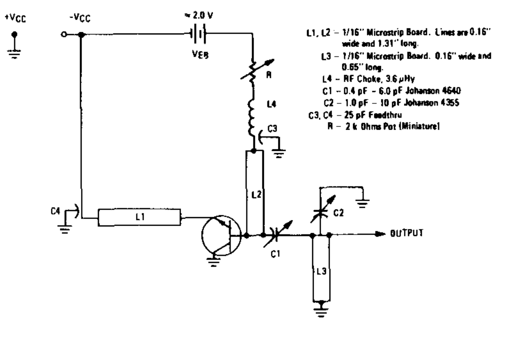
	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Base Breakdown Voltage ($I_C = 100\ \mu Adc$, $I_E = 0$)	BV_{CBO}	55	–	–	Vdc
Emitter-Base Breakdown Voltage ($I_E = 100\ \mu Adc$, $I_C = 0$)	BV_{EBO}	3.0	–	–	Vdc
Collector Cutoff Current ($V_{CE} = 15$ Vdc, $I_B = 0$)	I_{CEO}	–	–	100	μAdc
Collector Cutoff Current ($V_{CE} = 50$ Vdc, $V_{BE} = 0$)	I_{CES}	–	–	10	μAdc
ON CHARACTERISTICS					
Collector-Emitter Saturation Voltage ($I_C = 100$ mAdc, $I_B = 10$ mAdc)	$V_{CE(sat)}$	–	–	0.5	Vdc
DYNAMIC CHARACTERISTICS					
Current-Gain–Bandwidth Product ($I_C = 50$ mAdc, $V_{CE} = 15$ Vdc, f = 100 MHz)	f_T	1000	–	–	MHz
Output Capacitance ($V_{CB} = 30$ Vdc, $I_E = 0$, f = 1.0 MHz)	C_{ob}	–	1.8	3.0	pF
FUNCTIONAL TEST					
Power Output (Figure 1) ($P_{in} = 316$ mW, $V_{CE} = 28$ Vdc, f = 1.0 GHz)	P_{out}	0.9	–	–	Watt
Power Output (Oscillator) (Figure 2) ($V_{CE} = 20$ Vdc, $V_{EB} = 1.5$ Vdc, f = 1.68 GHz) (Minimum Efficiency = 15%)	P_{out}	–	0.3	–	Watt
Collector Efficiency ($P_{in} = 316$ mW, $V_{CE} = 28$ Vdc, f = 1.0 GHz)	η	35	–	–	%

FIGURE 1 – 1.0 GHz POWER AMPLIFIER TEST CIRCUIT



d1: 1" Input line, center conductor width = 0.288"
d2: 1" Output line, center conductor width = 0.125"
Q: 2N518B
R: 3.9 ohms
T1, T2: Microlab Double Stub Tuner, or Equivalent
Bias Tee: Microlab 88N, or Equivalent
Transistor Mount: 1/32" Microstrip board

FIGURE 2 – 1.68 GHz POWER OSCILLATOR TEST CIRCUIT



L1, L2 – 1/16" Microstrip Board. Lines are 0.16" wide and 1.31" long.
L3 – 1/16" Microstrip Board. 0.16" wide and 0.65" long.
L4 – RF Choke, 3.6 μHy
C1 – 0.4 pF – 6.0 pF Johanson 4640
C2 – 1.0 pF – 10 pF Johanson 4355
C3, C4 – 25 pF Feedthru
R – 2 k Ohms Pot (Miniature)

FIGURE 3 – POWER OUTPUT versus POWER INPUT

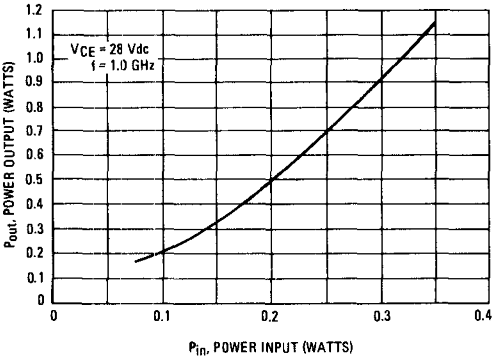


FIGURE 4 – POWER OUTPUT versus FREQUENCY

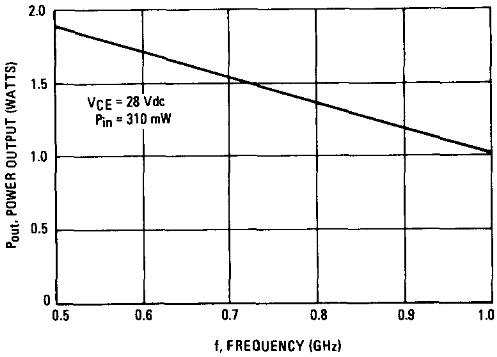


FIGURE 5 – POWER OUTPUT versus VOLTAGE

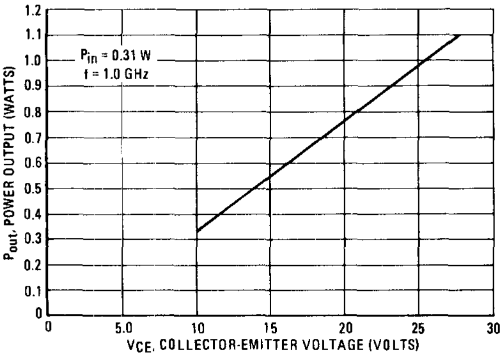


FIGURE 6 – OSCILLATOR POWER OUTPUT versus CURRENT

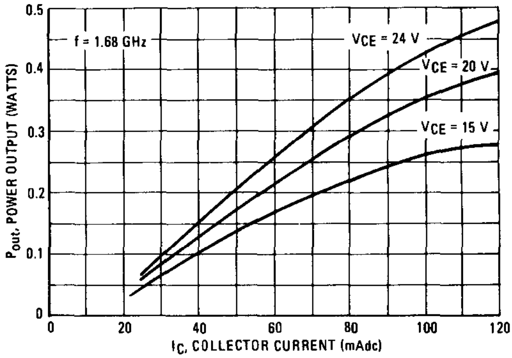


FIGURE 7 – CURRENT-GAIN–BANDWIDTH PRODUCT

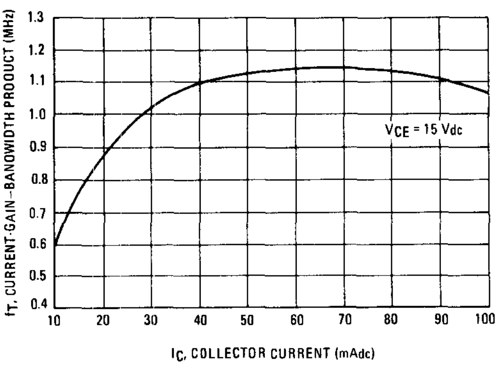
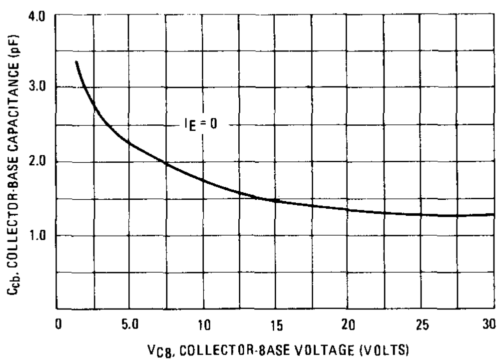


FIGURE 8 – COLLECTOR-BASE CAPACITANCE versus VOLTAGE



MM8010
MM8011

For Specifications, See MM8008 Data.

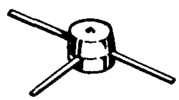
MMD7001 (SILICON)

SILICON EPITAXIAL DUAL SWITCHING DIODE

. . . designed for general purpose, high-speed switching applications.

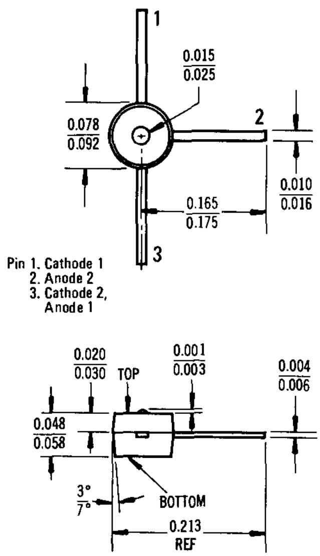
- High Breakdown Voltage – $V_{(BR)}$ = 45 Vdc (Min) @ $I_{(BR)}$ = 10 µAdc
- Fast Reverse Recovery Time – t_{rr} = 3.2 ns (Typ) @ $I_F = I_R$ = 10 mAdc
- Low Capacitance – C = 2.5 pF (Typ) @ V_R = 0
- Space-Saving Micro-Miniature Package

MICRO-MINIATURE SILICON EPITAXIAL DUAL SWITCHING DIODE

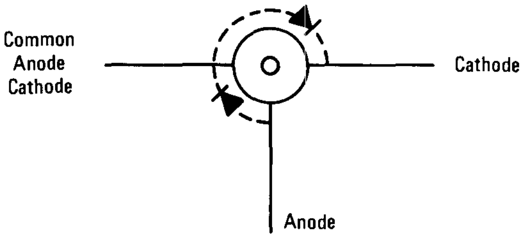


MAXIMUM RATINGS (each diode)

Rating	Symbol	Value	Unit
Reverse Voltage	V_R	45	Vdc
Recurrent Peak Forward Current	I_F	200	mAdc
Peak Forward Surge Current (Pulse Width = 10 µs)	$I_{FM(surge)}$	600	mAdc
Power Dissipation @ T_A = 25°C Derate above 25°C	P_D	225 2.05	mW mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	-55 to +135	°C



CASE 28
(Style 4)

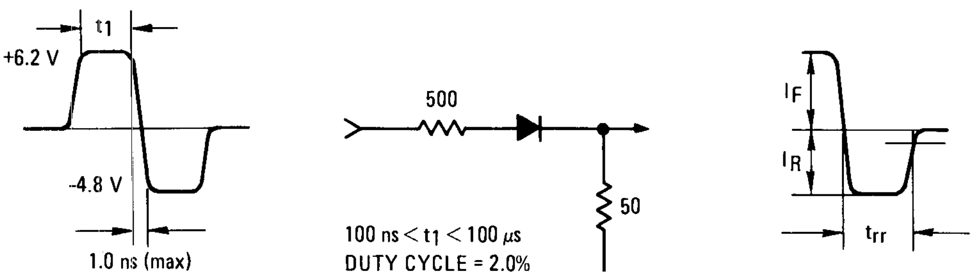


SERIES

ELECTRICAL CHARACTERISTICS ($T_A = 25^oC$)

Characteristic	Symbol	Min	Typ	Max	Unit
Breakdown Voltage ($I_{(BR)} = 10\ \mu Adc$)	$V_{(BR)}$	45	–	–	Vdc
Reverse Current ($V_R = 30$ Vdc)	I_R	–	–	0.1	μAdc
Forward Voltage	V_F				Vdc
($I_F = 100$ mAdc)		0.75	–	0.9	
($I_F = 300$ mAdc)		–	–	1.05	
($I_F = 500$ mAdc)		–	–	1.15	
Capacitance ($V_R = 0$)	C	–	2.5	3.5	pF
Total Control Charge ($I_F = 10$ mAdc)	Q_S	–	–	50	pC
Reverse Recovery Time ($I_F = I_R = 10$ mAdc, $V_R = 5.0$ Vdc, $i_{rr} = 1.0$ mAdc)	t_{rr}	–	3.2	–	ns

FIGURE 1 – RECOVERY TIME EQUIVALENT TEST CIRCUIT



MMT3014 (SILICON)

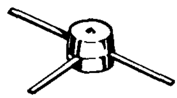
NPN SILICON ANNULAR TRANSISTOR

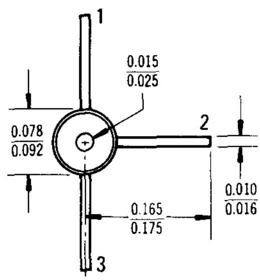
. . . designed for high-speed, saturated switching applications where high-density packaging is required.

- High-Speed Switching Times –
  $t_{on} + t_{off} = 41$ ns (Max) @ $I_C = 30$ mAdc
- Low Collector-Emitter Saturation Voltage –
  $V_{CE(sat)} = 0.22$ Vdc (Max) @ $I_C = 30$ mAdc
- Space Saving Micro-Miniature Package
- Ideal for Thick Film Digital Circuit Applications
- Dne-Piece, Injection-Molded Unibloc Package for High Reliability

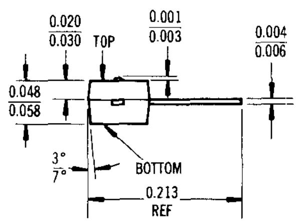
MICRO-MINIATURE

NPN SILICON SWITCHING TRANSISTOR





Pin 1. Base
2. Emitter
3. Collector



CASE 28 (1)

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	20	Vdc
Collector-Base Voltage	V_{CB}	40	Vdc
Emitter-Base Voltage	V_{EB}	5.0	Vdc
Collector Current – Continuous	I_C	200	mAdc
Total Device Dissipation @ $T_A = 25^oC$ Derate above 25°C	P_D	225 2.05	mW mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	-55 to +135	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	θ_{JA}	0.490	°C/mW

MMT3014 (continued)

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage* (I_C = 10 mAdc, I_B = 0)	BV_{CEO}*	20	–	Vdc
Collector-Base Breakdown Voltage (I_C = 100 μAdc, I_E = 0)	BV_{CBO}	40	–	Vdc
Emitter-Base Breakdown Voltage (I_E = 100 μAdc, I_C = 0)	BV_{EBO}	5.0	–	Vdc
Collector Cutoff Current (V_{CB} = 20 Vdc, I_E = 0)	I_{CBO}	–	100	nAdc
ON CHARACTERISTICS				
DC Current Gain*	h_{FE}*			–
(I_C = 30 mAdc, V_{CE} = 0.4 Vdc)		50	200	
(I_C = 100 mAdc, V_{CE} = 1.0 Vdc)		25	–	
Collector-Emitter Saturation Voltage (I_C = 30 mAdc, I_B = 3.0 mAdc)	$V_{CE(sat)}$	–	0.22	Vdc
Base-Emitter Saturation Voltage (I_C = 30 mAdc, I_B = 3.0 mAdc)	$V_{BE(sat)}$	0.70	0.9	Vdc
SMALL-SIGNAL CHARACTERISTICS				
Current-Gain—Bandwidth Product (I_C = 30 mAdc, V_{CE} = 10 Vdc, f = 100 MHz)	f_T	350	–	MHz
Input Capacitance (V_{BE} = 0.5 Vdc, I_C = 0, f = 1.0 MHz)	C_{ib}	–	8.0	pF
Output Capacitance (V_{CB} = 5.0 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	–	5.0	pF
SWITCHING CHARACTERISTICS				
Turn-On Time (V_{CC} = 2.0 Vdc, I_C = 30 mAdc, I_{B1} = 3.0 mAdc)	t_{on}	–	16	ns
Turn-Off Time (V_{CC} = 2.0 Vdc, I_C = 30 mAdc, I_{B1} = 3.0 mAdc, I_{B2} = 3.0 mAdc)	t_{off}	–	25	ns
Charge Storage Time (I_C = I_{B1} = I_{B2} = 10 mAdc)	τ_s	–	18	ns

*Pulse Test: Pulse Width = 300 μs, Duty Cycle ≤ 2.0%.

FIGURE 1 – TURN-ON AND TURN-OFF TIME TEST CIRCUIT

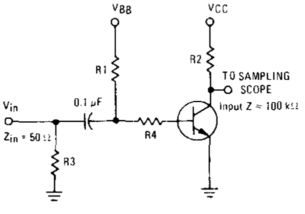
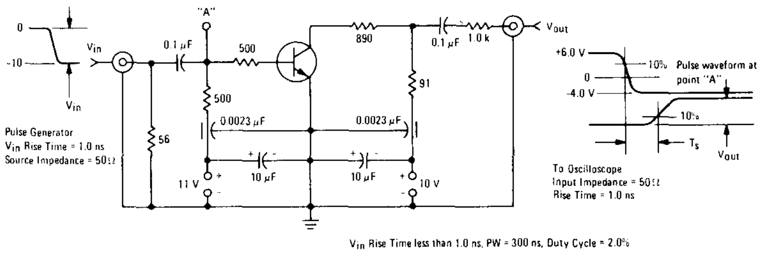


FIGURE 2 – CHARGE STORAGE TIME CONSTANT TEST CIRCUIT



SWITCHING TEST CIRCUIT VALUES								INPUT PULSE		
Test	V_{in}	V_{BB}	V_{CC}	R1	R2	R3	R4	t_r	t_f	Pulse Width
	VOLTS			OHMS				ns		
t_{on}	7.0	GND	2.0	100	62	100	2.0 k	<1.0	–	>200
t_{off}	-13	7.0	2.0							

MPS5172 (SILICON)

NPN SILICON ANNULAR TRANSISTOR

. . . designed for general-purpose, low-level amplifier applications.

- High DC Current Gain –
  h_{FE} = 100 - 500 @ I_C = 10 mAdc
- Low Collector-Emitter Saturation Voltage –
  $V_{CE(sat)}$ = 0.25 Vdc (Max) @ I_C = 10 mAdc
- One-Piece, Injection-Molded Unibloc Package

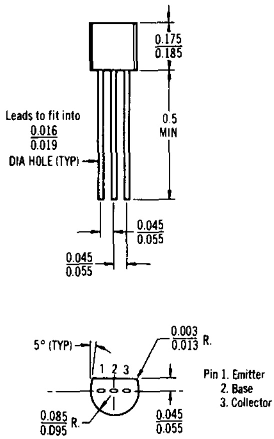
NPN SILICON
AMPLIFIER TRANSISTOR

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	25	Vdc
Collector-Base Voltage	V_{CB}	25	Vdc
Emitter-Base Voltage	V_{EB}	5.0	Vdc
Collector Current – Continuous	I_C	100	mAdc
Total Device Dissipation @ $T_A = 25^oC$ Derate above 25^oC	P_D	210 1.91	mW mW/^oC
Operating and Storage Junction Temperature Range	T_J, T_{stg}	-55 to +135	^oC

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	θ_{JA}	0.524	^oC/mW



CASE 29 (1)
TO-92

ELECTRICAL CHARACTERISTICS ($T_A = 25^{\circ}C$ unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 10 mAdc, I_B = 0)	BV_{CEO}	25	–	–	Vdc
Collector Cutoff Current (V_{CE} = 25 Vdc, V_{BE} = 0)	I_{CES}	–	–	100	nAdc
Collector Cutoff Current	I_{CBO}				
(V_{CB} = 25 Vdc, I_E = 0)		–	–	100	nAdc
(V_{CB} = 25 Vdc, I_E = 0, $T_A = 100^{\circ}C$)		–	–	10	μAdc
Emitter Cutoff Current (V_{BE} = 5.0 Vdc, I_C = 0)	I_{EBO}	–	–	100	nAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 10 mAdc, V_{CE} = 10 Vdc)	h_{FE}	100	–	500	–
Collector-Emitter Saturation Voltage (I_C = 10 mAdc, I_B = 1.0 mAdc)	$V_{CE(sat)}$	–	–	0.25	Vdc
Base-Emitter Saturation Voltage (I_C = 10 mAdc, I_B = 1.0 mAdc)	$V_{BE(sat)}$	–	0.75	–	Vdc
Base-Emitter On Voltage (I_C = 10 mAdc, V_{CE} = 10 Vdc)	$V_{BE(on)}$	0.5	–	1.2	Vdc
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain–Bandwidth Product (I_C = 2.0 mAdc, V_{CE} = 5.0 Vdc)	f_T	–	120	–	MHz
Collector-Base Capacitance (V_{CB} = 0, I_E = 0, f = 1.0 MHz)	C_{cb}	1.6	–	10	pF
Small-Signal Current Gain (I_C = 10 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)	h_{fe}	100	–	750	–

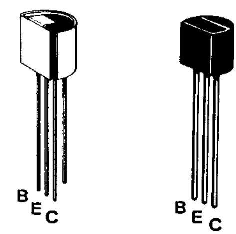
MPS6568 (SILICON)
MPS6568A

NPN SILICON ANNULAR TRANSISTORS

. . . designed for VHF-RF amplifier applications in TV receivers.

- Guaranteed Noise Figure –
  NF = 3.3 dB (Max) at 200 MHz
- Guaranteed AGC Characteristics
- Complete y-Parameter Curves at 200 MHz
- Guaranteed Power Gain –
  G_{pe} = 20 dB (Min) at 200 MHz

NPN SILICON
VHF RF AMPLIFIER
TRANSISTORS



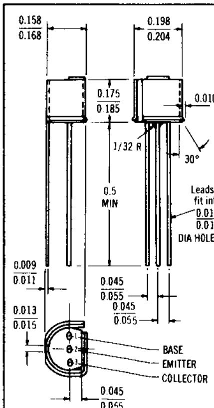
TO-92 WITH SHIELD — MPS6568 | TO-92 — MPS6568A

MAXIMUM RATINGS

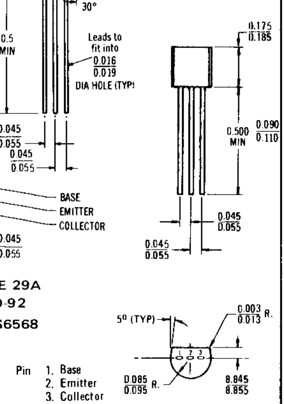
Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	20	Vdc
Collector-Base Voltage	V_{CB}	20	Vdc
Emitter-Base Voltage	V_{EB}	3.0	Vdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	310 2.81	mW mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	-55 to +135	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	θ_{JC}	0.137	°C/mW
Thermal Resistance, Case to Ambient	θ_{CA}	0.220	°C/mW



CASE 29A
TO-92
MPS6568



CASE 29 (2)
TO-92
MPS6568A

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage (I_C = 1.0 mAdc, I_B = 0)	BV_{CEO}	20	-	Vdc
Collector-Base Breakdown Voltage (I_C = 100 μAdc, I_E = 0)	BV_{CBO}	20	-	Vdc
Emitter-Base Breakdown Voltage (I_E = 100 μAdc, I_C = 0)	BV_{EBO}	3.0	-	Vdc
Collector Cutoff Current (V_{CB} = 10 Vdc, I_E = 0)	I_{CBO}	-	50	nAdc
ON CHARACTERISTICS				
DC Current Gain (I_C = 4.0 mAdc, V_{CE} = 5.0 mAdc)	h_{FE}	20	200	-
Collector-Emitter Saturation Voltage (I_C = 10 mAdc, I_B = 5.0 mAdc)	$V_{CE(sat)}$	0.1	3.0	Vdc
Base-Emitter Saturation Voltage (I_C = 10 mAdc, I_B = 5.0 mAdc)	$V_{BE(sat)}$	-	0.96	Vdc
SMALL-SIGNAL CHARACTERISTICS				
Current-Gain—Bandwidth Product (I_C = 4.0 mAdc, V_{CE} = 10 Vdc, f = 100 MHz)	f_T	375	800	MHz
Collector-Base Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 1.0 MHz, emitter guarded, with shield) MPS6568 (without shield) MPS6568A	C_{cb}	0.25	0.5 0.65	pF
Noise Figure (V_{AGC} = 1.4 Vdc, R_S = 50 ohms, f = 200 MHz, Figure 9)	NF	-	3.3	dB
FUNCTIONAL TEST				
Power Gain (V_{AGC} = 1.4 Vdc, R_S = 50 ohms, f = 200 MHz, Figure 9)	G_{pe}	20	27	dB
Forward AGC Voltage (Gain Reduction = 30 dB, R_S = 50 ohms, f = 200 MHz, Figure 9)	V_{AGC}	4.0	5.0	Vdc

AGC CHARACTERISTICS

V_{CC} = 12 Vdc, R_S = 50 Ohms, f = 200 MHz, See Figure 9

FIGURE 1 — POWER GAIN

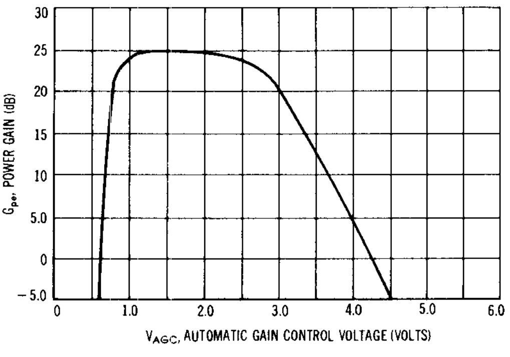
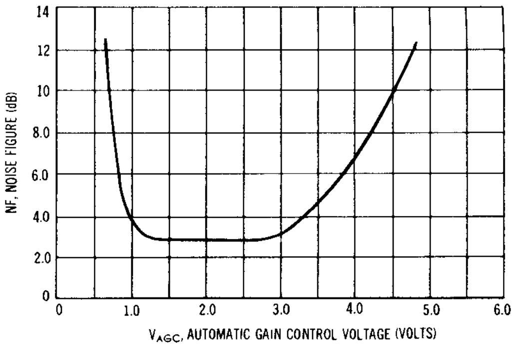


FIGURE 2 — NOISE FIGURE



COMMON-EMITTER y PARAMETERS

V_{CE} = 12 Vdc, T_A = 25°C, f = 200 MHz

FIGURE 3 — INPUT ADMITTANCE

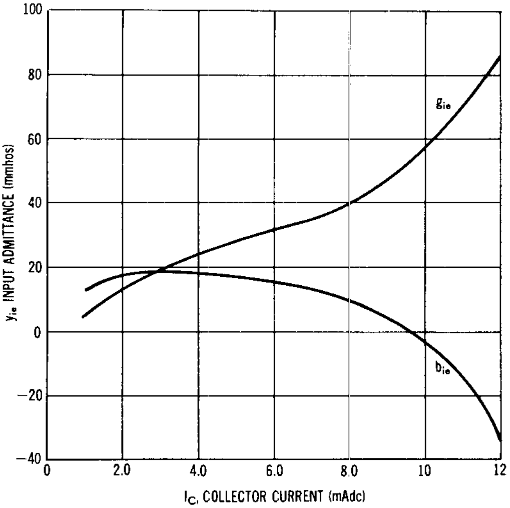


FIGURE 4 — REVERSE TRANSFER ADMITTANCE

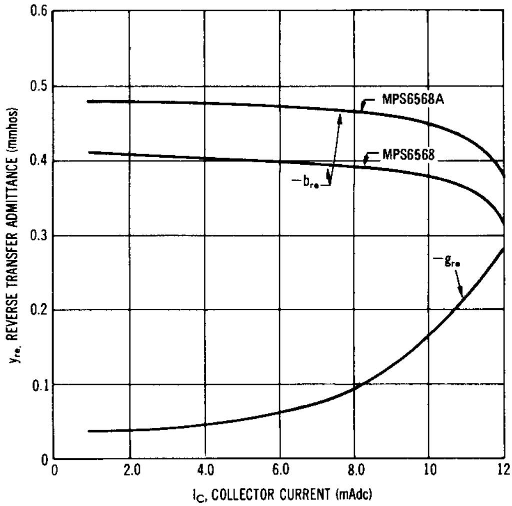


FIGURE 5 — FORWARD TRANSFER ADMITTANCE

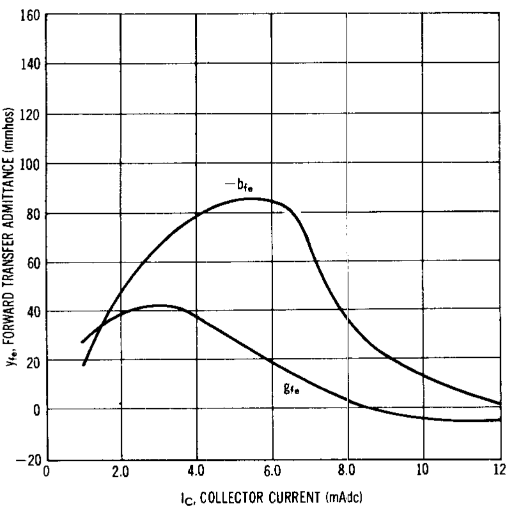


FIGURE 6 — OUTPUT ADMITTANCE

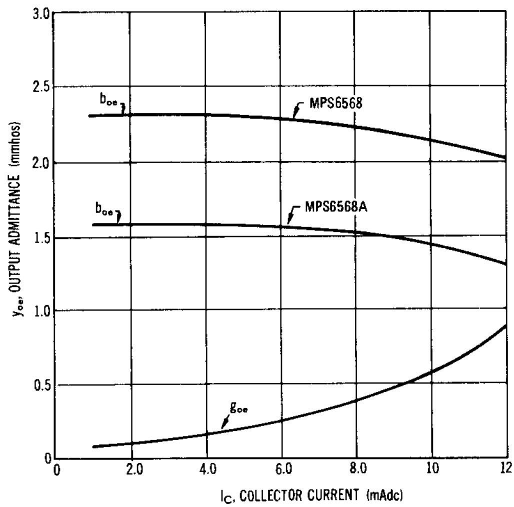


FIGURE 7 — DC CURRENT GAIN

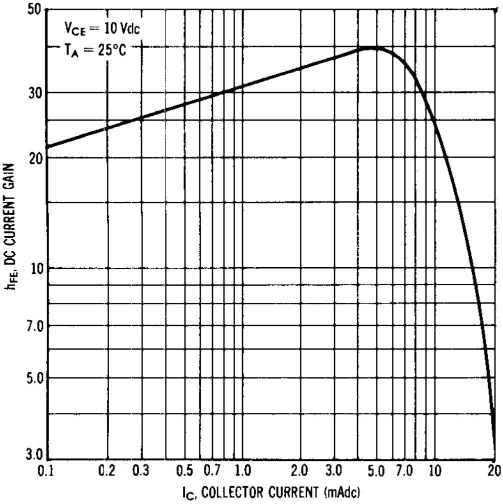


FIGURE 8 — COLLECTOR-BASE CAPACITANCE

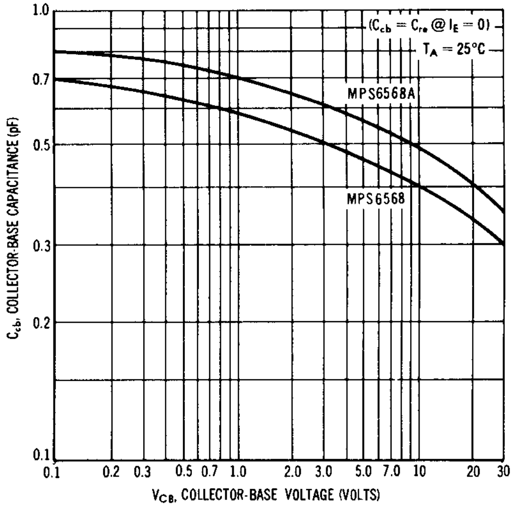
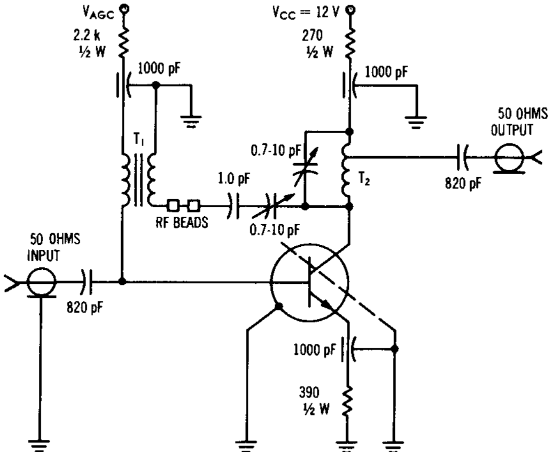


FIGURE 9 — 200 MHz FUNCTIONAL TEST CIRCUIT
(NEUTRALIZED)



T_1 = FERRITE CORE INDIANA GEN. CORP. F-684
T_2 = 6 TURNS #16 BUSS WIRE, ID = ¼″, L = ¾″.

MPS-A05 (SILICON)
MPS-A06

NPN SILICON ANNULAR AUDIO TRANSISTORS

... designed for use as medium-power drivers and low-power outputs.

- High Collector-Emitter Breakdown Voltage –
  BV_{CEO} = 60 Vdc (Min) @ I_C = 1.0 mAdc – MPS-A05
  = 80 Vdc (Min) @ I_C = 1.0 mAdc – MPS-A06
- Excellent Current-Gain Linearity – 1.0 mAdc to 200 mAdc
- Low Collector-Emitter Saturation Voltage –
  $V_{CE(sat)}$ = 0.25 Vdc (Max) @ I_C = 100 mAdc
- Complements to MPS-A55 and MPS-A56

NPN SILICON AUDIO TRANSISTORS

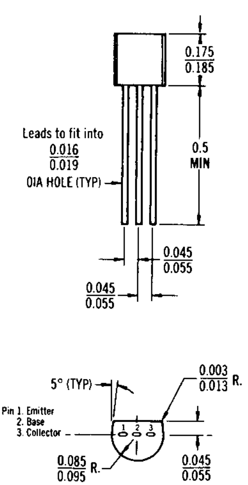
MAXIMUM RATINGS

Rating	Symbol	MPS-A05	MPS-A06	Unit
Collector-Emitter Voltage	V_{CEO}	60	80	Vdc
Collector-Base Voltage	V_{CB}	60	80	Vdc
Emitter-Base Voltage	V_{EB}	4.0		Vdc
Collector Current – Continuous	I_C	500		mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	500 4.54		mW mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	800 7.27		mW mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	-55 to +135		°C

THERMAL CHARACTERISTICS

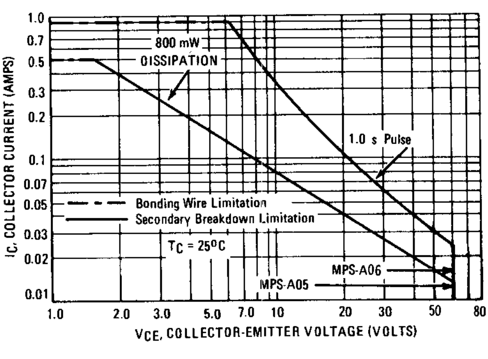
Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	θ_{JC}	0.137	°C/mW
Thermal Resistance, Junction to Ambient	θ_{JA}**	0.220	°C/mW

**θ_{JA} is measured with the device soldered into a typical printed circuit board.



CASE 29 (1)
TO-92

FIGURE 1 – DC SAFE OPERATING AREA



ELECTRICAL CHARACTERISTICS (T_A = 25°C unless othewise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 1.0 mAdc, I_B = 0) MPS-A05	BV_{CEO}	60	–	–	Vdc
MPS-A06		80	–	–	
Emitter-Base Breakdown Voltage (I_E = 100 μAdc, I_C = 0)	BV_{EBO}	4.0	–	–	Vdc
Collector Cutoff Current (V_{CB} = 60 Vdc, I_E = 0) MPS-A05	I_{CBO}	–	–	100	nAdc
(V_{CB} = 80 Vdc, I_E = 0) MPS-A06		–	–	100	
ON CHARACTERISTICS					
DC Current Gain (I_C = 10 mAdc, V_{CE} = 1.0 Vdc)	h_{FE}	50	125	–	–
(I_C = 100 mAdc, V_{CE} = 1.0 Vdc)		50	150	–	
(I_C = 350 mAdc, V_{CE} = 1.0 Vdc)		–	90	–	
Collector-Emitter Saturation Voltage (I_C = 100 mAdc, I_B = 10 mAdc)	$V_{CE(sat)}$	–	0.08	0.25	Vdc
Base-Emitter Saturation Voltage (I_C = 100 mAdc, I_B = 10 mAdc)	$V_{BE(sat)}$	–	0.75	–	Vdc
Base-Emitter On Voltage (I_C = 100 mAdc, V_{CE} = 1.0 Vdc)	$V_{BE(on)}$	–	0.7	1.2	Vdc
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain – Bandwidth Product (I_C = 100 mAdc, V_{CE} = 1.0 Vdc, f = 100 MHz)	f_T	50	200	–	MHz
Output Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 100 kHz)	C_{ob}	–	6.0	–	pF
Input Capacitance (V_{BE} = 0.5 Vdc, I_C = 0, f = 100 kHz)	C_{ib}	–	15	–	pF

FIGURE 2 – "SATURATION" AND "ON" VOLTAGES

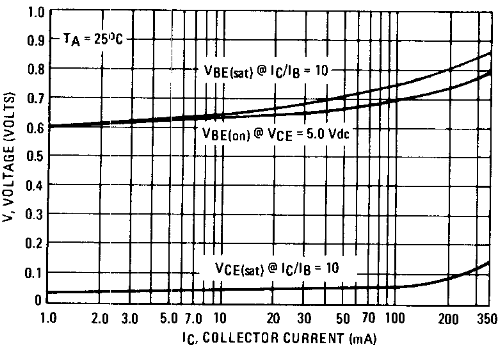
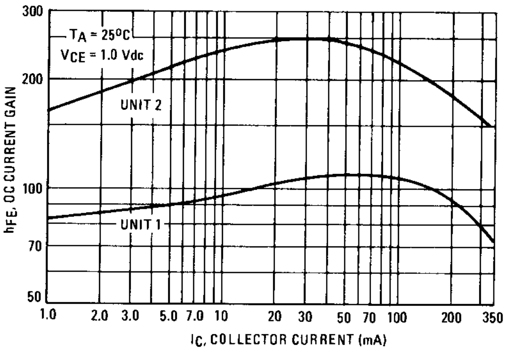


FIGURE 3 – DC CURRENT GAIN



MPS-A10 (SILICON)
MPS-K10, MPS-K11
MPS-K12

NPN SILICON ANNULAR TRANSISTORS

. . . designed for general-purpose use in audio, radio, and television applications.

- MPS-K10, MPS-K11, MPS-K12 are 3, 5 and 9 Transistor Kits Available in Varied h_{FE} Ranges — See Table 1
- High Breakdown Voltage — BV_{CEO} = 40 Vdc (Min) @ I_C = 1.0 mAdc
- Low Output Capacitance — C_{ob} = 4.0 pF (Max) @ V_{CB} = 10 Vdc
- One-Piece, Injection-Molded Unibloc Package

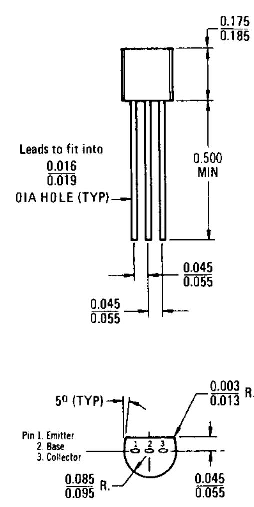
NPN SILICON AMPLIFIER TRANSISTORS

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	40	Vdc
Emitter-Base Voltage	V_{EB}	4.0	Vdc
Collector Current – Continuous	I_C	100	mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	300 2.73	mW mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	-55 to +135	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	θ_{JA}	0.367	°C/mW



CASE 29 (1)
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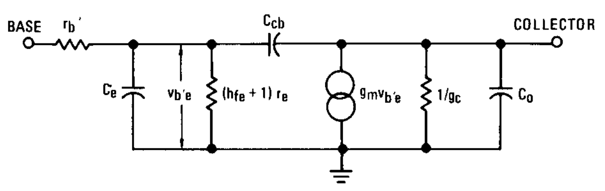
ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage (I_C = 1.0 mAdc, I_B = 0)	BV_{CEO}	40	-	Vdc
Emitter-Base Breakdown Voltage (I_E = 100 μAdc, I_C = 0)	BV_{EBO}	4.0	-	Vdc
Collector Cutoff Current (V_{CB} = 30 Vdc, I_E = 0)	I_{CBO}	-	100	nAdc
ON CHARACTERISTICS				
DC Current Gain (I_C = 5.0 mAdc, V_{CE} = 10 Vdc)	h_{FE}	40	400	-
DYNAMIC CHARACTERISTICS				
Current-Gain–Bandwidth Product (I_C = 5.0 mAdc, V_{CE} = 10 Vdc, f = 20 MHz)	f_T	50	-	MHz
Output Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 100 kHz)	C_{ob}	-	4.0	pF

FIGURE 1 – SIMPLIFIED AC EQUIVALENT CIRCUIT (Common Emitter)



Note:

Data for MPS-A10 is presented in terms of the equivalent circuit shown in Figure 1. Values for its components may be found or calculated as follows:

$r_b{}'$ – See Figure 8

$r_e = 26\ mV/I_E$

$C_e = \frac{1}{2\pi f_t r_e}$

$C_{cb} = C_{ob} - 0.2$ pF (See Figure 6)

$g_m = 1/r_e$

$g_c = (h_{fe} + 1)\, h_{ob}$ (See Figures 2 & 7)

$C_o = 0.2$ pF

Low frequency h parameters may be found from:

$h_{ie} = r_b{}' + (h_{fe} + 1)\, r_e$

h_{fe} = See Figure 2

h_{re} = Negligible

$h_{oe} = (h_{fe} + 1)\, h_{ob}$

FIGURE 2 – SMALL SIGNAL CURRENT GAIN

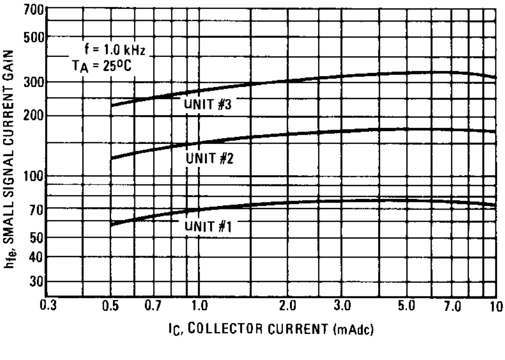


FIGURE 3 – NORMALIZED DC CURRENT GAIN

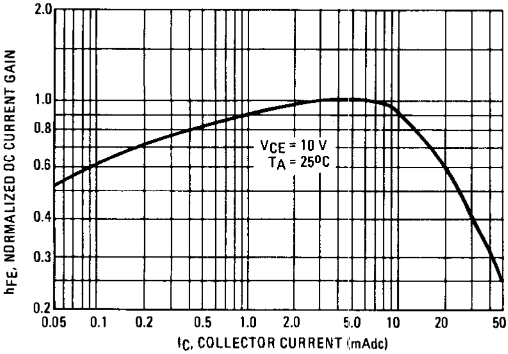


FIGURE 4 – "SATURATION" AND "ON" VOLTAGES

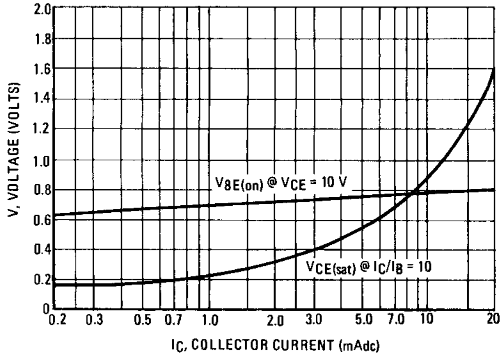


FIGURE 5 – CURRENT-GAIN–BANDWIDTH PRODUCT

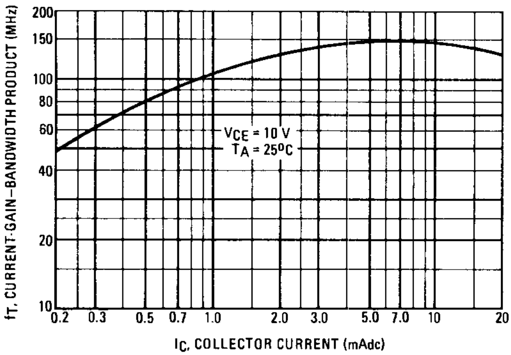


FIGURE 6 – CAPACITANCES

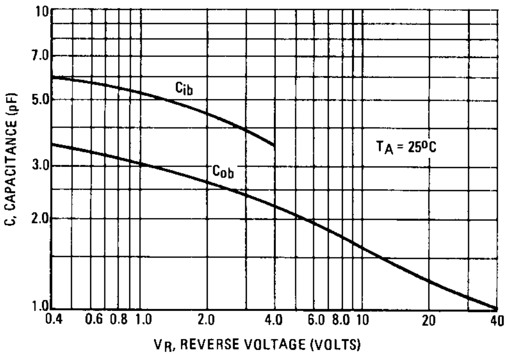


FIGURE 7 – OUTPUT ADMITTANCE

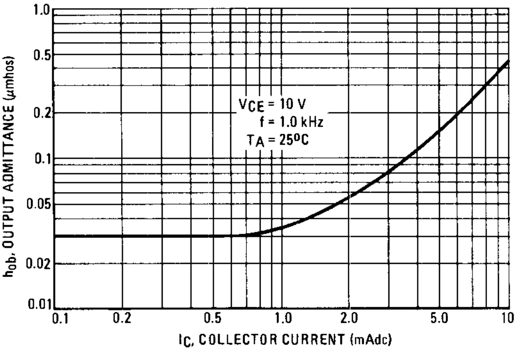
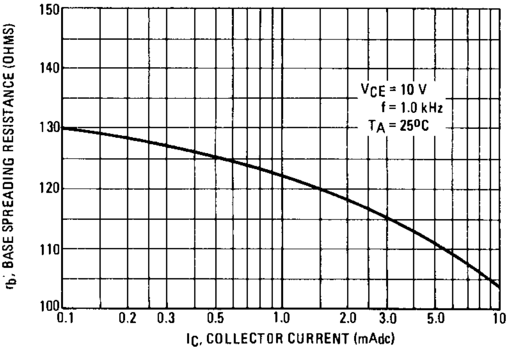


FIGURE 8 – BASE SPREADING RESISTANCE



MPS-K10, MPS-K11 and MPS-K12 are three, five and nine transistor kits consisting of MPS-A10's with various h_{FE} selections.

Table 1

MPS-K10 — Three Transistor Kit

Quantity Per Kit	Color Code	h_{FE} @ I_C = 5.0 mAdc, V_{CE} = 10 Vdc Min	Max
1	Red	40	400
1	White	80	400
1	Blue	120	300

MPS-K11 — Five Transistor Kit

Quantity Per Kit	Color Code	h_{FE} @ I_C = 5.0 mAdc, V_{CE} = 10 Vdc Min	Max
3	Red	40	400
1	Green	100	200
1	Yellow	150	300

MPS-K12 — Nine Transistor Kit

Quantity Per Kit	Color Code	h_{FE} @ I_C = 5.0 mAdc, V_{CE} = 10 Vdc Min	Max
4	Red	40	400
2	White	80	400
2	Green	100	200
1	Yellow	150	300

MPS-A13 (SILICON)
MPS-A14

NPN SILICON DARLINGTON AMPLIFIER TRANSISTORS

. . . designed for pre-amplifier input applications requiring high input impedance.

- High DC Current Gain —
  h_{FE} = 5,000 (Min) @ I_C = 10 mAdc (MPS-A13)
  10,000 (Min) @ I_C = 10 mAdc (MPS-A14)
- Collector-Emitter Breakdown Voltage —
  BV_{CEO} = 30 Vdc (Min) @ I_C = 10 mAdc
- Low Noise Figure —
  NF = 2.0 dB (Typ) @ I_C = 1.0 mAdc

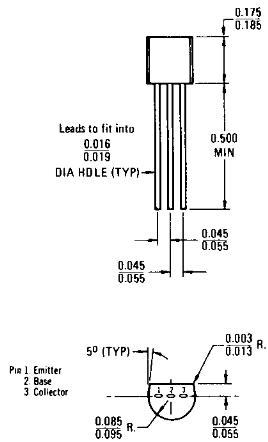
NPN SILICON DARLINGTON TRANSISTORS

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CES}	30	Vdc
Collector-Base Voltage	V_{CB}	30	Vdc
Emitter-Base Voltage	V_{EB}	10	Vdc
Collector Current – Continuous	I_C	300	mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	500 4.54	mW mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	-55 to +135	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	θ_{JA}	0.220	°C/mW



CASE 29 (1)
TO-92

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Collector-Emitter Breakdown Voltage (I_C = 100 μAdc, I_B = 0)		BV_{CES}	30	–	–	Vdc
Collector Cutoff Current (V_{CB} = 30 Vdc, I_E = 0)		I_{CBO}	–	–	100	nAdc
Emitter Cutoff Current (V_{BE} = 10 Vdc, I_C = 0)		I_{EBO}	–	–	100	nAdc
ON CHARACTERISTICS						
DC Current Gain		h_{FE}				–
(I_C = 10 mAdc, V_{CE} = 5.0 Vdc)	MPS-A13		5000	–	–	
	MPS-A14		10,000	–	–	
(I_C = 100 mAdc, V_{CE} = 5.0 Vdc)	MPS-A13		10,000	–	–	
	MPS-A14		20,000	–	–	
Collector-Emitter Saturation Voltage (I_C = 100 mAdc, I_B = 0.1 mAdc)		$V_{CE(sat)}$	–	0.8	1.5	Vdc
Base-Emitter On Voltage (I_C = 100 mAdc, V_{CE} = 5.0 Vdc)		$V_{BE(on)}$	–	1.25	2.0	Vdc
SMALL-SIGNAL CHARACTERISTICS						
Current-Gain—Bandwidth Product (I_C = 10 mAdc, V_{CE} = 5.0 Vdc, f = 100 MHz)		f_T	125	200	–	MHz
Output Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 100 kHz)		C_{ob}	–	5.0	–	pF
Noise Figure (I_C = 1.0 mAdc, V_{CE} = 5.0 Vdc, R_S = 100 k ohms, f = 1.0 kHz)		NF	–	2.0	–	dB

FIGURE 1 – NORMALIZED DC CURRENT GAIN

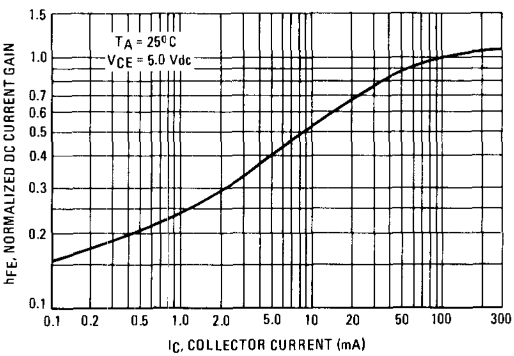


FIGURE 2 – BASE-EMITTER "ON" VOLTAGE

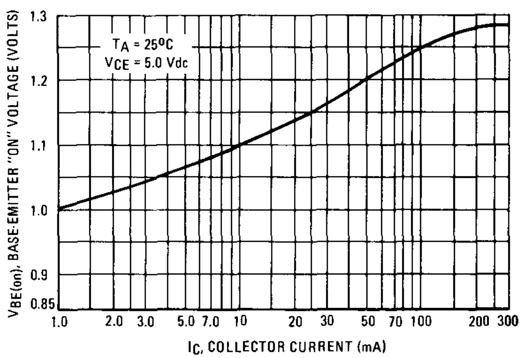


FIGURE 3 – TRANSCONDUCTANCE versus FREQUENCY

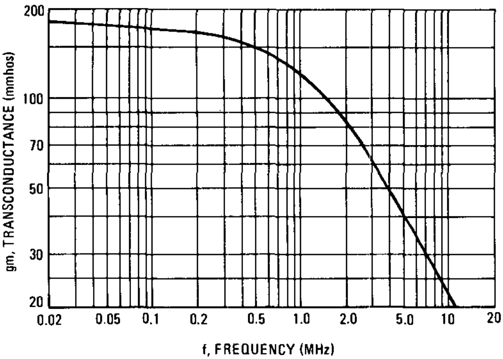


FIGURE 4 – NOISE FIGURE versus CURRENT

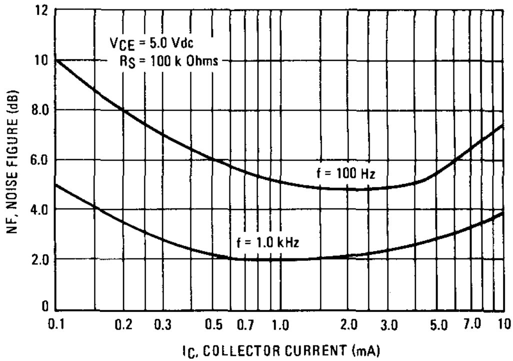


FIGURE 5 – NOISE FIGURE versus FREQUENCY

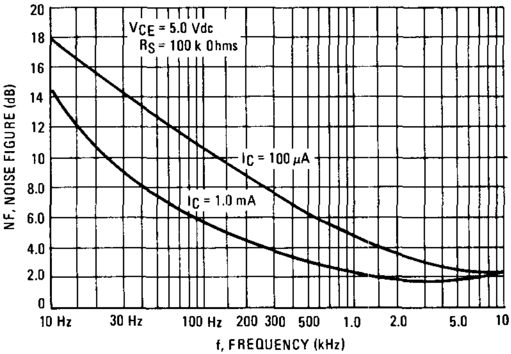
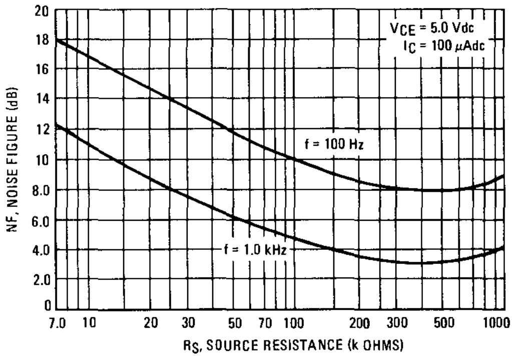


FIGURE 6 – NOISE FIGURE versus SOURCE RESISTANCE



MPS-A20 (SILICON)
MPS-K20, MPS-K21, MPS-K22

NPN SILICON ANNULAR TRANSISTORS

. . . designed for use in audio, radio, and television applications.

- MPS-K20, MPS-K21, MPS-K22 are 3, 5 and 9 Transistor Kits Available in Varied h_{FE} Ranges — See Table 1
- High Breakdown Voltage — BV_{CEO} = 40 Vdc (Min) @ I_C = 1.0 mAdc
- Low Collector-Emitter Saturation Voltage — $V_{CE(sat)}$ = 0.25 Vdc (Max) @ I_C = 10 mAdc
- Low Output Capacitance — C_{ob} = 4.0 pF (Max) @ V_{CB} = 10 Vdc
- One-Piece, Injection-Molded Unibloc Package

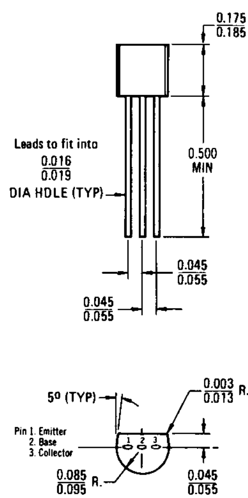
NPN SILICON AMPLIFIER TRANSISTORS

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	40	Vdc
Emitter-Base Voltage	V_{EB}	4.0	Vdc
Collector Current – Continuous	I_C	100	mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	300 2.73	mW mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	-55 to +135	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	θ_{JA}	0.367	°C/mW

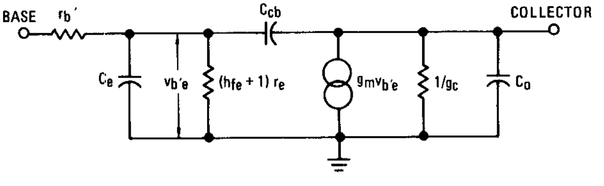


CASE 29 (1)
TO-92

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage (I_C = 1.0 mAdc, I_B = 0)	BV_{CEO}	40	-	Vdc
Emitter-Base Breakdown Voltage (I_E = 100 μAdc, I_C = 0)	BV_{EBO}	4.0	-	Vdc
Collector Cutoff Current (V_{CB} = 30 Vdc, I_E = 0)	I_{CBO}	-	100	nAdc
ON CHARACTERISTICS				
DC Current Gain (I_C = 5.0 mAdc, V_{CE} = 10 Vdc)	h_{FE}	40	400	-
Collector-Emitter Saturation Voltage (I_C = 10 mAdc, I_B = 1.0 mAdc)	$V_{CE(sat)}$	-	0.25	Vdc
DYNAMIC CHARACTERISTICS				
Current-Gain–Bandwidth Product (I_C = 5.0 mAdc, V_{CE} = 10 Vdc, f = 100 MHz)	f_T	125	-	MHz
Output Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 100 kHz)	C_{ob}	-	4.0	pF

FIGURE 1 – SIMPLIFIED AC EQUIVALENT CIRCUIT (Common Emitter)



Note:

Data for MPS-A20 is presented in terms of the equivalent circuit shown in Figure 1. Values for its components may be found or calculated as follows:

r_b' – See Figure 8 $\quad C_{cb} = C_{ob} - 0.2$ pF (See Figure 6)

$r_e = 26\ mV/I_E \quad g_m = 1/r_e$

$C_e = \frac{1}{2\pi f_t r_e} \quad g_c = (h_{fe} + 1)\ h_{ob}$ (See Figures 2 & 7)

$C_o = 0.2$ pF

Low frequency h parameters may be found from:

$h_{ie} = r_b' + (h_{fe} + 1)\ r_e$

h_{fe} = See Figure 2

h_{re} = Negligible

$h_{oe} = (h_{fe} + 1)\ h_{ob}$

FIGURE 2 – SMALL SIGNAL CURRENT GAIN

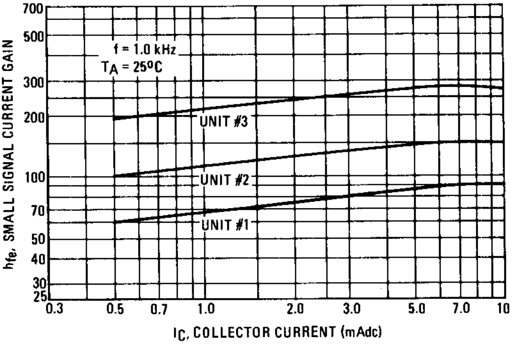


FIGURE 3 – NORMALIZED DC CURRENT GAIN

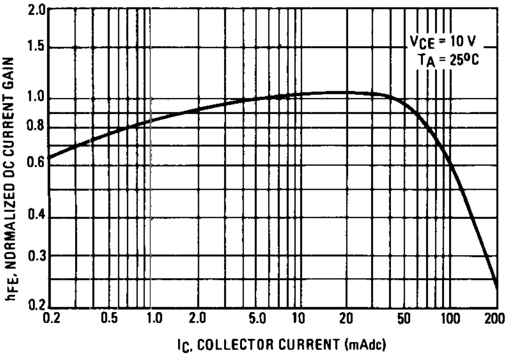


FIGURE 4 – "SATURATION" AND "ON" VOLTAGES

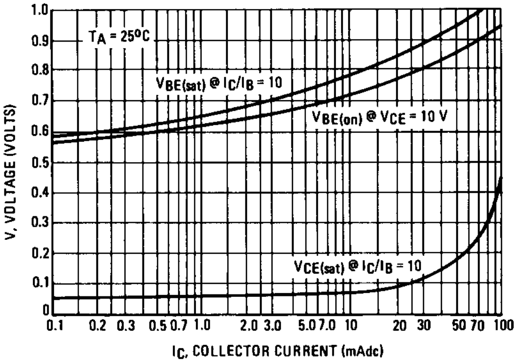


FIGURE 5 – CURRENT-GAIN–BANDWIDTH PRODUCT

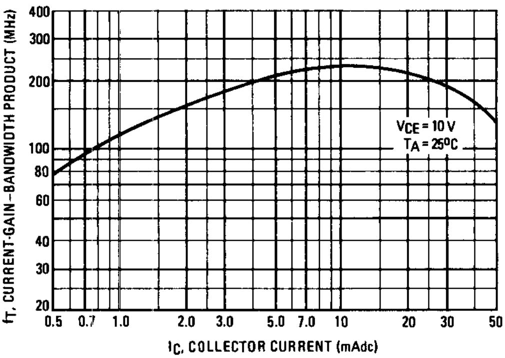


FIGURE 6 – CAPACITANCES

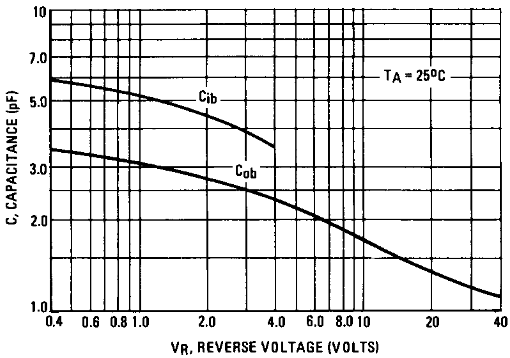


FIGURE 7 – OUTPUT ADMITTANCE

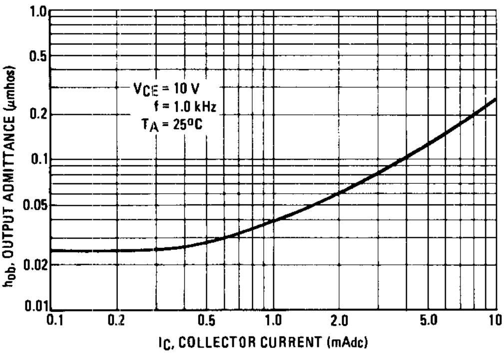
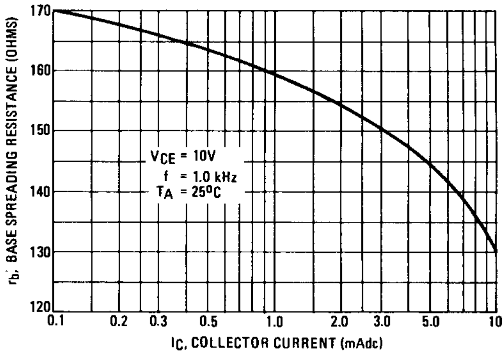


FIGURE 8 – BASE SPREADING RESISTANCE



MPS-K20, MPS-K21 and MPS-K22 are three, five and nine transistor kits consisting of MPS-A20's with various h_{FE} selections.

Table 1

MPS-K20 — Three Transistor Kit

Quantity Per Kit	Color Code	h_{FE} @ I_C = 5.0 mAdc, V_{CE} = 10 Vdc Min	Max
1	Red	40	400
1	White	80	400
1	Blue	120	300

MPS-K21 — Five Transistor Kit

Quantity Per Kit	Color Code	h_{FE} @ I_C = 5.0 mAdc, V_{CE} = 10 Vdc Min	Max
3	Red	40	400
1	Green	100	200
1	Yellow	150	300

MPS-K22 — Nine Transistor Kit

Quantity Per Kit	Color Code	h_{FE} @ I_C = 5.0 mAdc, V_{CE} = 10 Vdc Min	Max
4	Red	40	400
2	White	80	400
2	Green	100	200
1	Yellow	150	300

MPS-A55 (SILICON)
MPS-A56

PNP SILICON ANNULAR AUDIO TRANSISTORS

. . . designed for use as medium-power drivers and low-power outputs.

- High Collector-Emitter Breakdown Voltage –
  BV_{CEO} = 60 Vdc (Min) @ I_C = 1.0 mAdc – MPS-A55
  80 Vdc (Min) @ I_C = 1.0 mAdc – MPS-A56
- Excellent Current-Gain Linearity – 1.0 mAdc to 200 mAdc
- Low Collector-Emitter Saturation Voltage –
  $V_{CE(sat)}$ = 0.25 Vdc (Max) @ I_C = 100 mAdc
- Complements to MPS-A05 and MPS-A06

PNP SILICON AUDIO TRANSISTORS

MAXIMUM RATINGS

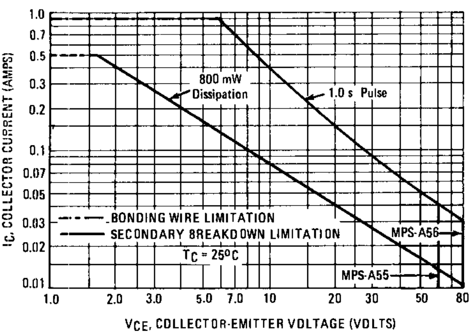
Rating	Symbol	MPS-A55	MPS-A56	Unit
Collector-Emitter Voltage	V_{CEO}	60	80	Vdc
Collector-Base Voltage	V_{CB}	60	80	Vdc
Emitter-Base Voltage	V_{EB}	4.0		Vdc
Collector Current – Continuous	I_C	500		mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	500 4.54		mW mW/°C
Total Device Dissipation @ T_C = 25°C Derete above 25°C	P_D	800 7.27		mW mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	-55 to +135		°C

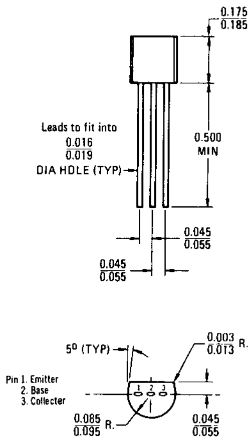
THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	θ_{JC}	0.137	°C/mW
Thermal Resistance, Junction to Ambient	θ_{JA}**	0.220	°C/mW

**θ_{JA} is measured with the device soldered into a typical printed circuit board.

FIGURE 1 – DC SAFE OPERATING AREA





CASE 29 (1)
TO-92

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 1.0 mAdc, I_B = 0) MPS-A55	BV_{CEO}	60	–	–	Vdc
MPS-A56		80	–	–	
Emitter-Base Breakdown Voltage (I_E = 100 μAdc, I_C = 0)	BV_{EBO}	4.0	–	–	Vdc
Collector Cutoff Current (V_{CB} = 60 Vdc, I_E = 0) MPS-A55	I_{CBO}	–	–	100	nAdc
(V_{CB} = 80 Vdc, I_E = 0) MPS-A56		–	–	100	
ON CHARACTERISTICS					
DC Current Gain (I_C = 10 mAdc, V_{CE} = 1.0 Vdc)	h_{FE}	50	150	–	–
(I_C = 100 mAdc, V_{CE} = 1.0 Vdc)		50	125	–	
(I_C = 350 mAdc, V_{CE} = 1.0 Vdc)		–	80	–	
Collector-Emitter Saturation Voltage (I_C = 100 mAdc, I_B = 10 mAdc)	$V_{CE(sat)}$	–	0.09	0.25	Vdc
Base-Emitter Saturation Voltage (I_C = 100 mAdc, I_B = 10 mAdc)	$V_{BE(sat)}$	–	0.78	–	Vdc
Base-Emitter On Voltage (I_C = 100 mAdc, V_{CE} = 1.0 Vdc)	$V_{BE(on)}$	–	0.73	1.2	Vdc
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain—Bandwidth Product (I_C = 100 mAdc, V_{CE} = 1.0 Vdc, f = 100 MHz)	f_T	50	100	–	MHz
Output Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 100 kHz)	C_{ob}	–	6.5	–	pF
Input Capacitance (V_{BE} = 0.5 Vdc, I_C = 0, f = 100 kHz)	C_{ib}	–	20	–	pF

FIGURE 2 – "SATURATION" AND "ON" VOLTAGES

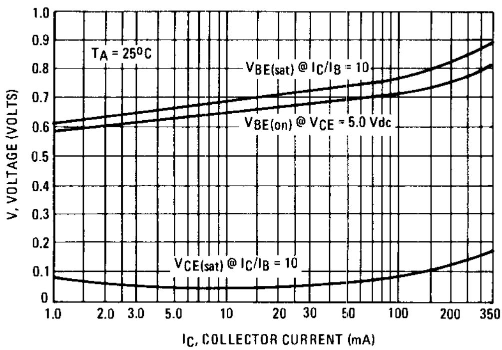
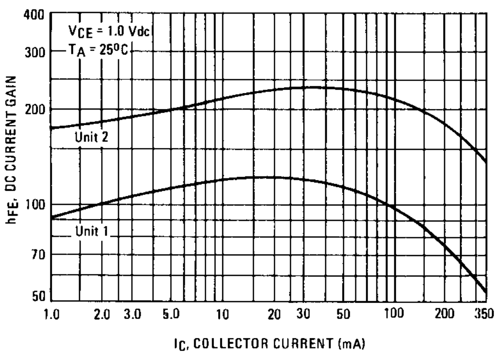


FIGURE 3 – DC CURRENT GAIN



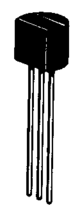
MPS-A65 (SILICON)
MPS-A66

PNP SILICON DARLINGTON AMPLIFIER TRANSISTORS

. . . designed for pre-amplifier input applications requiring high input impedance.

- High DC Current Gain —
  h_{FE} = 50,000 (Min) @ I_C = 10 mAdc (MPS-A65)
  75,000 (Min) @ I_C = 10 mAdc (MPS-A66)
- Collector-Emitter Breakdown Voltage —
  BV_{CEO} = 30 Vdc (Min) @ I_C = 10 mAdc
- Low Noise Figure —
  NF = 2.0 dB (Typ) @ I_C = 1.0 mAdc

PNP SILICON DARLINGTON TRANSISTORS

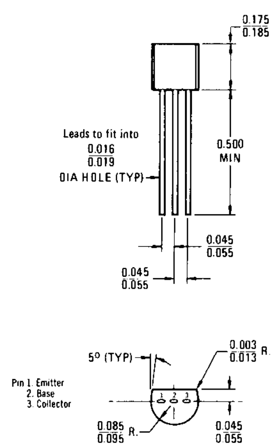


MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CES}	30	Vdc
Collector-Base Voltage	V_{CB}	30	Vdc
Emitter-Base Voltage	V_{EB}	8.0	Vdc
Collector Current — Continuous	I_C	300	mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	500 4.54	mW mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	-55 to +135	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	θ_{JA}	0.220	°C/mW



CASE 29 (1)
TO-92

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Collector-Emitter Breakdown Voltage (I_C = 100 μAdc, I_B = 0)		BV_{CES}	30	–	–	Vdc
Collector Cutoff Current (V_{CB} = 30 Vdc, I_E = 0)		I_{CBO}	–	–	100	nAdc
Emitter Cutoff Current (V_{BE} = 8.0 Vdc, I_C = 0)		I_{EBO}	–	–	100	nAdc
ON CHARACTERISTICS						
DC Current Gain		h_{FE}				–
(I_C = 10 mAdc, V_{CE} = 5.0 Vdc)	MPS-A65		50,000	–	–	
	MPS-A66		75,000	–	–	
(I_C = 100 mAdc, V_{CE} = 5.0 Vdc)	MPS-A65		20,000	–	–	
	MPS-A66		40,000	–	–	
Collector-Emitter Saturation Voltage (I_C = 100 mAdc, I_B = 0.1 mAdc)		$V_{CE(sat)}$	–	0.9	1.5	Vdc
Base-Emitter On Voltage (I_C = 100 mAdc, V_{CE} = 5.0 Vdc)		$V_{BE(on)}$	–	1.45	2.0	Vdc
SMALL-SIGNAL CHARACTERISTICS						
Current-Gain—Bandwidth Product (I_C = 10 mAdc, V_{CE} = 5.0 Vdc, f = 100 MHz)		f_T	100	175	–	MHz
Output Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 100 kHz)		C_{ob}	–	2.5	–	pF
Noise Figure (I_C = 1.0 mAdc, V_{CE} = 5.0 Vdc, R_S = 100 k ohms, f = 1.0 kHz)		NF	–	2.0	–	dB

FIGURE 1 – NORMALIZED DC CURRENT GAIN

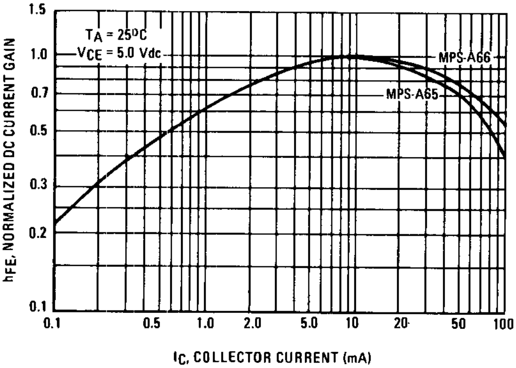


FIGURE 2 – BASE-EMITTER "ON" VOLTAGE

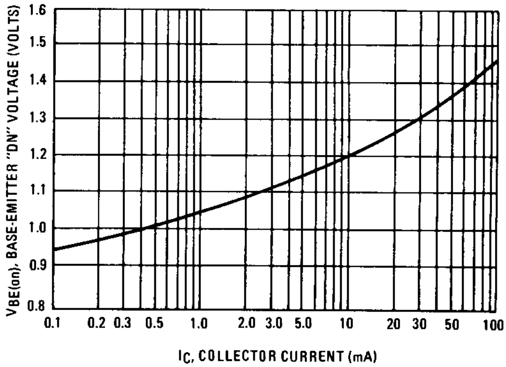


FIGURE 3 – TRANSCONDUCTANCE versus FREQUENCY

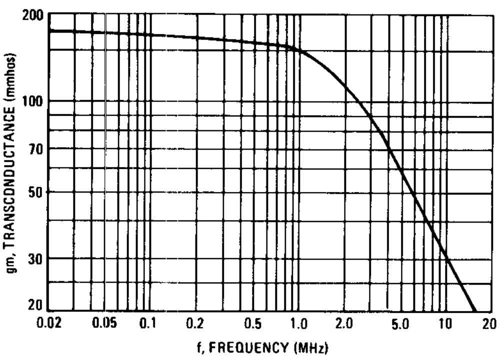


FIGURE 4 – NOISE FIGURE versus CURRENT

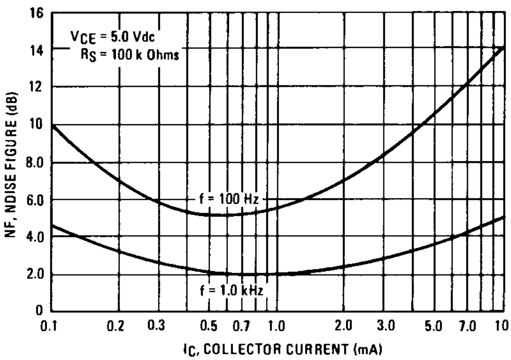


FIGURE 5 – NOISE FIGURE versus FREQUENCY

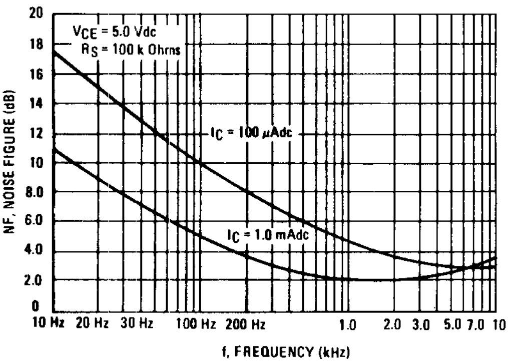
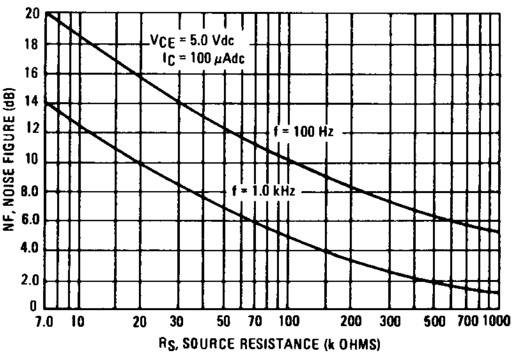


FIGURE 6 – NOISE FIGURE versus SOURCE RESISTANCE



MPS-A70 (SILICON)
MPS-K70, MPS-K71
MPS-K72

PNP SILICON ANNULAR TRANSISTORS

. . . designed for general purpose use in audio, radio, and television applications.

- MPS-K70, MPS-K71, MPS-K72 are 3, 5 and 9 Transistor Kits Available in Varied h_{FE} Ranges — See Table 1
- High Breakdown Voltage — BV_{CEO} = 40 Vdc (Min) @ I_C = 1.0 mAdc
- Low Collector-Emitter Saturation Voltage — $V_{CE(sat)}$ = 0.25 Vdc (Max) @ I_C = 10 mAdc
- Low Output Capacitance — C_{ob} = 4.0 pF (Max) @ V_{CB} = 10 Vdc
- One-Piece, Injection-Molded Unibloc Package

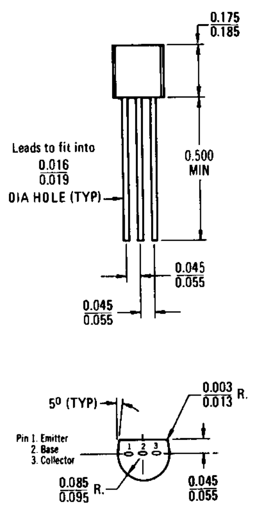
PNP SILICON AMPLIFIER TRANSISTORS

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	40	Vdc
Emitter-Base Voltage	V_{EB}	4.0	Vdc
Collector Current – Continuous	I_C	100	mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	300 2.73	mW mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	-55 to +135	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	θ_{JA}	0.367	°C/mW



CASE 29 (1)
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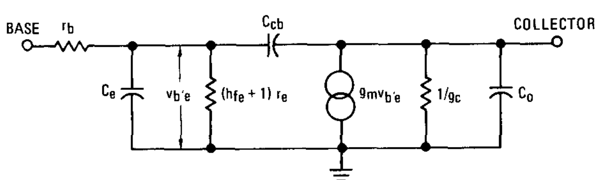
ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage (I_C = 1.0 mAdc, I_B = 0)	BV_{CEO}	40	-	Vdc
Emitter-Base Breakdown Voltage (I_E = 100 μAdc, I_C = 0)	BV_{EBO}	4.0	-	Vdc
Collector Cutoff Current (V_{CB} = 30 Vdc, I_E = 0)	I_{CBO}	-	100	nAdc
ON CHARACTERISTICS				
DC Current Gain (I_C = 5.0 mAdc, V_{CE} = 10 Vdc)	h_{FE}	40	400	-
Collector-Emitter Saturation Voltage (I_C = 10 mAdc, I_B = 1.0 mAdc)	$V_{CE(sat)}$	-	0.25	Vdc
DYNAMIC CHARACTERISTICS				
Current-Gain–Bandwidth Product (I_C = 5.0 mAdc, V_{CE} = 10 Vdc, f = 100 MHz)	f_T	125	-	MHz
Output Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 100 kHz)	C_{ob}	-	4.0	pF

FIGURE 1 – SIMPLIFIED AC EQUIVALENT CIRCUIT (Common Emitter)



Note:

Data for MPS-A70 is presented in terms of the equivalent circuit shown in Figure 1. Values for its components may be found or calculated as follows:

r_b' – See Figure 8

$r_e = 26\ mV/I_E$

$C_e = \frac{1}{2\pi f_t r_e}$

$C_{cb} = C_{ob} - 0.2$ pF (See Figure 6)

$g_m = 1/r_e$

$g_c = (h_{fe} + 1)\, h_{ob}$ (See Figures 2 & 7)

$C_o = 0.2$ pF

Low frequency h parameters may be found from:

$h_{ie} = r_b' + (h_{fe} + 1)\, r_e$

h_{fe} = See Figure 2

h_{re} = Negligible

$h_{oe} = (h_{fe} + 1)\, h_{ob}$

FIGURE 2 – SMALL SIGNAL CURRENT GAIN

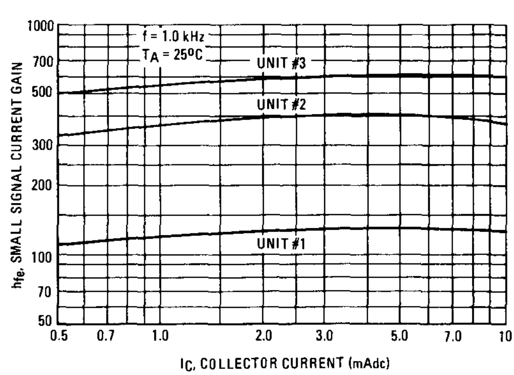


FIGURE 3 – NORMALIZED DC CURRENT GAIN

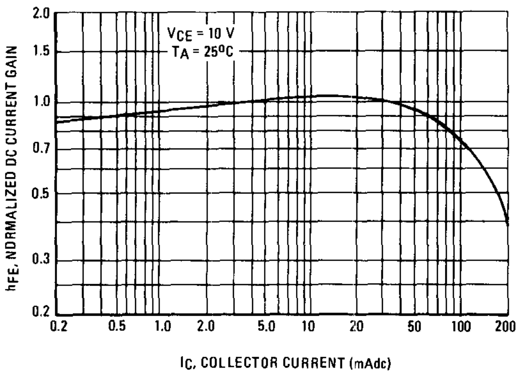


FIGURE 4 – "SATURATION" AND "ON" VOLTAGES

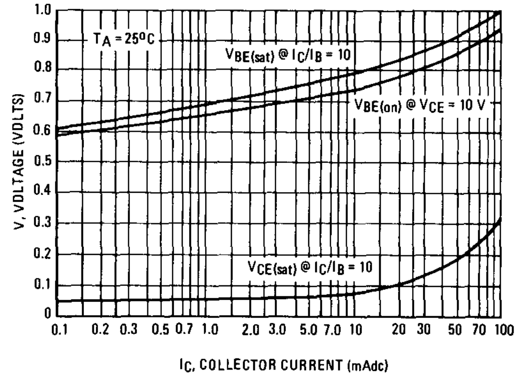


FIGURE 5 – CURRENT-GAIN–BANDWIDTH PRODUCT

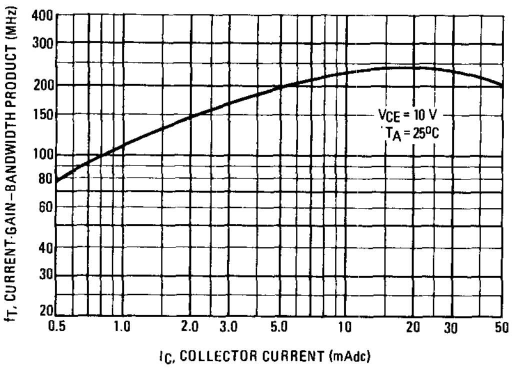


FIGURE 6 – CAPACITANCES

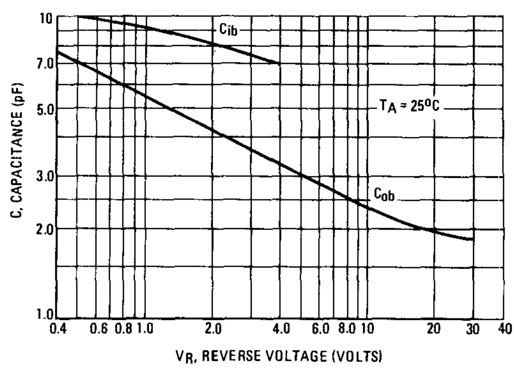


FIGURE 7 – OUTPUT ADMITTANCE

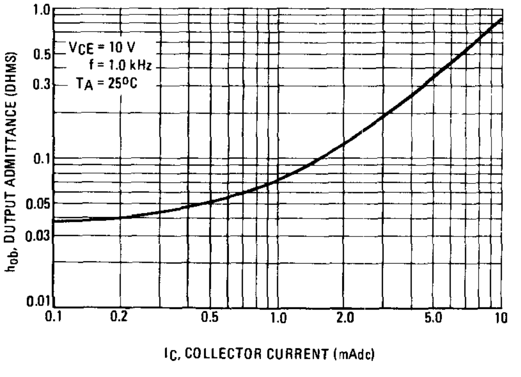
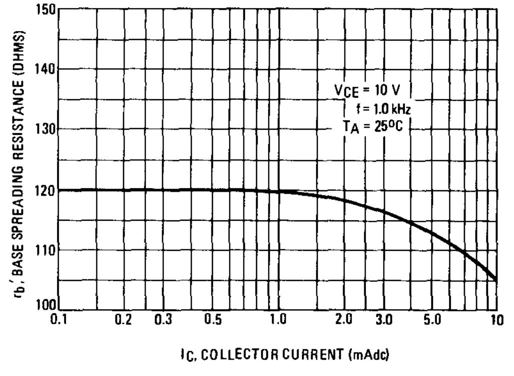


FIGURE 8 – BASE SPREADING RESISTANCE



MPS-A70, MPS-K70, MPS-K71, MPS-K72 (continued)

MPS-K70, MPS-K71and MPS-K72 are three, five and nine transistor kits consisting of MPS-A70's with various h_{FE} selections.

Table 1

MPS-K70 -- Three Transistor Kit

Quantity Per Kit	Color Code	h_{FE} @ I_C = 5.0 mAdc, V_{CE} = 10 Vdc	
		Min	Max
1	Red	40	400
1	White	80	400
1	Blue	120	300

MPS-K71 -- Five Transistor Kit

Quantity Per Kit	Color Code	h_{FE} @ I_C = 5.0 mAdc, V_{CE} = 10 Vdc	
		Min	Max
3	Red	40	400
1	Green	100	200
1	Yellow	150	300

MPS-K72 -- Nine Transistor Kit

Quantity Per Kit	Color Code	h_{FE} @ I_C = 5.0 mAdc, V_{CE} = 10 Vdc	
		Min	Max
4	Red	40	400
2	White	80	400
2	Green	100	200
1	Yellow	150	300

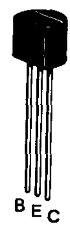
MPS-H02 (SILICON)

NPN SILICON ANNULAR TRANSISTOR

. . . designed for a common-emitter VHF-RF amplifier stage in TV receivers.

- Low Collector-Base Capacitance – C_{cb} = 0.5 pF (Max)
- Guaranteed Noise Figure – NF = 3.3 dB (Max) @ f = 200 MHz
- Guaranteed AGC Characteristics
- Complete y-Parameter Curves from 50 MHz to 300 MHz
- Guaranteed Power Gain – G_{pe} = 20 dB (Min) @ f = 200 MHz

NPN SILICON VHF TRANSISTOR

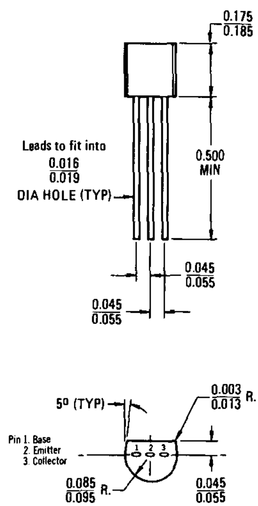


MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	20	Vdc
Collector-Base Voltage	V_{CB}	20	Vdc
Emitter-Base Voltage	V_{EB}	3.0	Vdc
Total Device Dissipation @ $T_A = 25^oC$ Derate above 25°C	P_D	500 4.54	mW mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	-55 to +135	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	θ_{JC}	0.137	°C/mW
Thermal Resistance, Junction to Ambient	θ_{JA}	0.220	°C/mW



CASE 29 (2)
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MPS-H02 (continued)

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage (I_C = 1.0 mAdc, I_B = 0)	BV_{CEO}	20	–	Vdc
Collector-Base Breakdown Voltage (I_C = 100 μAdc, I_E = 0)	BV_{CBO}	20	–	Vdc
Emitter-Base Breakdown Voltage (I_E = 100 μAdc, I_C = 0)	BV_{EBO}	3.0	–	Vdc
Collector Cutoff Current (V_{CB} = 10 Vdc, I_E = 0)	I_{CBO}	–	50	nAdc
ON CHARACTERISTICS				
DC Current Gain (I_C = 4.0 mAdc, V_{CE} = 10 Vdc)	h_{FE}	20	200	–
SMALL-SIGNAL CHARACTERISTICS				
Current-Gain–Bandwidth Product (I_C = 4.0 mAdc, V_{CE} = 10 Vdc, f = 100 MHz)	f_T	375	–	MHz
Collector-Base Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 1.0 MHz)	C_{cb}	–	0.5	pF
Noise Figure (Figure 9) (V_{AGC} = 1.4 Vdc, R_S = 50 Ohms, f = 200 MHz)	NF	–	3.3	dB
FUNCTIONAL TEST				
Common-Emitter Amplifier Power Gain (Figure 9) (V_{AGC} = 1.4 Vdc, R_S = 50 Ohms, f = 200 MHz)	G_{pe}	20	–	dB
Forward AGC Voltage (Figure 9) (Gain Reduction = 30 dB, R_S = 50 Ohms, f = 200 MHz)	V_{AGC}	4.0	5.0	Vdc

AGC CHARACTERISTICS
(V_{CC} = 12 Vdc, R_S = 50 Ohms, f = 200 MHz, See Figure 9)

FIGURE 1 – POWER GAIN

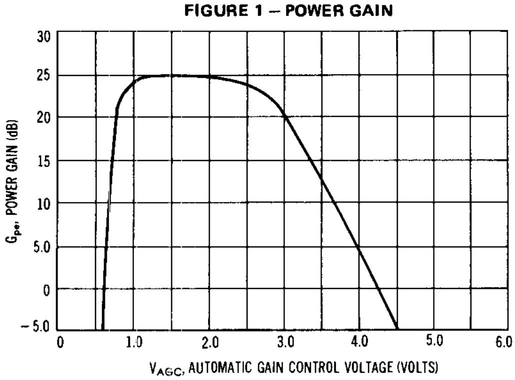
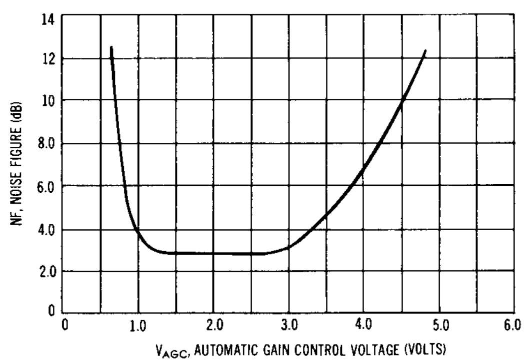


FIGURE 2 – NOISE FIGURE



COMMON-EMITTER y PARAMETERS
(I_C = 4.0 mAdc, V_{CE} = 10 Vdc, T_A = 25°C)

FIGURE 3 – INPUT ADMITTANCE

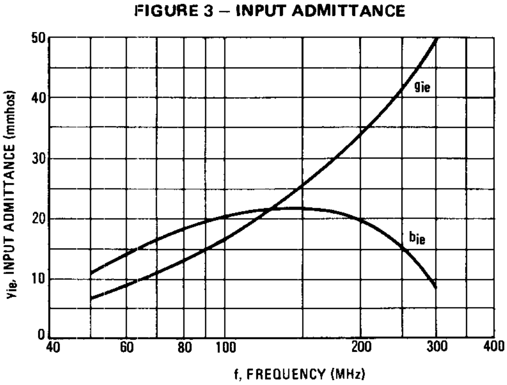
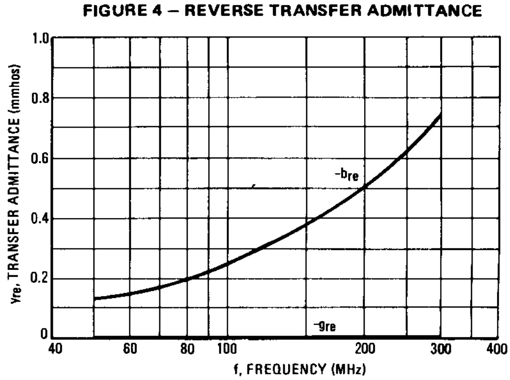


FIGURE 4 – REVERSE TRANSFER ADMITTANCE



COMMON-EMITTER y PARAMETERS
(I_C = 4.0 mAdc, V_{CE} = 10 Vdc, T_A = 25°C)

FIGURE 5 — FORWARD TRANSFER ADMITTANCE

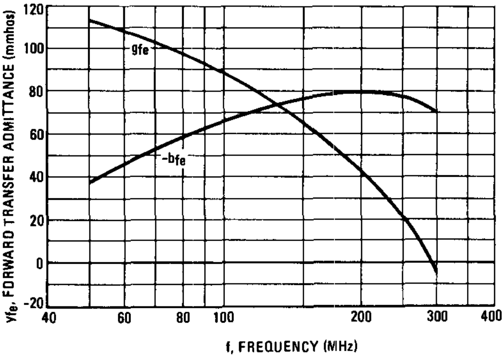


FIGURE 6 — OUTPUT ADMITTANCE

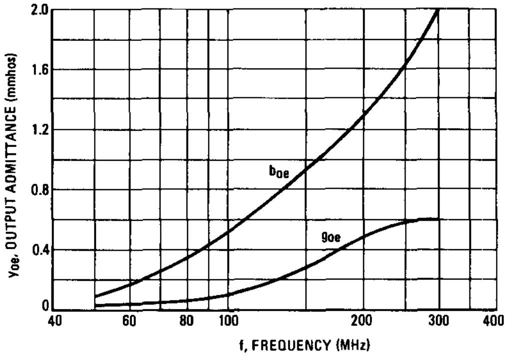


FIGURE 7 — DC CURRENT GAIN

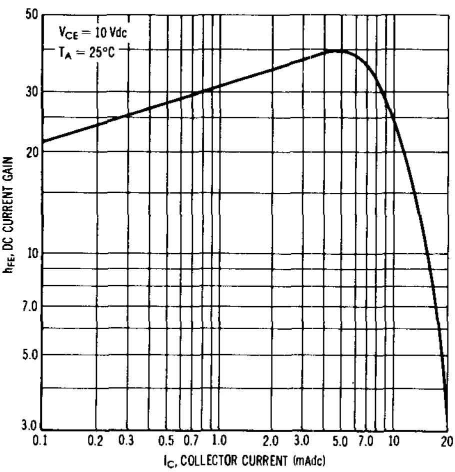


FIGURE 8 — COLLECTOR-BASE CAPACITANCE

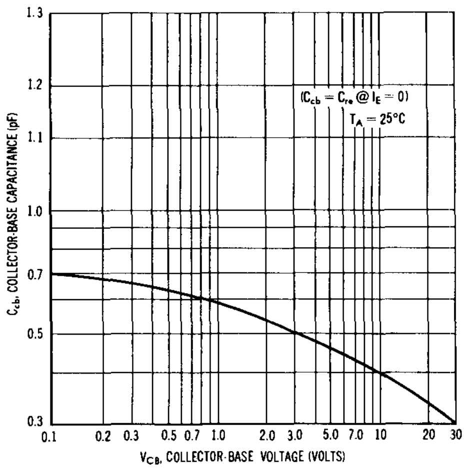
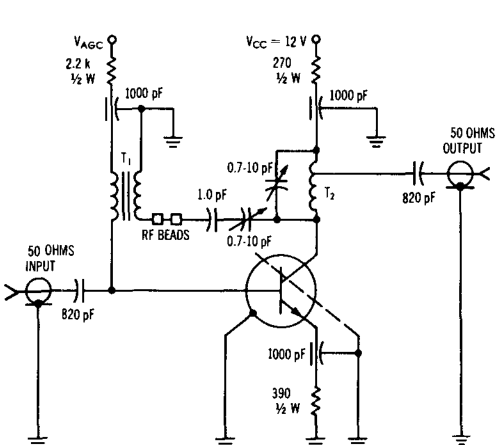


FIGURE 9 — 200 MHz FUNCTIONAL TEST CIRCUIT (NEUTRALIZED)



T_1 = FERRITE CORE INDIANA GEN. CORP. F-684
T_2 = 6 TURNS #16 BUSS WIRE, ID = ¼″, L = ¾″

MPS-H10 (SILICON)
MPS-H11

NPN SILICON EPITAXIAL TRANSISTORS

. . . designed for use in VHF/UHF common base oscillator applications.

- High Current-Gain—Bandwidth Product — f_T = 650 MHz (Min) @ I_C = 4.0 mAdc
- Low Collector-Base Time Constant — $r_b'C_c$ = 9.0 ps (Max) @ I_C = 4.0 mAdc
- Feedback Capacitance — C_{rb} = 0.35–0.65 pF – MPS-H10
  0.6–0.9 pF – MPS-H11

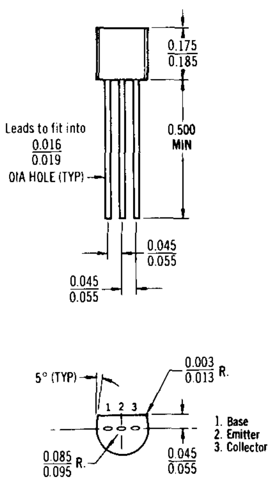
NPN SILICON
VHF/UHF TRANSISTORS

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	25	Vdc
Collector-Base Voltage	V_{CB}	30	Vdc
Emitter-Base Voltage	V_{EB}	3.0	Vdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	310 2.81	mW mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	-55 to +135	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	θ_{JA}	0.357	°C/mW



CASE 29 (2)
TO-92

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage (I_C = 1.0 mAdc, I_B = 0)	BV_{CEO}	25	–	Vdc
Collector-Base Breakdown Voltage (I_C = 100 μAdc, I_E = 0)	BV_{CBO}	30	–	Vdc
Emitter-Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)	BV_{EBO}	3.0	–	Vdc
Collector Cutoff Current (V_{CB} = 25 Vdc, I_E = 0)	I_{CBO}	–	100	nAdc
Emitter Cutoff Current (V_{BE} = 2.0 Vdc, I_C = 0)	I_{EBO}	–	100	nAdc
ON CHARACTERISTICS				
DC Current Gain (I_C = 4.0 mAdc, V_{CE} = 10 Vdc)	h_{FE}	60	–	–
Collector-Emitter Saturation Voltage (I_C = 4.0 mAdc, I_B = 0.4 mAdc)	$V_{CE(sat)}$	–	0.5	Vdc
Base-Emitter On Voltage (I_C = 4.0 mAdc, V_{CE} = 10 Vdc)	$V_{BE(on)}$	–	0.95	Vdc
DYNAMIC CHARACTERISTICS				
Current-Gain—Bandwidth Product (I_C = 4.0 mAdc, V_{CE} = 10 Vdc, f = 100 MHz)	f_T	650	–	MHz
Collector-Base Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 1.0 MHz)	C_{cb}	–	0.7	pF
Common-Base Feedback Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 1.0 MHz) MPS-H10	C_{rb}	0.35	0.65	pF
MPS-H11		0.6	0.9	
Collector-Base Time Constant (I_C = 4.0 mAdc, V_{CB} = 10 Vdc, f = 31.8 MHz)	$r_b'C_c$	–	9.0	ps

COMMON-BASE y PARAMETERS versus FREQUENCY
(V_{CB} = 10 Vdc, I_C = 4.0 mAdc, T_A = 25°C)

y_{ib}, INPUT ADMITTANCE

FIGURE 1 – RECTANGULAR FORM

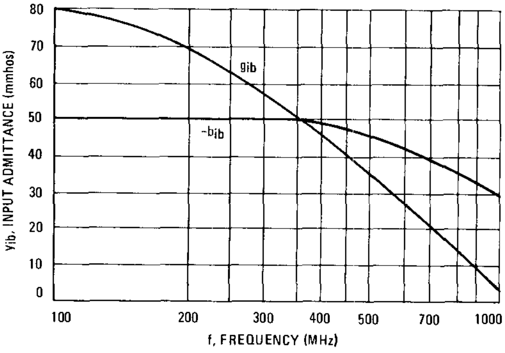
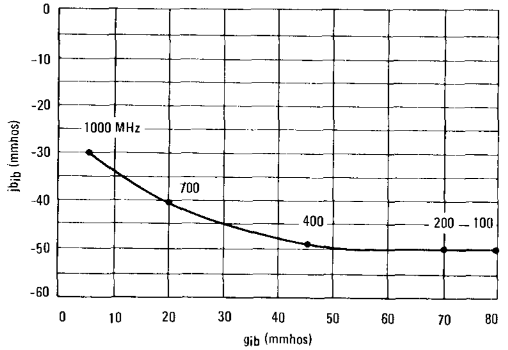


FIGURE 2 – POLAR FORM



COMMON-BASE y PARAMETERS versus FREQUENCY
(V_{CB} = 10 Vdc, I_C = 4.0 mAdc, T_A = 25°C)

y_{fb}, FORWARD TRANSFER ADMITTANCE

FIGURE 3 – RECTANGULAR FORM

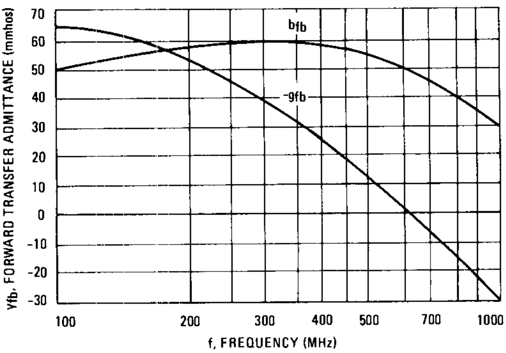
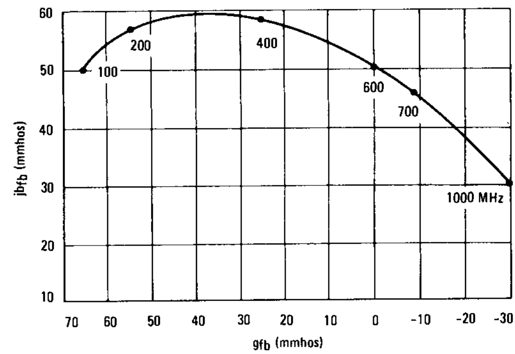


FIGURE 4 – POLAR FORM



y_{rb}, REVERSE TRANSFER ADMITTANCE

FIGURE 5 – RECTANGULAR FORM

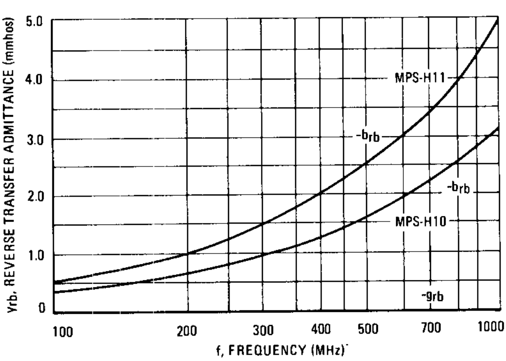
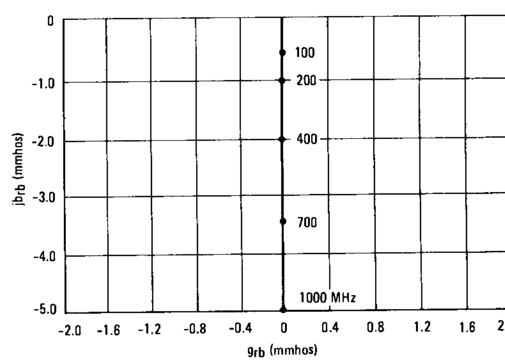


FIGURE 6 – POLAR FORM



y_{ob}, OUTPUT ADMITTANCE

FIGURE 7 – RECTANGULAR FORM

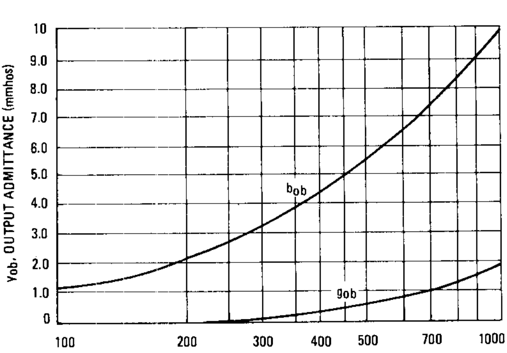
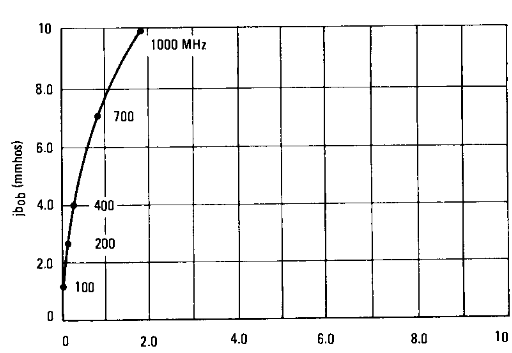


FIGURE 8 – POLAR FORM



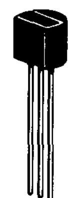
MPS-H20 (SILICON)

NPN SILICON EPITAXIAL TRANSISTORS

. . . designed for VHF mixer applications in TV receivers.

- Excellent Conversion Gain – 23 dB (Typ)
- Low Collector-Base Capacitance – C_{cb} = 0.65 pF (Max)
- High Current-Gain–Bandwidth Product – f_T = 400 MHz (Min)
- Complete y-Parameter Curves from 50 to 300 MHz
- One-Piece, Injection Molded Unibloc Package

NPN SILICON VHF TRANSISTOR

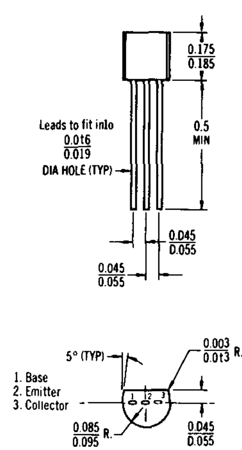


MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	30	Vdc
Collector-Base Voltage	V_{CB}	40	Vdc
Emitter-Base Voltage	V_{EB}	4.0	Vde
Collector Current – Continuous	I_C	100	mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	310 2.81	mW mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	-55 to +135	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	θ_{JA}	0.357	°C/mW



CASE 29 (2)
TO-92

ELECTRICAL CHARACTERISTICS ($T_A = 25^oC$ unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 1.0 mAdc, I_B = 0)	BV_{CEO}	30	–	–	Vdc
Collector-Base Breakdown Voltage (I_C = 100 μAdc, I_E = 0)	BV_{CBO}	40	–	–	Vdc
Emitter-Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)	BV_{EBO}	4.0	–	–	Vdc
Collector Cutoff Current (V_{CB} = 15 Vdc, I_E = 0)	I_{CBO}	–	–	50	nAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 4.0 mAdc, V_{CE} = 10 Vdc)	h_{FE}	25	–	–	–
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain—Bandwidth Product (I_C = 4.0 mAdc, V_{CE} = 10 Vdc, f = 100 MHz)	f_T	400	620	–	MHz
Collector-Base Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 1.0 MHz)	C_{cb}	–	0.5	0.65	pF
Collector-Base Time Constant (I_E = 4.0 mAdc, V_{CB} = 10 Vdc, f = 31.8 MHz)	$r_b'C_c$	–	10	–	ps
Conversion Gain (213 to 45 MHz) (I_C = 4.0 mAdc, V_{CE} = 10 Vdc, Oscillator Injection = 200 mVdc, See Figures 1, 2 and 9)	–	18	23	–	dB

CONVERSION GAIN CHARACTERISTICS
(TEST CIRCUIT FIGURE 9)

FIGURE 1 – VARIATION WITH COLLECTOR CURRENT

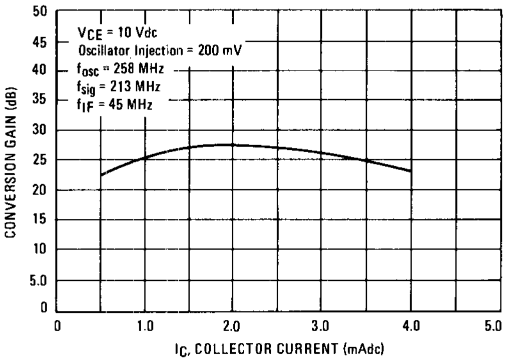
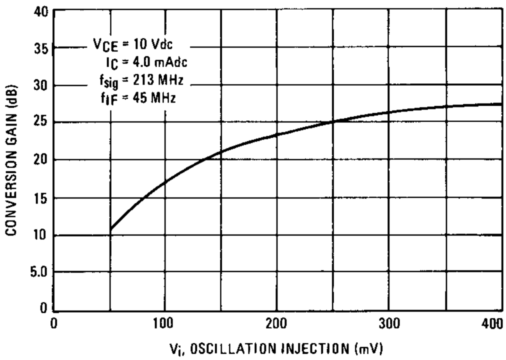


FIGURE 2 – VARIATION WITH INJECTION LEVEL



COMMON-EMITTER y PARAMETERS
(I_C = 4.0 mAdc, V_{CE} = 10 Vdc, $T_A = 25^oC$)

FIGURE 3 – INPUT ADMITTANCE

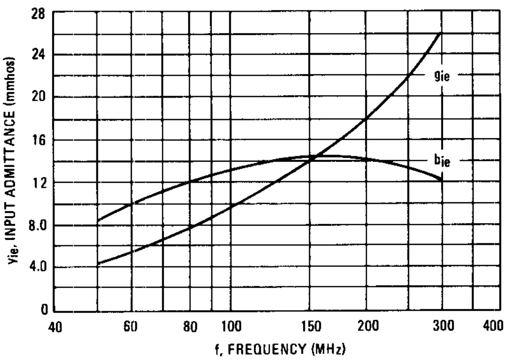
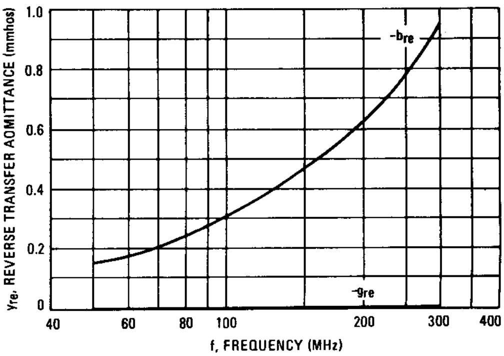


FIGURE 4 – REVERSE TRANSFER ADMITTANCE



COMMON-EMITTER y PARAMETERS

(I_C = 4.0 mAdc, V_{CE} = 10 Vdc, T_A = 25°C)

FIGURE 5 – FORWARD TRANSFER ADMITTANCE

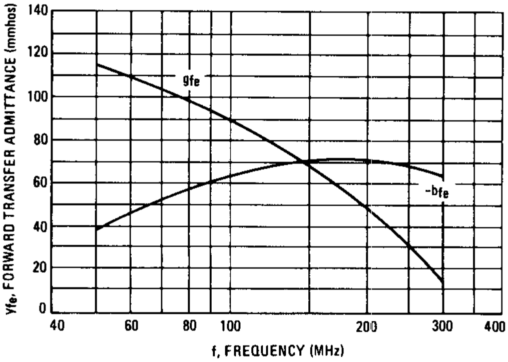


FIGURE 6 – OUTPUT ADMITTANCE

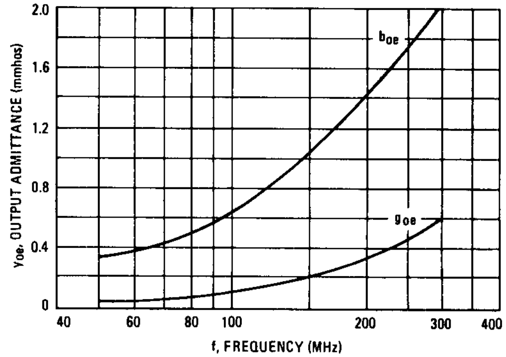


FIGURE 7 – CURRENT-GAIN–BANDWIDTH PRODUCT

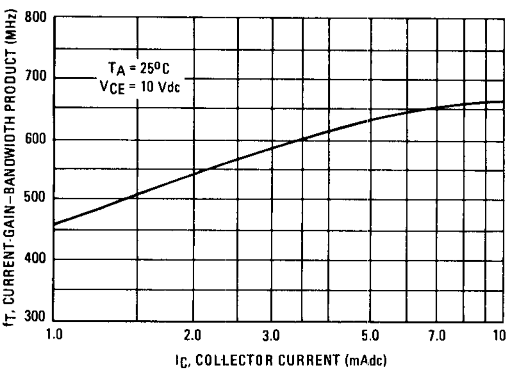


FIGURE 8 – CAPACITANCES

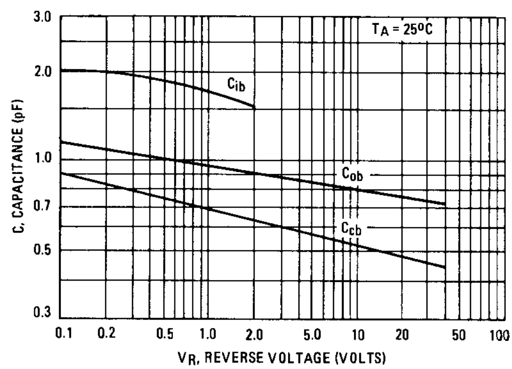
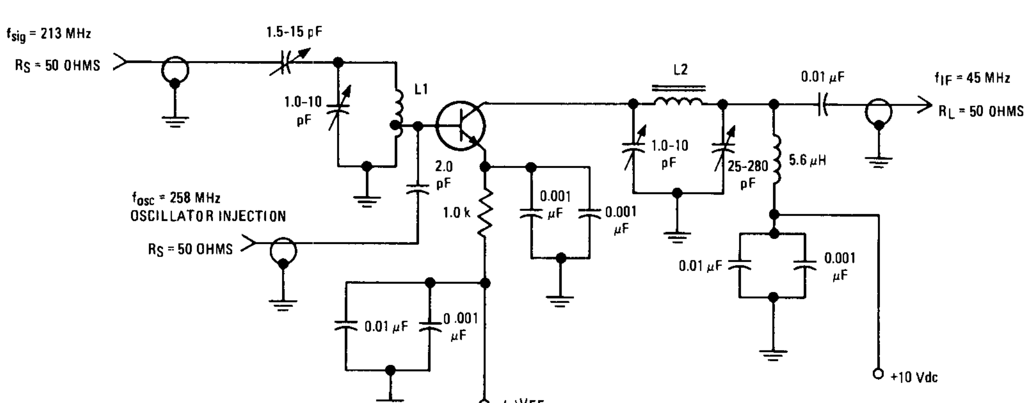


FIGURE 9 – MIXER TEST CIRCUIT



L1 = 3 TURNS #18 ENAMELED WIRE,
1/4" I.D., AIR WOUND, WINDING LENGTH 1/2";
BASE TAPPED 1 TURN FROM GROUND.

L2 = 10 TURNS #26 INSULATED WIRE, WOUND
ON 1/4" I.D. COIL FORM, ARNOLD PART
NO. A1-10 IRON POWDER CORE.

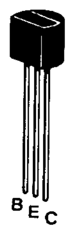
MPS-H30 (SILICON)
MPS-H31

NPN SILICON ANNULAR TRANSISTORS

. . . designed for first and second video IF stages in TV receivers.

- Guaranteed Noise Figure — NF = 6.0 dB (Max) at 45 MHz
- Guaranteed AGC Characteristics
- Complete y-Parameter Curves at 45 MHz
- Guaranteed Power Gain — G_{pe} = 22.5 dB (Min) (Unneutralized) at 45 MHz

NPN SILICON IF AMPLIFIER TRANSISTORS

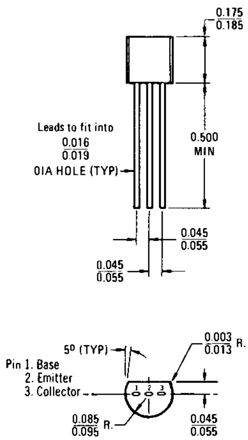


MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	20	Vdc
Collector-Base Voltage	V_{CB}	20	Vdc
Emitter-Base Voltage	V_{EB}	3.0	Vdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	310 2.81	mW mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	-55 to +135	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	θ_{JA}	0.357	°C/mW



CASE 29 (2)
TO-92

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Max	Unit
Collector-Emitter Breakdown Voltage (I_C = 1.0 mAdc, I_B = 0)	BV_{CEO}	20	-	Vdc
Collector-Base Breakdown Voltage (I_C = 100 μAdc, I_E = 0)	BV_{CBO}	20	-	Vdc
Emitter-Base Breakdown Voltage (I_E = 100 μAdc, I_C = 0)	BV_{EBO}	3.0	-	Vdc
Collector Cutoff Current (V_{CB} = 10 Vdc, I_E = 0)	I_{CBO}	-	50	nAdc
ON CHARACTERISTICS				
DC Current Gain (I_C = 4.0 mAdc, V_{CE} = 5.0 Vdc)	h_{FE}	20	200	-
Collector-Emitter Saturation Voltage (I_C = 10 mAdc, I_B = 5.0 mAdc)	$V_{CE(sat)}$	0.1	3.0	Vdc
Base-Emitter Saturation Voltage (I_C = 10 mAdc, I_B = 5.0 mAdc)	$V_{BE(sat)}$	-	0.96	Vdc
SMALL-SIGNAL CHARACTERISTICS				
Current-Gain—Bandwidth Product (I_C = 4.0 mAdc, V_{CE} = 10 Vdc, f = 100 MHz)	f_T	300	800	MHz
Collector-Base Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 1.0 MHz, emitter guarded)	C_{cb}	-	0.65	pF
Noise Figure (V_{AGC} = 2.75 Vdc, R_S = 50 ohms, f = 45 MHz, Figure 9)	NF	-	6.0	dB
FUNCTIONAL TESTS				
Power Gain (V_{AGC} = 2.75 Vdc, R_S = 50 ohms, f = 45 MHz, Figure 9)	G_{pe}	22.5	31	dB
Forward AGC Voltage (Gain Reduction = 30 dB, R_S = 50 ohms, f = 45 MHz, Figure 9) MPS-H30 MPS-H31	V_{AGC}	4.4 5.2	5.4 6.2	Vdc

AGC CHARACTERISTICS

V_{CC} = 12 Vdc, R_S = 50 Ohms, f = 45 MHz, See Figure 9

FIGURE 1 — POWER GAIN

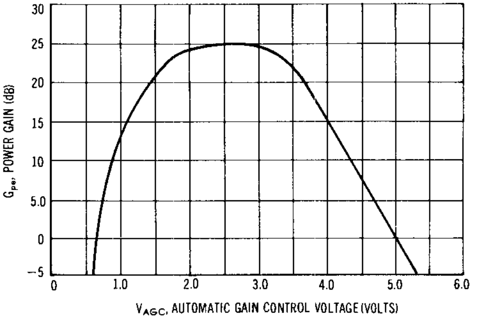
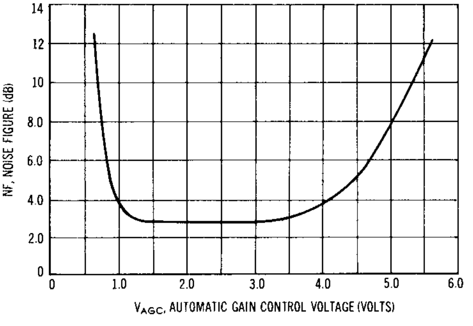


FIGURE 2 — NOISE FIGURE



COMMON-EMITTER y PARAMETERS

V_{CE} = 12 Vdc, T_A = 25°C, f = 45 MHz

FIGURE 3 — INPUT ADMITTANCE

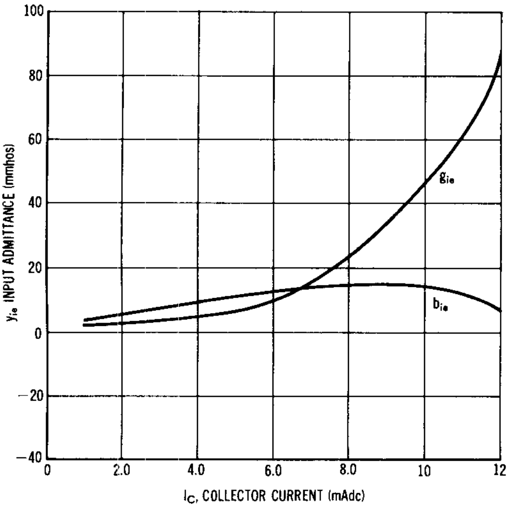


FIGURE 4 — REVERSE TRANSFER ADMITTANCE

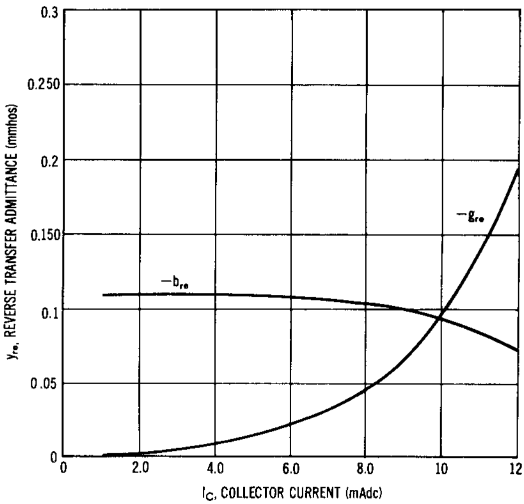


FIGURE 5 — FORWARD TRANSFER ADMITTANCE

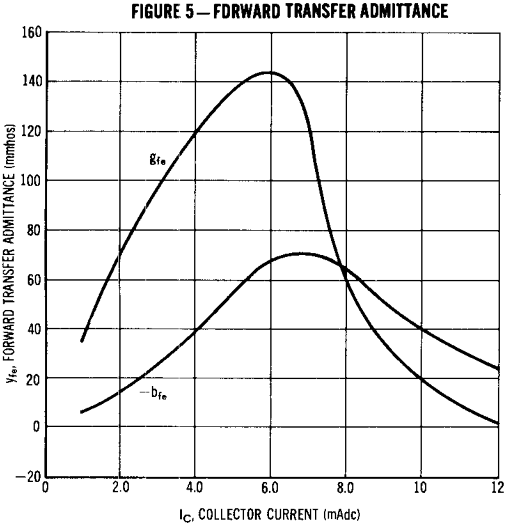


FIGURE 6 — OUTPUT ADMITTANCE

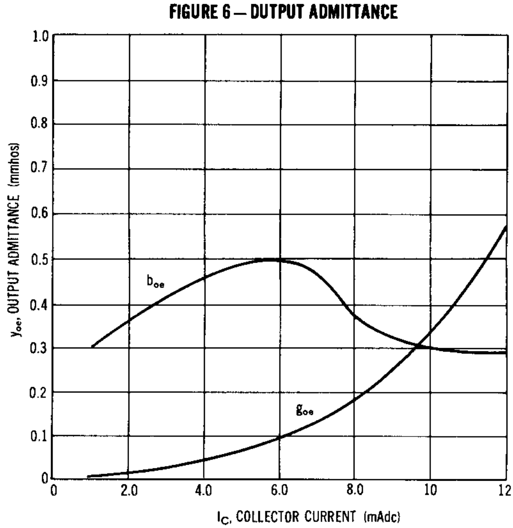


FIGURE 7 — DC CURRENT GAIN

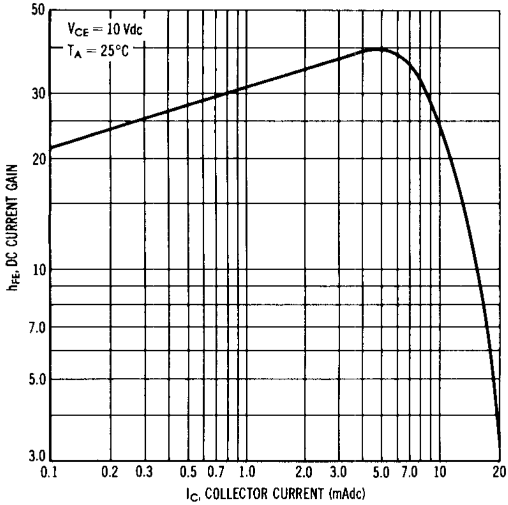


FIGURE 8 — COLLECTOR-BASE CAPACITANCE

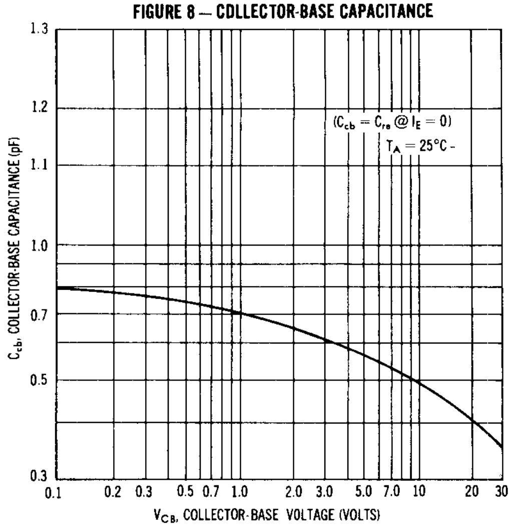
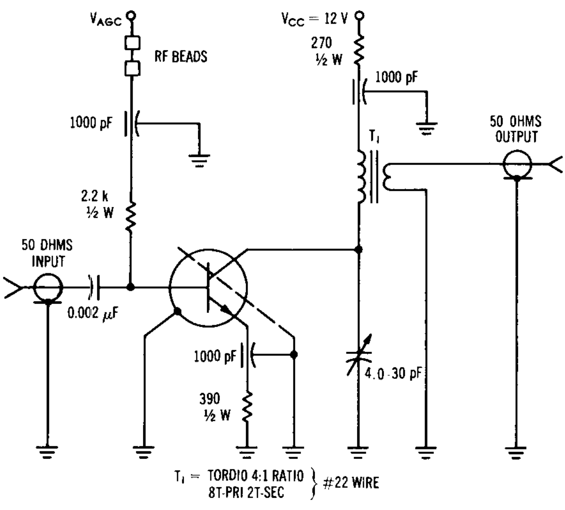


FIGURE 9 — 45 MHz FUNCTIONAL TEST CIRCUIT (UNNEUTRALIZED)



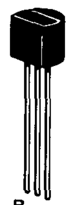
MPS-H32 (SILICON)

NPN SILICON ANNULAR TRANSISTOR

. . . designed for first and second video IF stages in TV receivers.

- Low Collector-Base Capacitance – C_{cb} = 0.22 pF (Max)
- Maximum Unilateralized Power Gain –
  G_{um} = 44 dB (Typ)
- Low Noise Figure – NF = 3.3 dB (Typ) @ f = 45 MHz
- Forward AGC Characteristics
- Complete y-Parameter Curves at 45 MHz
- Guaranteed Power Gain –
  G_{pe} = 22.5 dB (Min) (Unneutralized) @ f = 45 MHz

NPN SILICON
VHF TRANSISTOR

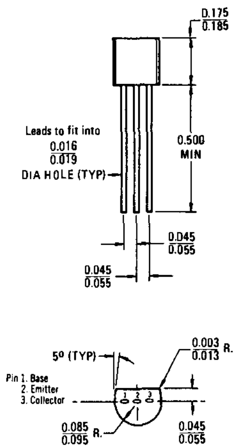


MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	30	Vdc
Collector-Base Voltage	V_{CB}	40	Vdc
Emitter-Base Voltage	V_{EB}	4.0	Vdc
Total Device Dissipation @ $T_A = 25°C$ Derate above 25°C	P_D	500 4.54	mW mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	-55 to +135	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	θ_{JC}	0.137	°C/mW
Thermal Resistance, Junction to Ambient	θ_{JA}	0.220	°C/mW



CASE 29 (2)
TO-92

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 1.0 mAdc, I_B = 0)	BV_{CEO}	30	–	–	Vdc
Collector-Base Breakdown Voltage (I_C = 100 μAdc, I_E = 0)	BV_{CBO}	40	–	–	Vdc
Emitter-Base Breakdown Voltage (I_E = 100 μAdc, I_C = 0)	BV_{EBO}	4.0	–	–	Vdc
Collector Cutoff Current (V_{CB} = 10 Vdc, I_E = 0)	I_{CBO}	–	–	50	nAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 4.0 mAdc, V_{CE} = 5.0 Vdc)	h_{FE}	27	35	200	–
Collector-Emitter Saturation Voltage (I_C = 10 mAdc, I_B = 5.0 mAdc)	$V_{CE(sat)}$	–	1.5	3.0	Vdc
Base-Emitter Saturation Voltage (I_C = 10 mAdc, I_B = 5.0 mAdc)	$V_{BE(sat)}$	–	0.9	1.2	Vdc
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain—Bandwidth Product (I_C = 4.0 mAdc, V_{CE} = 10 Vdc, f = 100 MHz)	f_T	300	440	–	MHz
Collector-Base Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 1.0 MHz) (Emitter Guarded)	C_{cb}	–	0.2	0.22	pF
Noise Figure (Figure 10) ($I_E \approx$ 4.0 mAdc, $V_{CE} \approx$ 9.3 Vdc, V_{AGC} = 2.75 Vdc, R_S = 50 Ohms, f = 45 MHz)	NF	–	3.3	–	dB
FUNCTIONAL TEST					
Common-Emitter Amplifier Power Gain (Figure 10) ($I_E \approx$ 4.0 mAdc, $V_{CE} \approx$ 9.3 Vdc, V_{AGC} = 2.75 Vdc, R_S = 50 Ohms, f = 45 MHz)	G_{pe}	22.5	25	–	dB
Forward AGC Voltage (Figure 10) (Gain Reduction = 30 dB, R_S = 50 Ohms, f = 45 MHz)	V_{AGC}	–	5.5	–	Vdc

SUMMARY-COMMON EMITTER y PARAMETERS (V_{CE} = 10 Vdc, I_C = 4.0 mAdc, f = 45 MHz)

Input Conductance	g_{ie}	–	6.0	–	mmhos
Input Capacitance	C_{ie}	–	33	–	pF
Forward Transfer Admittance Magnitude	$\|y_{fe}\|$	–	110	–	mmhos
Forward Transfer Admittance Phase Angle	$\angle y_{fe}$	–	-22	–	Degrees
Feedback Capacitance	C_{re}	–	0.2	–	pF
Output Conductance	g_{oe}	–	20	–	μmhos
Output Capacitance	C_{oe}	–	1.4	–	pF
Maximum Unilateralized Power Gain $G_{um} = \frac{\|y_{fe}\|^2}{4\, g_{ie}\, g_{oe}}$	G_{um}	–	44	–	dB

AGC CHARACTERISTICS

V_{CC} = 12 Vdc, R_S = 50 Ohms, f = 45 MHz, See Figure 10

FIGURE 1 – POWER GAIN

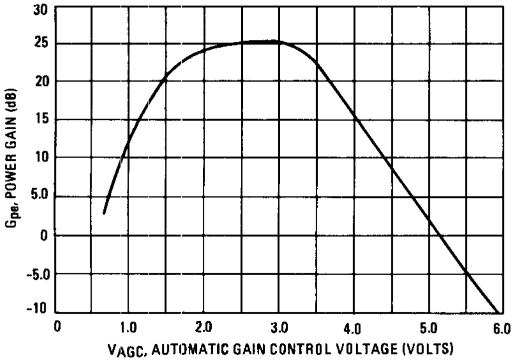
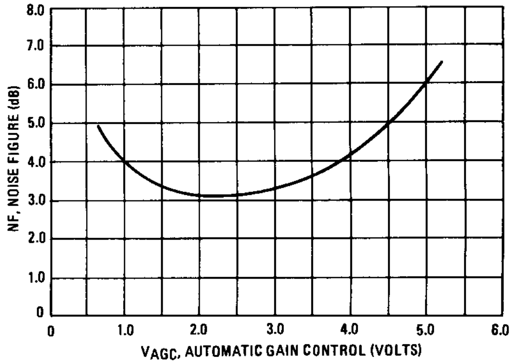


FIGURE 2 – NOISE FIGURE



COMMON-EMITTER y PARAMETERS

V_{CE} = 10 Vdc, f = 45 MHz, T_A = 25°C

FIGURE 3 – INPUT ADMITTANCE

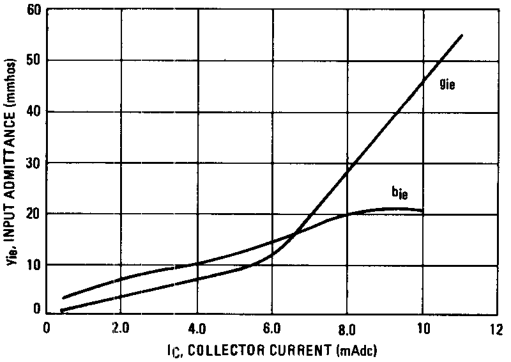


FIGURE 4 – REVERSE TRANSFER ADMITTANCE

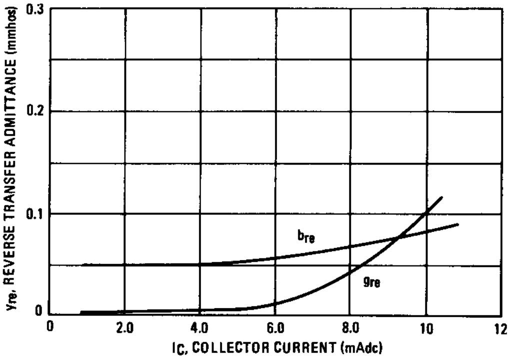


FIGURE 5 – FORWARD TRANSFER ADMITTANCE

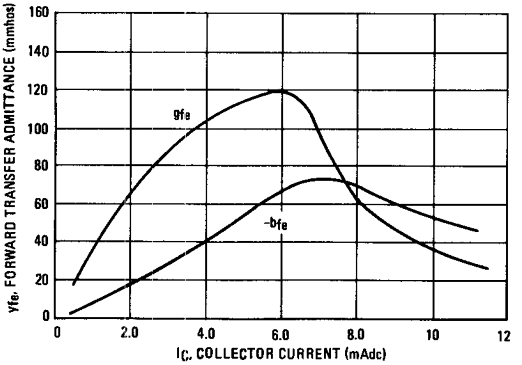


FIGURE 6 – OUTPUT ADMITTANCE

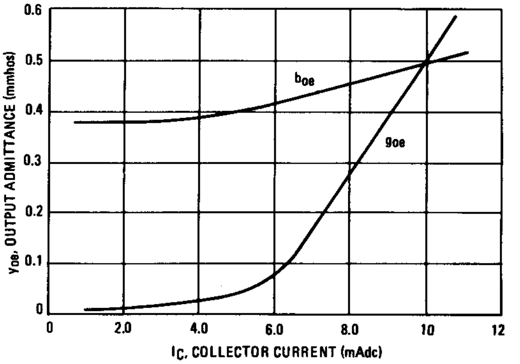


FIGURE 7 – DC CURRENT GAIN

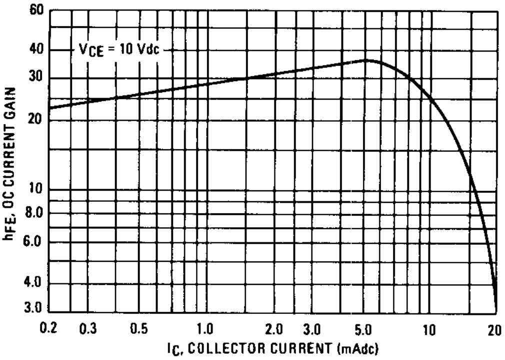


FIGURE 8 – COLLECTOR-BASE CAPACITANCE

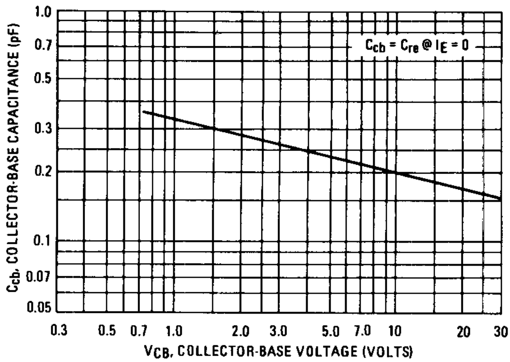


FIGURE 9 – CURRENT-GAIN–BANDWIDTH PRODUCT

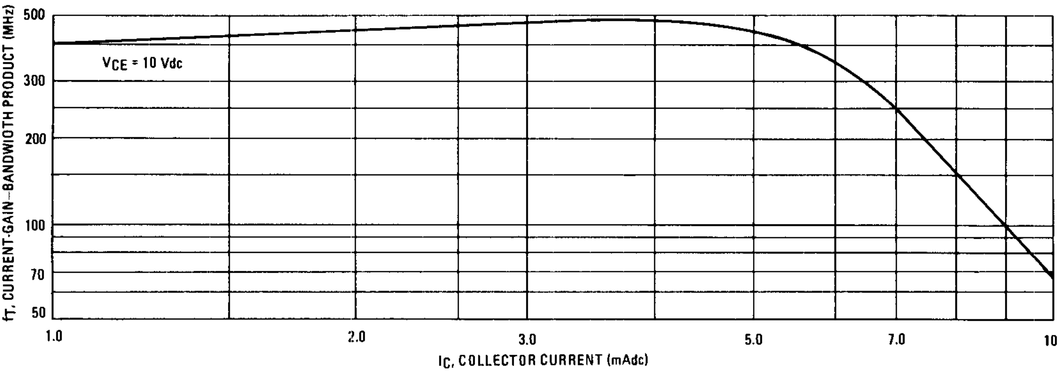
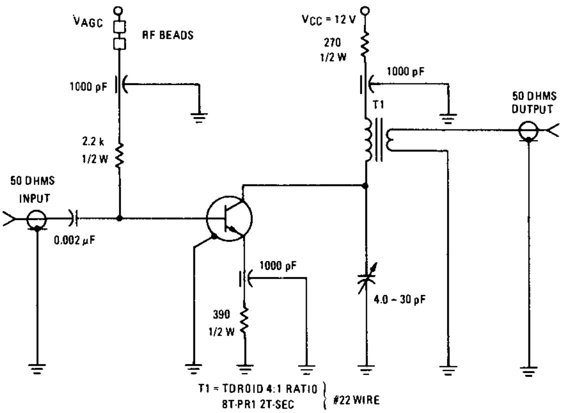


FIGURE 10 – 45 MHz FUNCTIONAL TEST CIRCUIT (UNNEUTRALIZED)



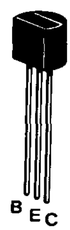
MPS-H37 (SILICON)

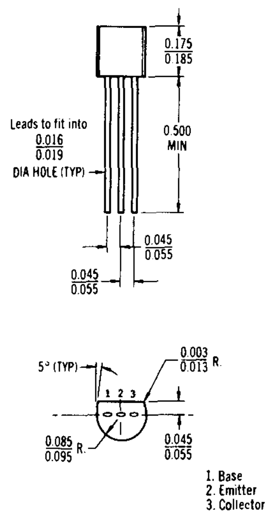
NPN SILICON ANNULAR TRANSISTOR

. . . designed for 4.5 MHz sound IF applications in TV receivers.

- High Breakdown Voltage —
  BV_{CEO} = 40 V (Min) @ I_C = 1.0 mAdc
- High Output Resistance @ 4.5 MHz —
  R_{oep} = 100 k Ohms (Min) @ I_C = 2.0 mAdc
- Low Reverse Feedback Capacitance —
  C_{re} = 0.7 pF (Max) @ V_{CB} = 10 Vdc
- Complete y-Parameter Curves @ 4.5 MHz

NPN SILICON IF AMPLIFIER TRANSISTOR





CASE 29 (2)
TO-92

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	40	Vdc
Emitter-Base Voltage	V_{EB}	5.0	Vdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	310 2.81	mW mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	-55 to +135	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	θ_{JA}	0.357	°C/mW

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage (I_C = 1.0 mAdc, I_E = 0)	BV_{CEO}	40	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)	BV_{EBO}	5.0	—	Vdc
Collector Cutoff Current (V_{CB} = 35 Vdc, I_E = 0)	I_{CBO}	—	0.5	μAdc
ON CHARACTERISTICS				
DC Current Gain (I_C = 5.0 mAdc, V_{CE} = 10 Vdc)	h_{FE}	25	—	—
Collector-Emitter Saturation Voltage (I_C = 10 mAdc, I_B = 1.0 mAdc)	$V_{CE(sat)}$	—	0.5	Vdc
Base-Emitter On Voltage (I_C = 5.0 mAdc, V_{CE} = 10 Vdc)	$V_{BE(on)}$	—	0.9	Vdc
DYNAMIC CHARACTERISTICS				
Current-Gain—Bandwidth Product (I_C = 5.0 mAdc, V_{CE} = 10 Vdc, f = 100 MHz)	f_T	300	—	MHz
Common-Emitter Reverse Transfer Capacitance (V_{CB} = 10 Vdc, I_E = 0)	C_{re}	—	0.7	pF
Output Resistance (I_C = 2.0 mAdc, V_{CE} = 10 Vdc, f = 4.5 MHz)	R_{oep}	100	—	k ohms

COMMON-EMITTER y PARAMETERS

f = 4.5 MHz, T_A = 25°C

FIGURE 1 — INPUT ADMITTANCE

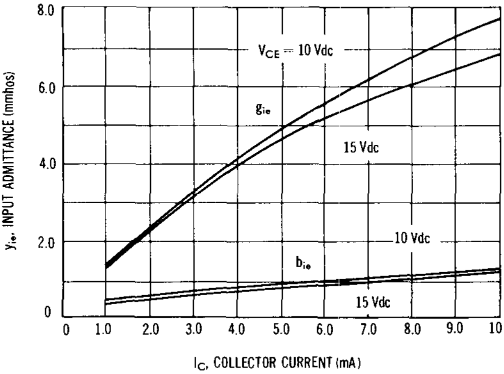


FIGURE 2 — REVERSE TRANSFER ADMITTANCE

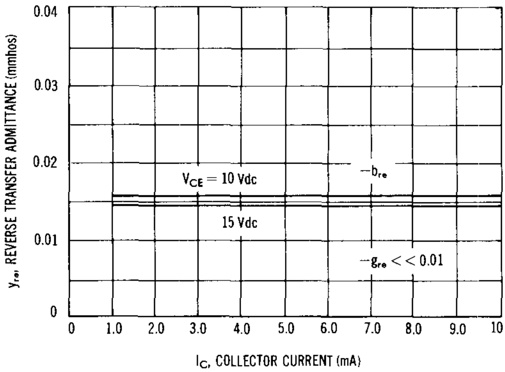


FIGURE 3 — FORWARD TRANSFER ADMITTANCE

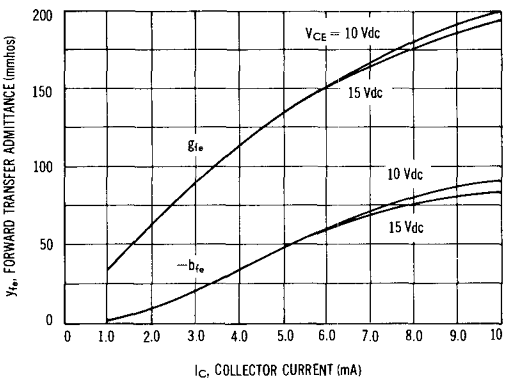


FIGURE 4 — OUTPUT ADMITTANCE

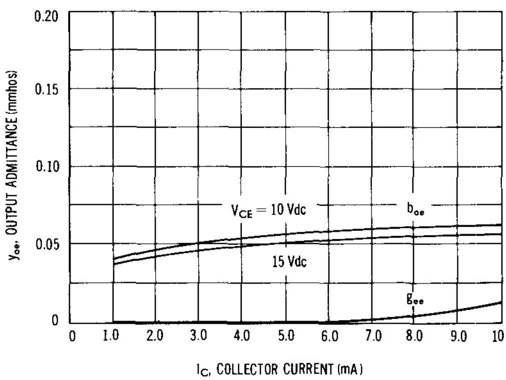


FIGURE 5 — CAPACITANCES

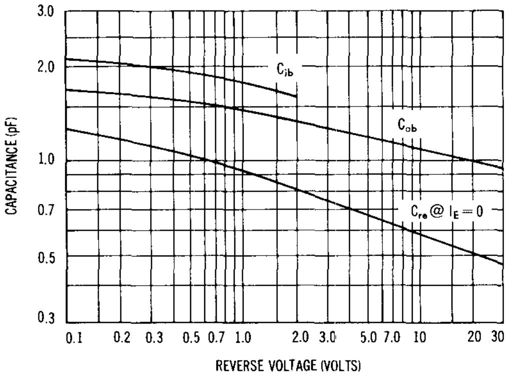
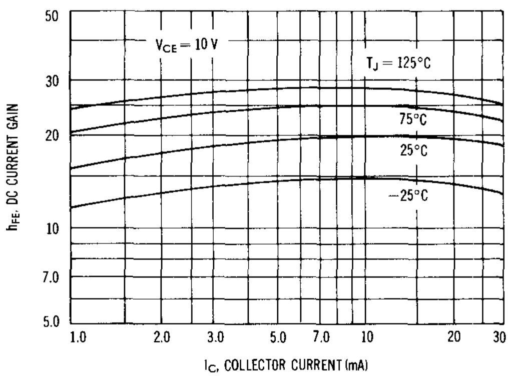


FIGURE 6 — DC CURRENT GAIN



MPS-L01 (SILICON)

NPN SILICON ANNULAR TRANSISTOR

. . . designed for general-purpose, high-voltage amplifier applications.

- High Breakdown Voltages – BV_{CEO} = 120 Vdc (Min), BV_{CBO} = 140 Vdc (Min)
- Low Saturation Voltage $V_{CE(sat)}$ = 0.30 V (max) @ I_C = 50 mA
- One-Piece, Injection-Molded Unibloc Package for High Reliability

HIGH VOLTAGE

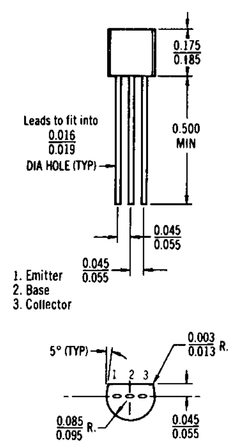
NPN SILICON AMPLIFIER TRANSISTOR

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	120	Vdc
Collector-Base Voltage	V_{CB}	140	Vdc
Emitter-Base Voltage	V_{EB}	5.0	Vdc
Collector Current – Continuous	I_C	600	mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	310 2.81	mW mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	–55 to +135	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	θ_{JA}	0.357	°C/mW



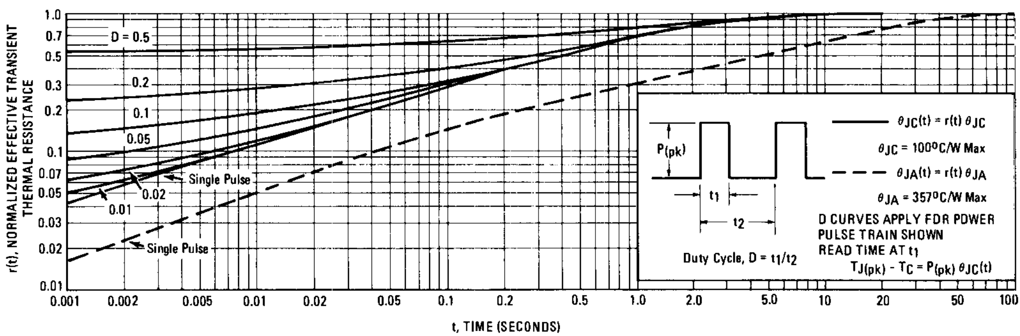
CASE 29 (1)
TO-92

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage* (I_C = 1.0 mAdc, I_B = 0)	BV_{CEO}*	120	–	Vdc
Collector-Base Breakdown Voltage (I_C = 100 μAdc, I_E = 0)	BV_{CBO}	140	–	Vdc
Emitter-Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)	BV_{EBO}	5.0	–	Vdc
Collector Cutoff Current (V_{CB} = 75 Vdc, I_E = 0)	I_{CBO}	–	1.0	μAdc
Emitter Cutoff Current (V_{EB} = 4.0 Vdc, I_C = 0)	I_{EBO}	–	100	nAdc
ON CHARACTERISTICS				
DC Current Gain* (I_C = 10 mAdc, V_{CE} = 5.0 Vdc)	h_{FE}*	50	300	–
Collector-Emitter Saturation Voltage (I_C = 10 mAdc, I_B = 1.0 mAdc) (I_C = 50 mAdc, I_B = 5.0 mAdc)	$V_{CE(sat)}$	– –	0.20 0.30	Vdc
Base-Emitter Saturation Voltage (I_C = 10 mAdc, I_B = 1.0 mAdc) (I_C = 50 mAdc, I_B = 5.0 mAdc)	$V_{BE(sat)}$	– –	1.2 1.4	Vdc
DYNAMIC CHARACTERISTICS				
Current-Gain—Bandwidth Product (I_C = 10 mAdc, V_{CE} = 10 Vdc, f = 100 MHz)	f_T	60	–	MHz
Output Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	–	8.0	pF
Small-Signal Current Gain (I_C = 1.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)	h_{fe}	30	–	–

*Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

FIGURE 1 — THERMAL RESPONSE



h PARAMETERS

(V_{CE} = 10 Vdc, f = 1.0 kHz, T_A = 25°C)

FIGURE 2 – CURRENT GAIN

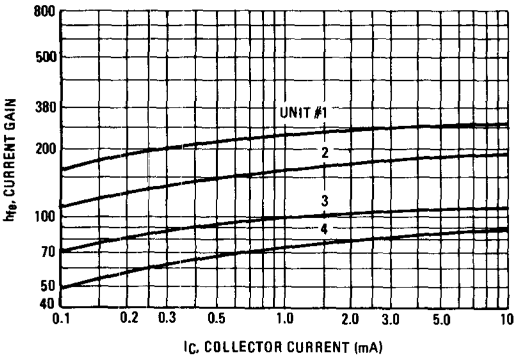


FIGURE 3 – OUTPUT ADMITTANCE

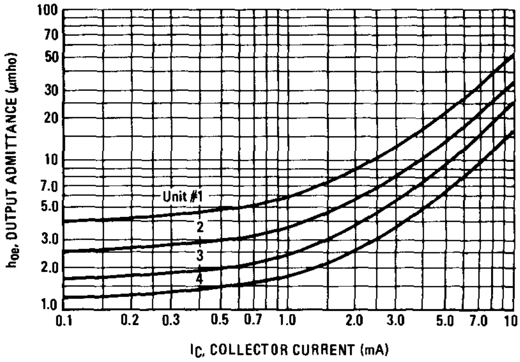


FIGURE 4 – INPUT IMPEDANCE

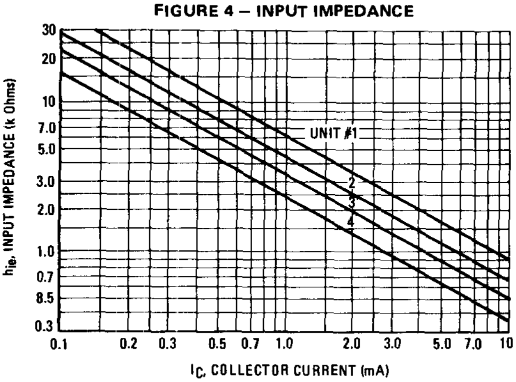


FIGURE 5 – VOLTAGE FEEDBACK RATIO

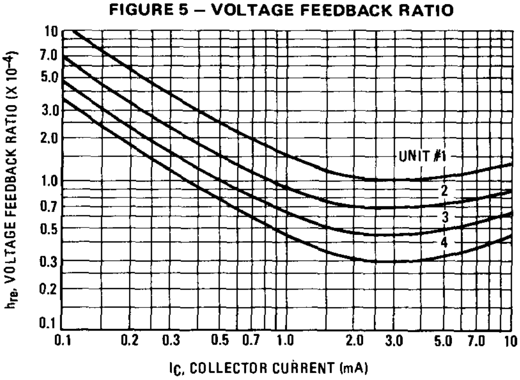
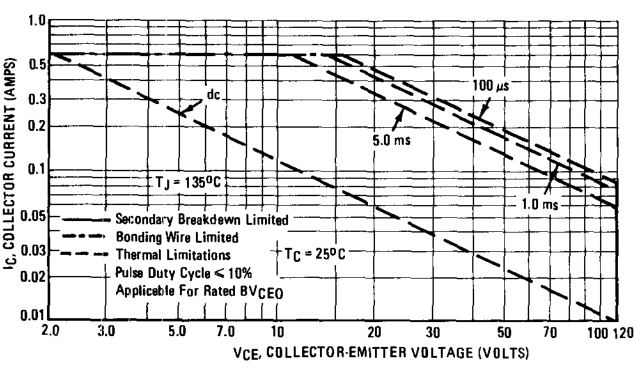


FIGURE 6 – ACTIVE REGION SAFE OPERATING AREA



There are two limitations on the power handling ability of a transistor: junction temperature and secondary breakdown. Safe operating area curves indicate I_C–V_{CE} limits of the transistor that must be observed for reliable operation; i.e., the transistor must not be subjected to greater dissipation than the curves indicate.

The data of Figure 6 is based on $T_{J(pk)}$ = 135°C; T_C is variable depending on conditions. Pulse curves are valid for duty cycles of 10% provided $T_{J(pk)} \leq$ 135°C. $T_{J(pk)}$ may be calculated from the data in Figure 1. At high case temperatures, thermal limitations will reduce the power that can be handled to values less than the limitations imposed by secondary breakdown.

FIGURE 7 – DC CURRENT GAIN

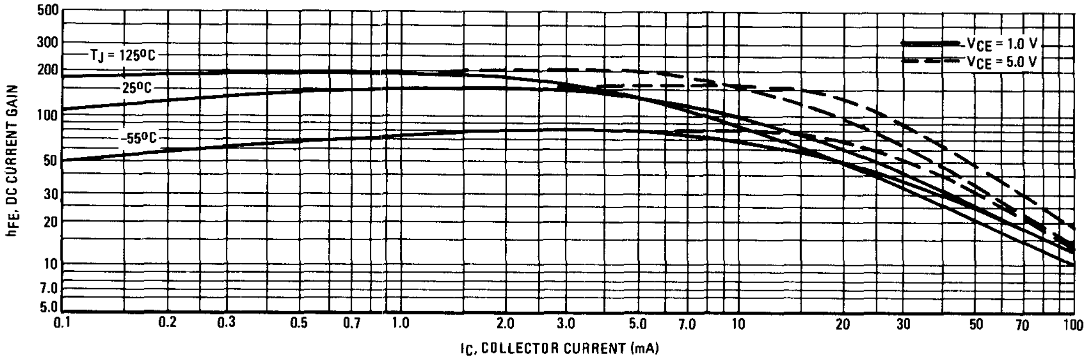


FIGURE 8 – COLLECTOR SATURATION REGION

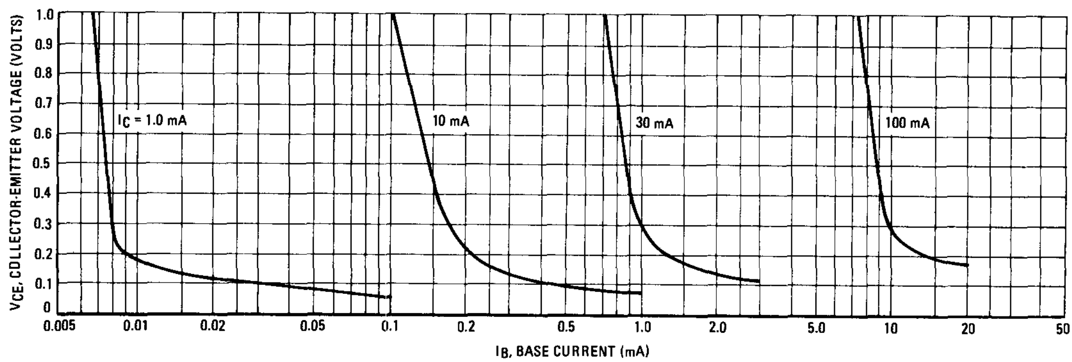


FIGURE 9 – COLLECTOR CUT-OFF REGION

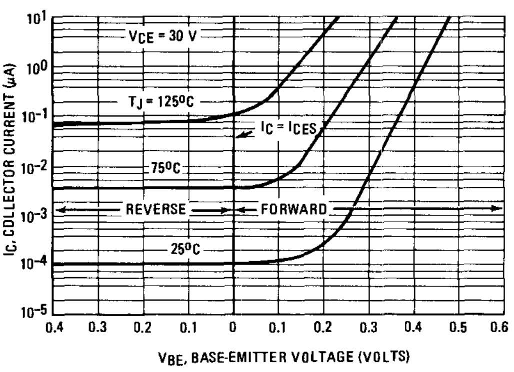


FIGURE 10 – EFFECTS OF BASE-EMITTER RESISTANCE

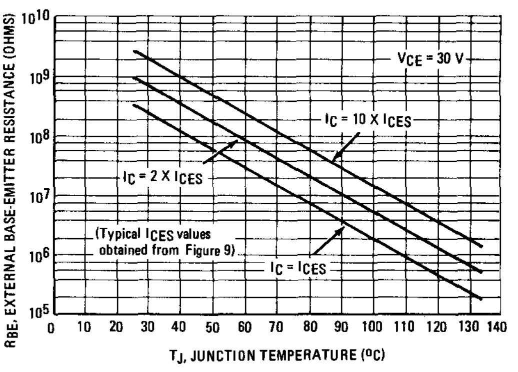


FIGURE 11 – "ON" VOLTAGES

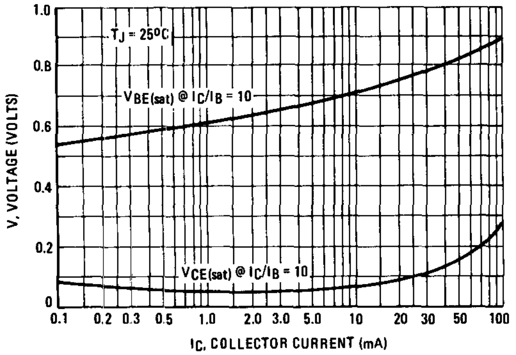


FIGURE 12 – TEMPERATURE COEFFICIENTS

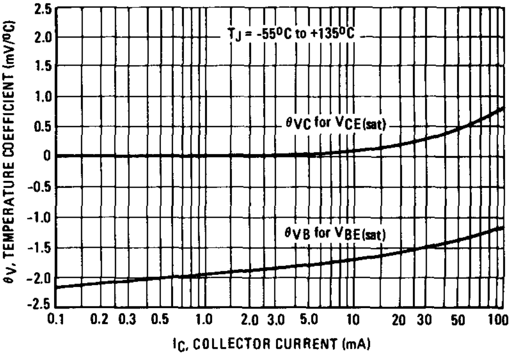


FIGURE 13 – SWITCHING TIME TEST CIRCUIT

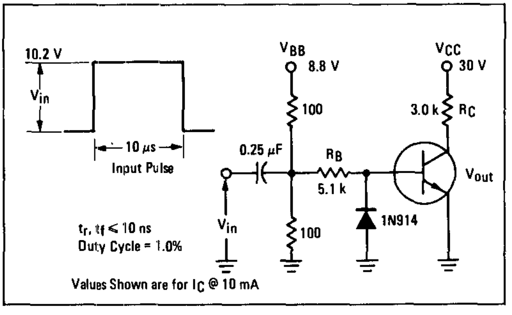


FIGURE 14 – CAPACITANCES

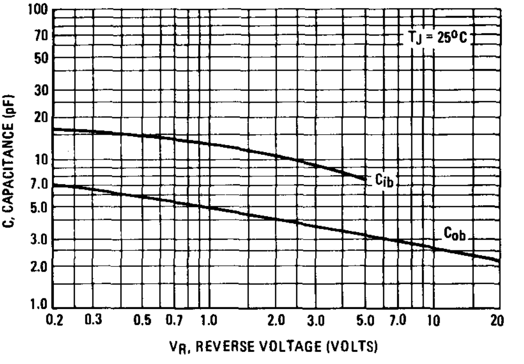


FIGURE 15 – TURN-ON TIME

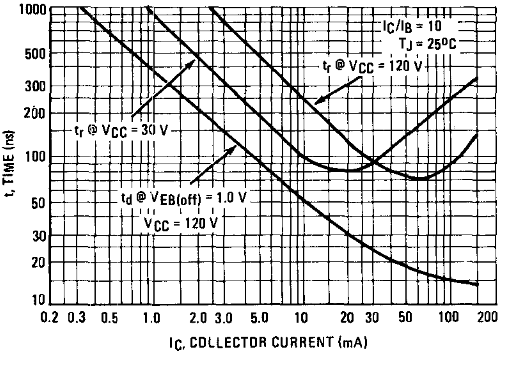
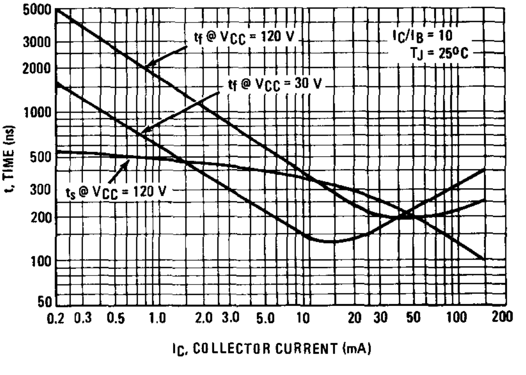


FIGURE 16 – TURN-OFF TIME



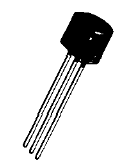
MPS-L07 (SILICON)
MPS-L08

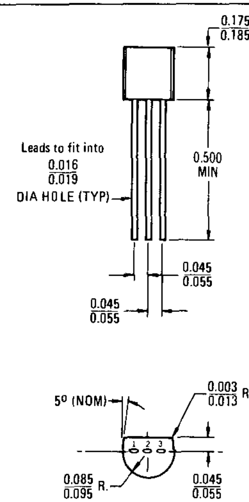
PNP SILICON ANNULAR TRANSISTORS

. . . designed for high-speed saturated switching applications.

- Fast Switching Time –
  $t_{on} + t_{off}$ = 50 ns (Typ) @ I_C = 10 mAdc
- Low Storage Time –
  τ_s = 15 ns (Max) @ I_C = 10 mAdc (MPS-L07)
  = 20 ns (Max) @ I_C = 10 mAdc (MPS-L08)
- Low Collector-Emitter Saturation Voltage –
  $V_{CE(sat)}$ = 0.07 Vdc (Typ) @ I_C = 10 mAdc
- High Current-Gain–Bandwidth Product –
  f_T = 500 MHz (Min) @ 10 mA (MPS-L07)
  = 700 MHz (Min) @ 10 mA (MPS-L08)

PNP SILICON SWITCHING TRANSISTORS





CASE 29 (1)
TO-92

MAXIMUM RATINGS

Rating	Symbol	MPS-L07	MPS-L08	Unit
Collector-Emitter Voltage	V_{CEO}	6.0	12	Vdc
Collector-Base Voltage	V_{CB}	6.0	12	Vdc
Emitter-Base Voltage	V_{EB}	4.5		Vdc
Collector Current – Continuous	I_C	80		mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	310 2.81		mW mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	-55 to +135		°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	θ_{JA}	0.357	°C/mW

FIGURE 1 – TURN-ON AND TURN-OFF TEST CIRCUIT

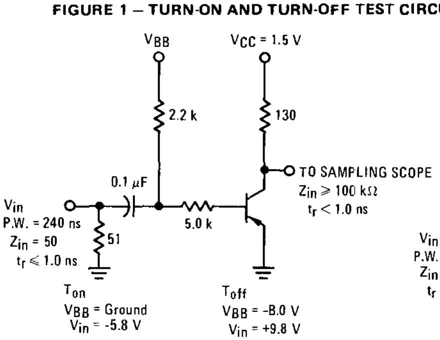
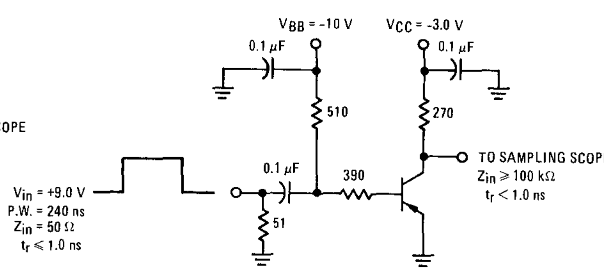


FIGURE 2 – CHARGE STORAGE TIME TEST CIRCUIT



MPS-L07, MPS-L08 (continued)

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Collector-Emitter Sustaining Voltage		$V_{CEO(sus)}$				Vdc
(I_C = 3.0 mAdc, I_B = 0)	MPS-L07		6.0	–	–	
	MPS-L08		12	–	–	
Collector-Emitter Breakdown Voltage		BV_{CES}				Vdc
(I_C = 100 μAdc, V_{BE} = 0)	MPS-L07		6.0	–	–	
	MPS-L08		12	–	–	
Collector-Base Breakdown Voltage		BV_{CBO}				Vdc
(I_C = 100 μAdc, I_E = 0)	MPS-L07		6.0	–	–	
	MPS-L08		12	–	–	
Emitter-Base Breakdown Voltage (I_E = 100 μAdc, I_C = 0)		$8V_{EBO}$	4.5	–	–	Vdc
Collector Cutoff Current		I_{CES}				nAdc
(V_{CE} = 3.0 Vdc, V_{BE} = 0)	MPS-L07		–	1.0	10	
(V_{CE} = 6.0 Vdc, V_{BE} = 0)	MPS-L08		–	1.0	10	
(V_{CE} = 3.0 Vdc, V_{BE} = 0, T_A = 65°C)	MPS-L07		–	–	5.0	μAdc
(V_{CE} = 6.0 Vdc, V_{BE} = 0, T_A = 65°C)	MPS-L08		–	–	5.0	
Base Current		I_B				nAdc
(V_{CE} = 3.0 Vdc, V_{BE} = 0)	MPS-L07		–	–	10	
(V_{CE} = 6.0 Vdc, V_{BE} = 0)	MPS-L08		–	–	10	
ON CHARACTERISTICS						
DC Current Gain		h_{FE}				–
(I_C = 1.0 mAdc, V_{CE} = 0.5 Vdc)			15	40	–	
(I_C = 10 mAdc, V_{CE} = 3.0 Vdc)			30	50	120	
(I_C = 50 mAdc, V_{CE} = 1.0 Vdc)			30	35	–	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$				Vdc
(I_C = 10 mAdc, I_B = 1.0 mAdc)			–	0.07	0.15	
(I_C = 50 mAdc, I_B = 5.0 mAdc)			–	0.2	0.5	
Base-Emitter Saturation Voltage		$V_{BE(sat)}$				Vdc
(I_C = 10 mAdc, I_B = 1.0 mAdc)			0.73	0.79	0.88	
(I_C = 50 mAdc, I_B = 5.0 mAdc)			–	0.89	1.5	
DYNAMIC CHARACTERISTICS						
Current-Gain – Bandwidth Product		f_T				MHz
(I_C = 10 mAdc, V_{CE} = 5.0 Vdc, f = 100 MHz)	MPS-L07		500	1000	–	
(I_C = 10 mAdc, V_{CE} = 10 Vdc, f = 100 MHz)	MPS-L08		700	1200	–	
Output Capacitance (V_{CB} = 5.0 Vdc, I_E = 0, f = 140 kHz)		C_{ob}	–	1.9	3.0	pF
Input Capacitance (V_{BE} = 0.5 Vdc, I_C = 0, f = 140 kHz)		C_{ib}	–	3.6	5.0	pF
SWITCHING CHARACTERISTICS						
Turn-On Time	(I_C = 10 mAdc, I_{B1} = I_{B2} = 1.0 mAdc) (Figure 1)	t_{on}	–	15	20	ns
Turn-Off Time		t_{off}	–	35	40	ns
Charge Storage Time (Figure 2)		t_s				ns
(I_C = 10 mAdc, I_{B1} = I_{B2} = 10 mAdc)	MPS-L07		–	–	15	
	MPS-L08		–	–	20	

MPS-L51 (SILICON)

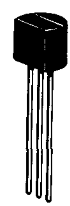
PNP SILICON ANNULAR TRANSISTOR

. . . designed for general-purpose, high-voltage amplifier applications.

- High Breakdown Voltages — BV_{CEO} = 100 Vdc (Min), BV_{CBO} = 100 Vdc (Min)
- Low Saturation Voltage $V_{CE(sat)}$ = 0.30 V (max) @ I_C = 50 mA
- One-Piece, Injection-Molded Unibloc Package for High Reliability

HIGH VOLTAGE

PNP SILICON AMPLIFIER TRANSISTOR

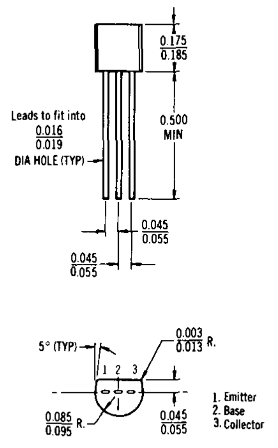


MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	100	Vdc
Collector-Base Voltage	V_{CB}	100	Vdc
Emitter-Base Voltage	V_{EB}	4.0	Vdc
Collector Current - Continuous	I_C	600	mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	310 2.81	mW mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +135	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	θ_{JA}	0.357	°C/mW



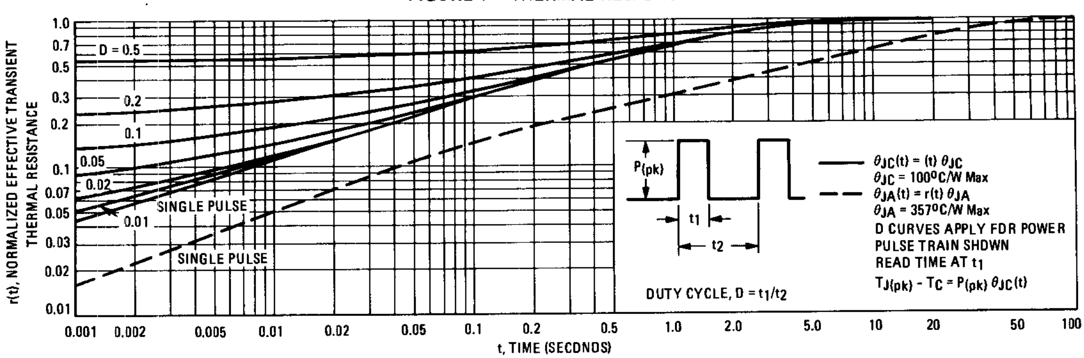
CASE 29 (1)
TO-92

ELECTRICAL CHARACTERISTICS ($T_A = 25^oC$ unless otherwise noted)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage* (I_C = 1.0 mAdc, I_B = 0)	BV_{CEO}*	100	–	Vdc
Collector-Base Breakdown Voltage (I_C = 100 μAdc, I_E = 0)	BV_{CBO}	100	–	Vdc
Emitter-Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)	BV_{EBO}	4.0	–	Vdc
Collector Cutoff Current (V_{CB} = 50 Vdc, I_E = 0)	I_{CBO}	–	1.0	μAdc
Emitter Cutoff Current (V_{BE} = 3.0 Vdc, I_C = 0)	I_{EBO}	–	100	nAdc
ON CHARACTERISTICS				
DC Current Gain* (I_C = 50 mAdc, V_{CE} = 5.0 Vdc)	h_{FE}*	40	250	–
Collector-Emitter Saturation Voltage (I_C = 10 mAdc, I_B = 1.0 mAdc) (I_C = 50 mAdc, I_B = 5.0 mAdc)	$V_{CE(sat)}$	–	0.25 0.30	Vdc
Base-Emitter Saturation Voltage (I_C = 10 mAdc, I_B = 1.0 mAdc) (I_C = 50 mAdc, I_B = 5.0 mAdc)	$V_{BE(sat)}$	–	1.2 1.2	Vdc
DYNAMIC CHARACTERISTICS				
Current-Gain-Bandwidth Product (I_C = 10 mAdc, V_{CE} = 10 Vdc, f = 100 MHz)	f_T	60	–	MHz
Output Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	–	8.0	pF
Small-Signal Current Gain (I_C = 1.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)	h_{fe}	20	–	–

*Pulse Test: Pulse Test = 300 μs. Duty Cycle = 2.0%

FIGURE 1 – THERMAL RESPONSE



h PARAMETERS

(V_{CE} = 10 Vdc, f = 1.0 kHz, T_A = 25°C)

FIGURE 2 – CURRENT GAIN

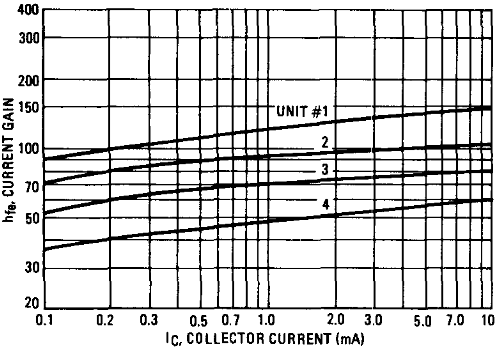


FIGURE 3 – OUTPUT ADMITTANCE

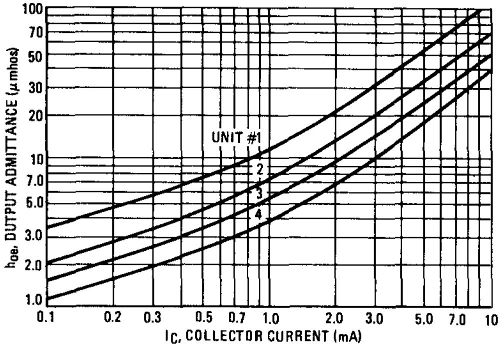


FIGURE 4 – INPUT IMPEDANCE

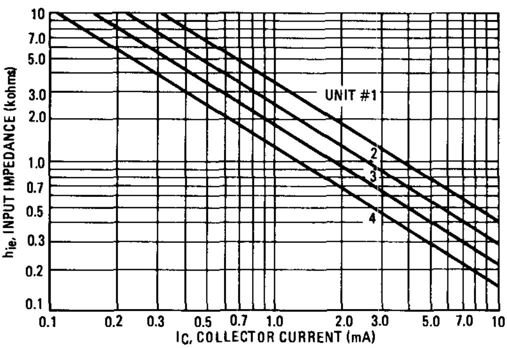


FIGURE 5 – VOLTAGE FEEDBACK RATIO

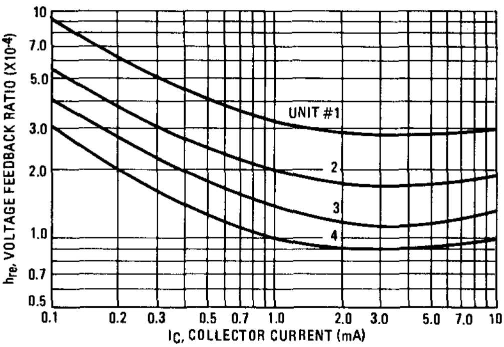
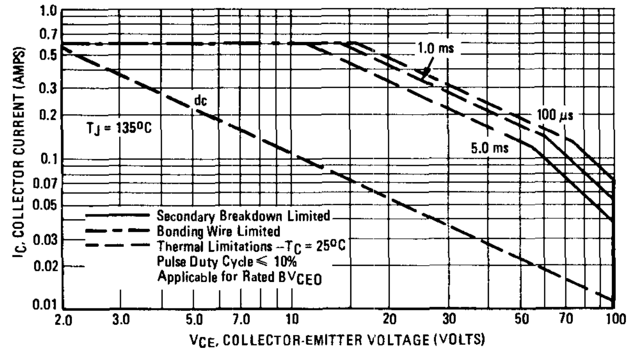


FIGURE 6 – ACTIVE REGION SAFE OPERATING AREA



There are two limitations on the power handling ability of a transistor: junction temperature and secondary breakdown. Safe operating area curves indicate I_C–V_{CE} limits of the transistor that must be observed for reliable operation; i.e., the transistor must not be subjected to greater dissipation than the curves indicate.

The data of Figure 6 is based on $T_{J(pk)}$ = 135°C; T_C is variable depending on conditions. Pulse curves are valid for duty cycles of 10% provided $T_{J(pk)} \leq 135°C$. $T_{J(pk)}$ may be calculated from the data in Figure 1. At high case temperatures, thermal limitations will reduce the power that can be handled to values less than the limitations imposed by secondary breakdown.

FIGURE 7 – DC CURRENT GAIN

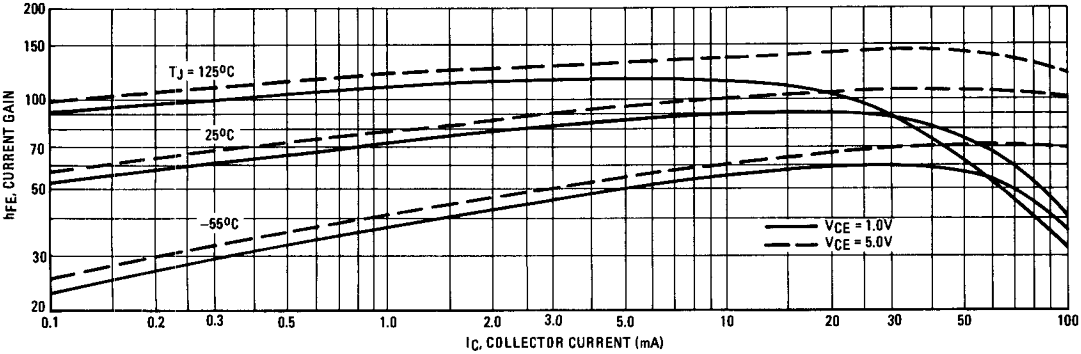


FIGURE 8 – COLLECTOR SATURATION REGION

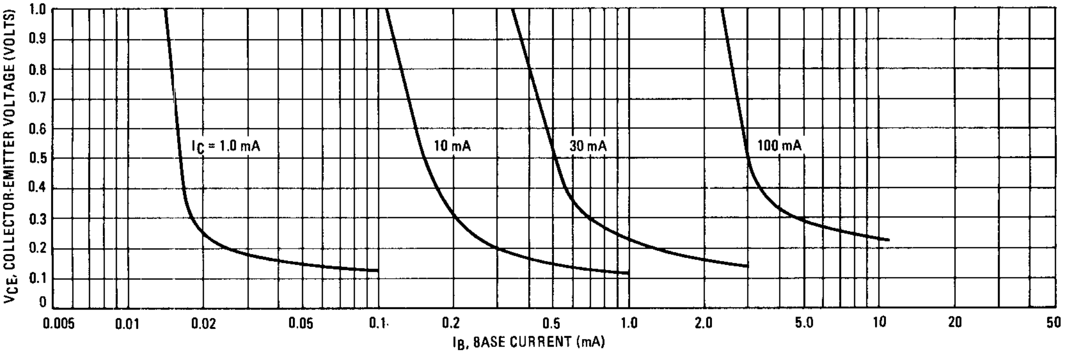


FIGURE 9 – COLLECTOR CUT-OFF REGION

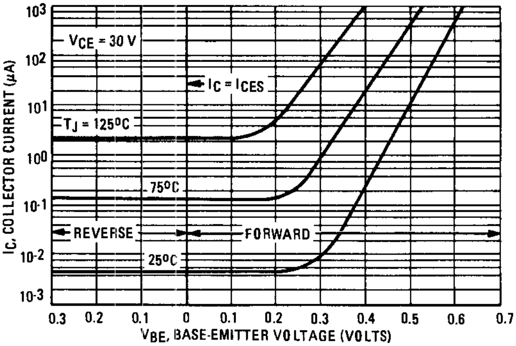


FIGURE 10 – EFFECTS OF BASE-EMITTER RESISTANCE

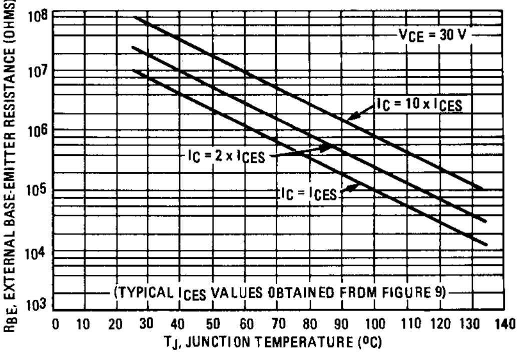


FIGURE 11 – "ON" VOLTAGES

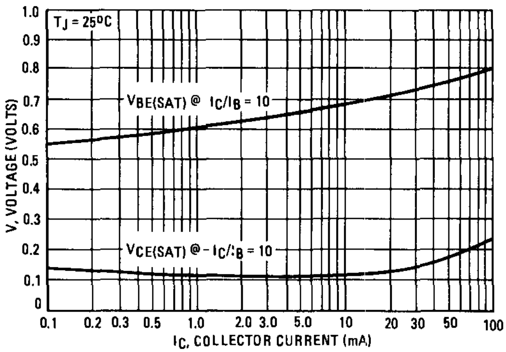


FIGURE 12 – TEMPERATURE COEFFICIENTS

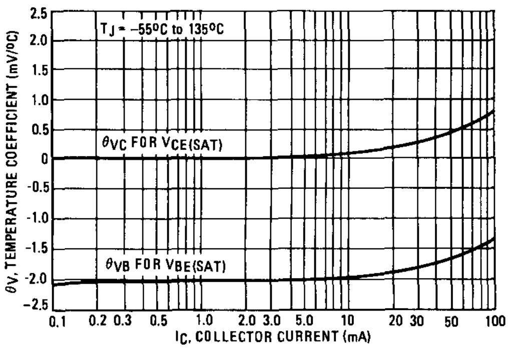


FIGURE 13 – SWITCHING TIME TEST CIRCUIT

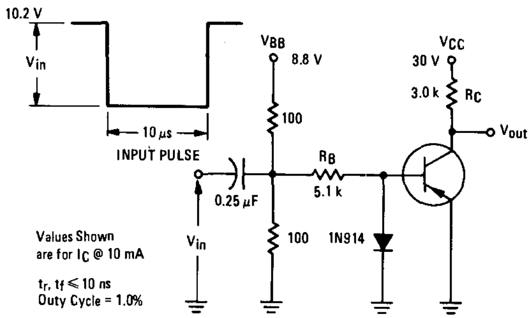


FIGURE 14 – CAPACITANCES

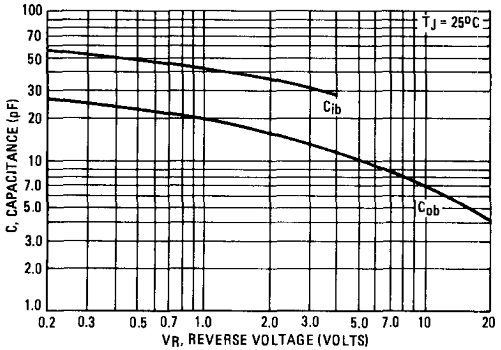


FIGURE 15 – TURN-ON TIME

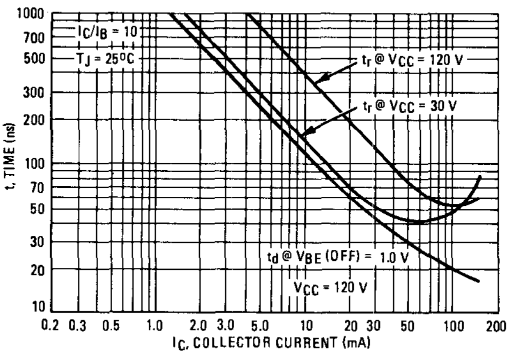
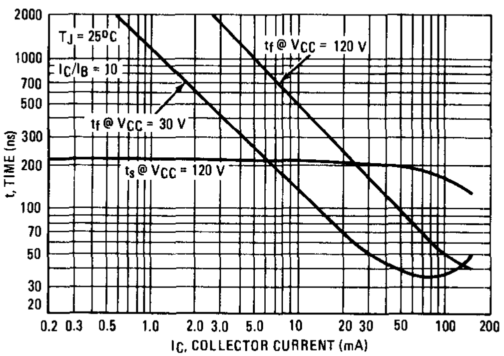


FIGURE 16 – TURN-OFF TIME



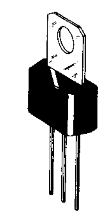
MPS-U05 (SILICON)
MPS-U06

NPN SILICON ANNULAR AMPLIFIER TRANSISTORS

. . . designed for general-purpose, high-voltage amplifier and driver applications.

- High Collector-Emitter Breakdown Voltage –
  BV_{CEO} = 60 Vdc (Min) @ I_C = 1.0 mAdc – MPS-U05
  80 Vdc (Min) @ I_C = 1.0 mAdc – MPS-U06
- High Power Dissipation – P_D = 5.0 W @ T_C = 25°C
- Complements to MPS-U55 and MPS-U56

NPN SILICON AMPLIFIER TRANSISTORS

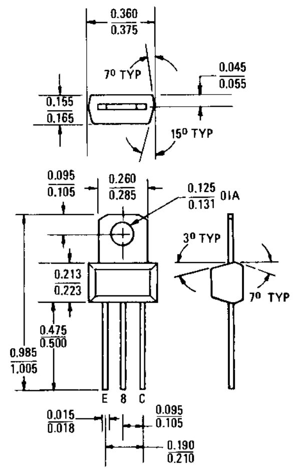


MAXIMUM RATINGS

Rating	Symbol	MPS-U05	MPS-U06	Unit
Collector-Emitter Voltage	V_{CEO}	60	80	Vdc
Collector-Base Voltage	V_{CB}	60	80	Vdc
Emitter-Base Voltage	V_{EB}	4.0		Vdc
Collector Current – Continuous	I_C	1.0		Adc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	1.0 9.10		Watt mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	5.0 45.4		Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	-55 to +135		°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	θ_{JC}	22	°C/W
Thermal Resistance, Junction to Ambient	θ_{JA}	110	°C/W



Collector connected to tab

CASE 152

MPS-U05, MPS-U06 (continued)

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Collector-Emitter Breakdown Voltage		BV_{CEO}				Vdc
(I_C = 1.0 mAdc, I_B = 0)	MPS-U05		60	–	–	
	MPS-U06		80	–	–	
Emitter-Base Breakdown Voltage (I_E = 100 μAdc, I_C = 0)		BV_{EBO}	4.0	–	–	Vdc
Collector Cutoff Current		I_{CBO}				nAdc
(V_{CB} = 40 Vdc, I_E = 0)	MPS-U05		–	–	100	
(V_{CB} = 60 Vdc, I_E = 0)	MPS-U06		–	–	100	
ON CHARACTERISTICS						
DC Current Gain		h_{FE}				–
(I_C = 50 mAdc, V_{CE} = 5.0 Vdc)			100	180	–	
(I_C = 250 mAdc, V_{CE} = 1.0 Vdc)			–	125	–	
(I_C = 250 mAdc, V_{CE} = 5.0 Vdc)			50	170	–	
(I_C = 500 mAdc, V_{CE} = 5.0 Vdc)			–	100	–	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$				Vdc
(I_C = 250 mAdc, I_B = 10 mAdc)			–	0.25	0.6	
(I_C = 250 mAdc, I_B = 25 mAdc)			–	0.1	–	
Base-Emitter Saturation Voltage (I_C = 250 mAdc, I_B = 25 mAdc)		$V_{BE(sat)}$	–	0.83	–	Vdc
Base-Emitter On Voltage (I_C = 250 mAdc, V_{CE} = 5.0 Vdc)		$V_{BE(on)}$	–	0.75	1.2	Vdc
SMALL-SIGNAL CHARACTERISTICS						
Current-Gain—Bandwidth Product (I_C = 250 mAdc, V_{CE} = 5.0 Vdc, f = 100 MHz)		f_T	50	150	–	MHz
Output Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 100 kHz)		C_{ob}	–	6.0	12	pF
Input Capacitance (V_{BE} = 0.5 Vdc, I_C = 0, f = 100 kHz)		C_{ib}	–	14	–	pF

FIGURE 1 – TYPICAL DC CURRENT GAIN

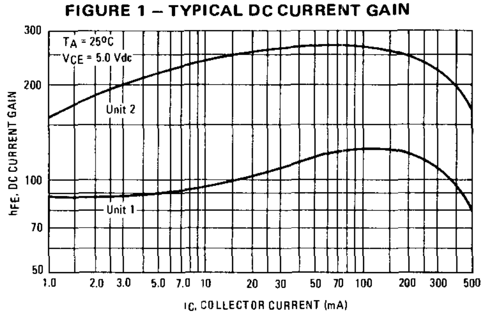


FIGURE 2 – "SATURATION" AND "ON" VOLTAGES

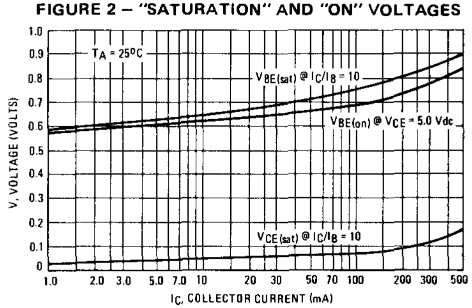
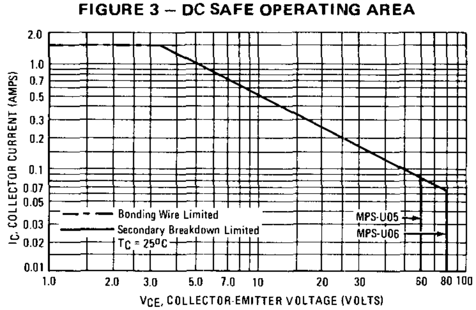


FIGURE 3 – DC SAFE OPERATING AREA



There are two limitations on the power handling ability of a transistor: junction temperature and secondary breakdown. Safe operating area curves indicate $I_C - V_{CE}$ limits of the transistor that must be observed for reliable operation; i.e., the transistor must not be subjected to greater dissipation than the curves indicate.

The data of Figure 3 is based on $T_{J(pk)}$ = 135°C; T_C is variable depending on conditions. At high case temperatures, thermal limitations will reduce the power that can be handled to values less than the limitations imposed by secondary breakdown.

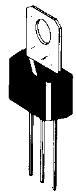
MPS-U10 (SILICON)

HIGH VOLTAGE
NPN SILICON
AMPLIFIER TRANSISTOR

NPN SILICON ANNULAR TRANSISTOR

. . . designed for high-voltage video output stages in TV receivers.

- High Collector-Emitter Breakdown Voltage – BV_{CEO} = 300 Vdc (Min) @ I_C = 1.0 mAdc
- Low Collector-Base Capacitance – C_{cb} = 3.0 pF (Max) @ V_{CB} = 20 Vdc

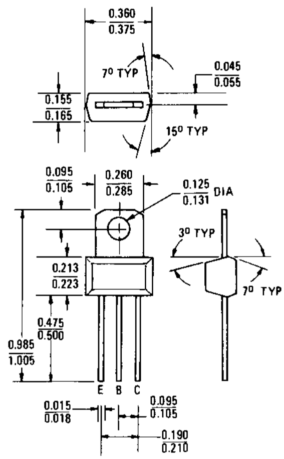


MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	300	Vdc
Collector-Base Voltage	V_{CB}	300	Vdc
Emitter-Base Voltage	V_{EB}	8.0	Vdc
Collector Current – Continuous	I_C	1.0	Adc
Total Device Dissipation @ $T_A = 25^oC$ Derate above 25^oC	P_D	1.0 9.10	Watt $mW/^oC$
Operating and Storage Junction Temperature Range	T_J, T_{stg}	-55 to +135	^oC

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	θ_{JC}	22	$^oC/W$
Thermal Resistance, Junction to Ambient	θ_{JA}	110	$^oC/W$



Collector Connected to Tab

CASE 152

MPS-U10 (continued)

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage (I_C = 1.0 mAdc, I_B = 0)	BV_{CEO}	300	–	Vdc
Collector-Base Breakdown Voltage (I_C = 100 μAdc, I_E = 0)	BV_{CBO}	300	–	Vdc
Emitter-Base Breakdown Voltage (I_E = 100 μAdc, I_C = 0)	BV_{EBO}	8.0	–	Vdc
Collector Cutoff Current (V_{CB} = 200 Vdc, I_E = 0)	I_{CBO}	–	0.2	μAdc
Emitter Cutoff Current (V_{BE} = 6.0 Vdc, I_C = 0)	I_{EBO}	–	0.1	μAdc
ON CHARACTERISTICS				
DC Current Gain	h_{FE}			–
(I_C = 1.0 mAdc, V_{CE} = 15 Vdc)		25	–	
(I_C = 10 mAdc, V_{CE} = 15 Vdc)		40	–	
(I_C = 30 mAdc, V_{CE} = 10 Vdc)		40	–	
Collector-Emitter Saturation Voltage (I_C = 20 mAdc, I_B = 2.0 mAdc)	$V_{CE(sat)}$	–	1.5	Vdc
Base-Emitter Saturation Voltage (I_C = 20 mAdc, I_B = 2.0 mAdc)	$V_{BE(sat)}$	–	0.8	Vdc
DYNAMIC CHARACTERISTICS				
Current-Gain—Bandwidth Product (I_C = 10 mAdc, V_{CE} = 20 Vdc, f = 100 MHz)	f_T	60	–	MHz
Collector Base Capacitance (V_{CB} = 20 Vdc, I_E = 0, f = 1.0 MHz)	C_{cb}	–	3.0	pF

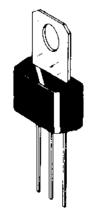
MPS-U55 (SILICON)
MPS-U56

PNP SILICON ANNULAR AMPLIFIER TRANSISTORS

. . . designed for general-purpose, high-voltage amplifier and driver applications.

- High Collector-Emitter Breakdown Voltage —
  BV_{CEO} = 60 Vdc (Min) @ I_C = 1.0 mAdc — MPS-U55
  80 Vdc (Min) @ I_C = 1.0 mAdc — MPS-U56
- High Power Dissipation — P_D = 5.0 W @ T_C = 25°C
- Complements to MPS-U05 and MPS-U06

PNP SILICON ANNULAR AMPLIFIER TRANSISTORS

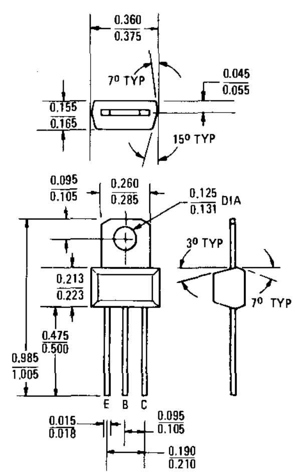


MAXIMUM RATINGS

Rating	Symbol	MPS-U55	MPS-U56	Unit
Collector-Emitter Voltage	V_{CEO}	60	80	Vdc
Collector-Base Voltage	V_{CB}	60	80	Vdc
Emitter-Base Voltage	V_{EB}	4.0		Vdc
Collector Current — Continuous	I_C	1.0		Adc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	1.0 9.10		Watt mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	5.0 45.4		Watt mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	-55 to +135		°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	θ_{JC}	22	°C/W
Thermal Resistance, Junction to Ambient	θ_{JA}	110	°C/W



Collector connected to tab

CASE 152

MPS-U55, MPS-U56 (continued)

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Collector-Emitter Breakdown Voltage		BV_{CEO}				Vdc
(I_C = 1.0 mAdc, I_B = 0)	MPS-U55		60	–	–	
	MPS-U56		80	–	–	
Emitter-Base Breakdown Voltage (I_E = 100 μAdc, I_C = 0)		BV_{EBO}	4.0	–	–	Vdc
Collector Cutoff Current		I_{CBO}				nAdc
(V_{CB} = 40 Vdc, I_E = 0)	MPS-U55		–	–	100	
(V_{CB} = 60 Vdc, I_E = 0)	MPS-U56		–	–	100	
ON CHARACTERISTICS						
DC Current Gain		h_{FE}				–
(I_C = 50 mAdc, V_{CE} = 5.0 Vdc)			100	180	–	
(I_C = 250 mAdc, V_{CE} = 1.0 Vdc)			–	100	–	
(I_C = 250 mAdc, V_{CE} = 5.0 Vdc)			50	140	–	
(I_C = 500 mAdc, V_{CE} = 5.0 Vdc)			–	90	–	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$				Vdc
(I_C = 250 mAdc, I_B = 10 mAdc)			–	0.3	0.6	
(I_C = 250 mAdc, I_B = 25 mAdc)			–	0.15	–	
Base-Emitter Saturation Voltage (I_C = 250 mAdc, I_B = 25 mAdc)		$V_{BE(sat)}$	–	0.86	–	Vdc
Base-Emitter On Voltage (I_C = 250 mAdc, V_{CE} = 5.0 Vdc)		$V_{BE(on)}$	–	0.78	1.2	Vdc
SMALL-SIGNAL CHARACTERISTICS						
Current-Gain--Bandwidth Product (I_C = 250 mAdc, V_{CE} = 5.0 Vdc, f = 100 MHz)		f_T	50	125	–	MHz
Output Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 100 kHz)		C_{ob}	–	8.5	12	pF
Input Capacitance (V_{BE} = 0.5 Vdc, I_C = 0, f = 100 kHz)		C_{ib}	–	20	–	pF

FIGURE 1 – TYPICAL DC CURRENT GAIN

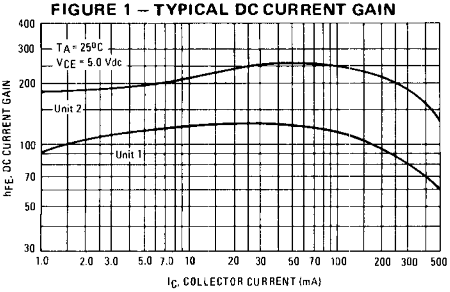


FIGURE 2 – "SATURATION" AND "ON" VOLTAGES

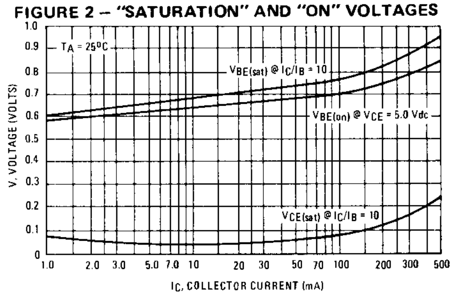
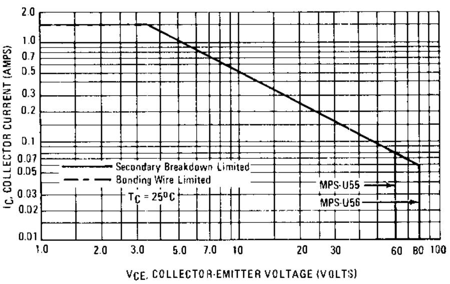


FIGURE 3 – DC SAFE OPERATING AREA



There are two limitations on the power handling ability of a transistor: junction temperature and secondary breakdown. Safe operating area curves indicate $I_C - V_{CE}$ limits of the transistor that must be observed for reliable operation; i.e., the transistor must not be subjected to greater dissipation than the curves indicate.

The data of Figure 3 is based on $T_{J(pk)}$ = 135°C; T_C is variable depending on conditions. At high case temperatures, thermal limitations will reduce the power that can be handled to values less than the limitations imposed by secondary breakdown.

MR1210 thru MR1219 (SILICON)
MR1810 thru MR1819

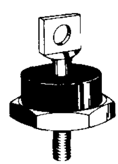
UNIQUE, MULTI-CELL RECTIFIERS OFFERING HIGHEST ORDER OF RELIABILITY IN POWER APPLICATIONS

Designers Data for "Worst Case" Conditions

Motorola DESIGNERS Data Sheets are prepared to facilitate "worst-case" circuit design entirely from information presented on these pages. To do this, the usual typical curves which provided some guidance to the engineer, have been supplemented by limit curves which are directly applicable to "worst-case" rectifier circuit design. Limit curves represent boundaries on parameters and does not necessarily indicate typical rectifier behavior.

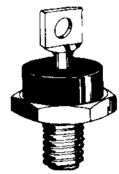
HIGH-CURRENT SILICON RECTIFIERS

80/100 AMPERE
50-600 VOLTS
DIFFUSED JUNCTIONS



MR1210SL thru MR1219SL

CASE 167



MR1810SL thru MR1819SL

CASE 189

MAXIMUM RATINGS

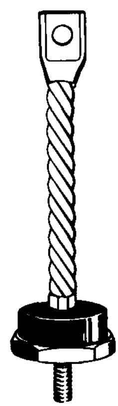
Rating	Symbol	MR 1210	MR 1211	MR 1212	MR 1213	MR 1214	MR 1215	MR 1216	MR 1217	MR 1218	MR 1219	Unit
		MR 1810	MR 1811	MR 1812	MR 1813	MR 1814	MR 1815	MR 1816	MR 1817	MR 1818	MR 1819	
Peak Repetitive Reverse Voltage Working Peak Reverse Voltage DC Blocking Voltage	$V_{RM(rep)}$ $V_{RM(wkg)}$ V_R	50	100	150	200	250	300	350	400	500	600	Volts
Non-Repetitive Peak Reverse Voltage (one halfwave, single phase, 60 Hz peak)	$V_{RM(non\text{-}rep)}$	100	200	250	300	350	400	450	500	600	720	Volts
RMS Reverse Voltage	V_r	35	70	105	140	175	210	245	280	350	420	Volts
Average Rectified Forward Current (single phase, resistive load, 60 Hz, see Figure 3) $T_C = 135^oC$ $T_C = 150^oC$	I_O	← 100 → ← 80 →										Amp
Non-Repetitive Peak Surge Currents (surge applied at rated load conditions, see Figure 5) $T_C = 150^oC$	$I_{FM(surge)}$	← 2,000 (for 1/2 cycle) → ← 1,200 (for six consecutive cycles) →										Amp
I^2t Rating (non-repetitive, for t greater than 1 ms and less than 8.3 ms)	I^2t	← 8,300 →										A^2s
Operating and Storage Junction Temperature Range (see Figure 4 for other conditions)	T_J, T_{stg}	← -65 to +190 →										^oC

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Full Cycle Average Forward Voltage Drop (rated I_O and V_r, single phase, 60 Hz, $T_C = 150^oC$)	$V_{F(AV)}$	0.4	Volt
Full Cycle Average Reverse Current (rated I_O and V_r, single phase, 60 Hz, $T_C = 150^oC$)	$I_{R(AV)}$	15	mA

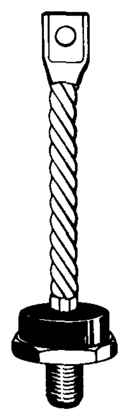
THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	θ_{JC}	0.40	^oC/Watt



MR1210SB thru MR1219SB

CASE 168



MR1810SB thru MR1819SB

CASE 190

FIGURE 1 – MAXIMUM FORWARD VOLTAGE DROP

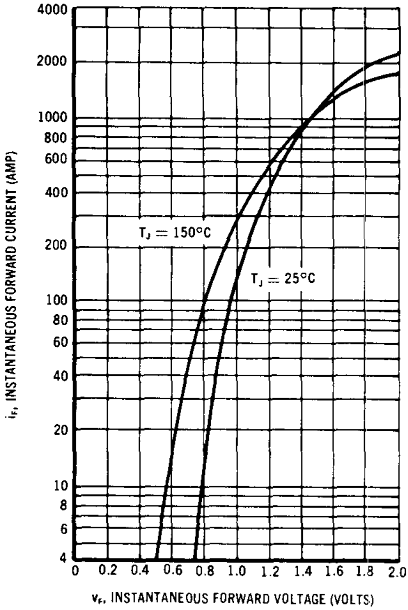


FIGURE 2 – MAXIMUM FORWARD POWER DISSIPATION

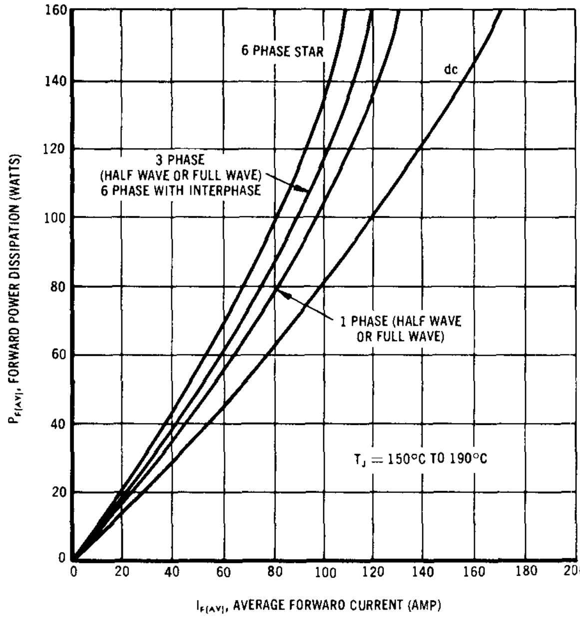


FIGURE 3 – MAXIMUM CURRENT RATINGS

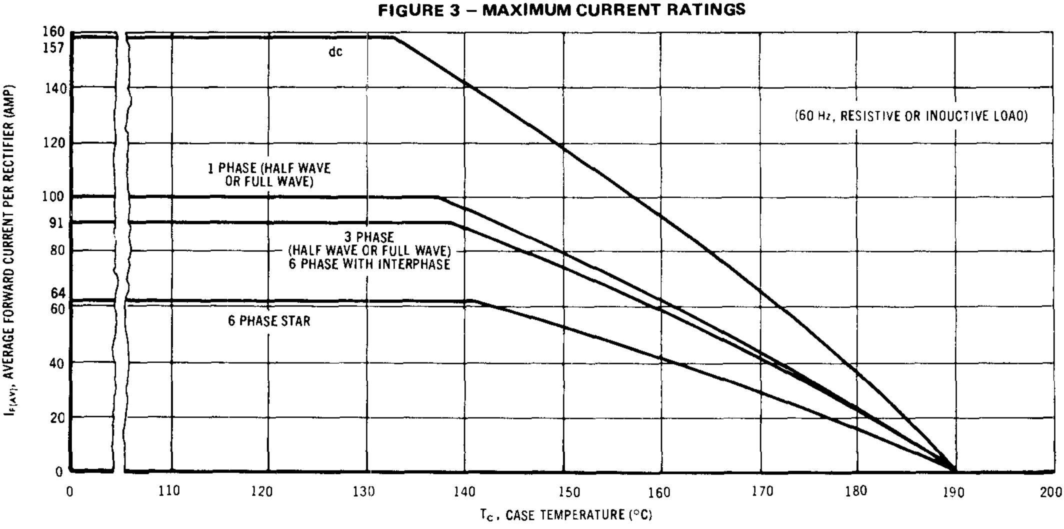


FIGURE 4 – EFFECTIVE TRANSIENT THERMAL IMPEDANCE

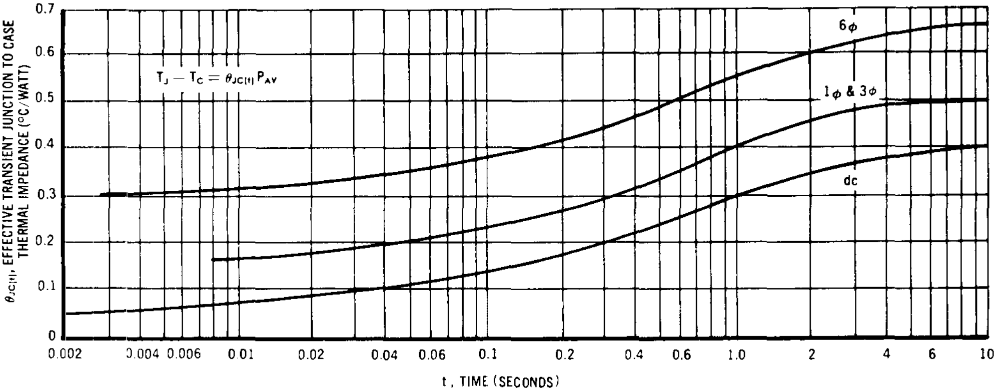


FIGURE 5 – MAXIMUM ALLOWABLE SURGE CURRENT

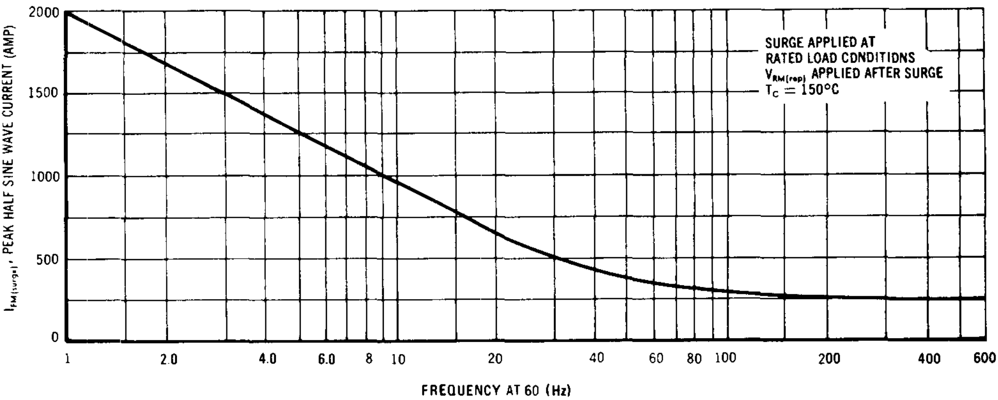
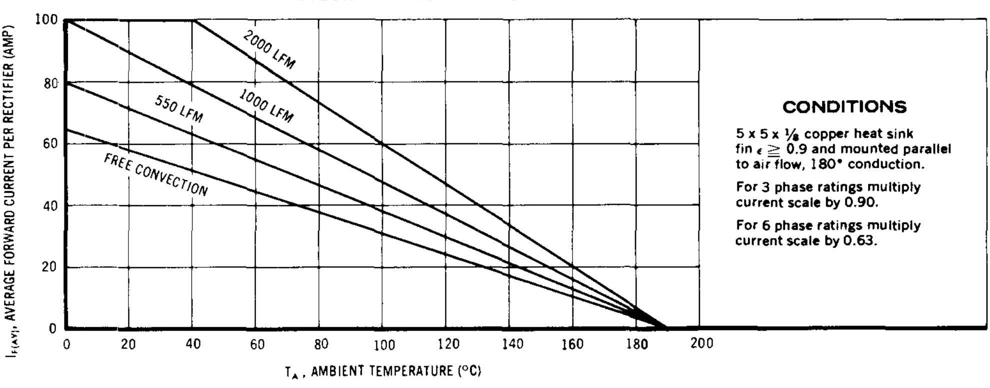


FIGURE 6 – MAXIMUM CURRENT DERATING DATA



CONDITIONS

5 x 5 x 1/8 copper heat sink fin $\epsilon \geq 0.9$ and mounted parallel to air flow, 180° conduction.

For 3 phase ratings multiply current scale by 0.90.

For 6 phase ratings multiply current scale by 0.63.

PACKAGE CONFIGURATIONS:

MR1210SB and MR1810SB rectifiers are designed for stud mounting and have a flexible braided lead terminal (See Outline 1).

MR1210SL and MR1810SL rectifiers are designed for stud mounting and have a solid lug terminal (See Outline 2).

All units have a plated copper base and terminal. Molded external case with internal hermetically sealed, metallic case rectifier cells

POLARITY:

Standard polarity devices are CATHODE TO CASE. Reverse polarity devices are ANODE TO CASE and are designated by an "R" suffix i.e. MR1215SLR. These devices have a molded plastic top for mechanical strength and seal. The color of the plastic indicates the polarity of the cells inside.

"RED PLASTIC CATHODE TO CASE"
"BLACK PLASTIC ANODE TO CASE"

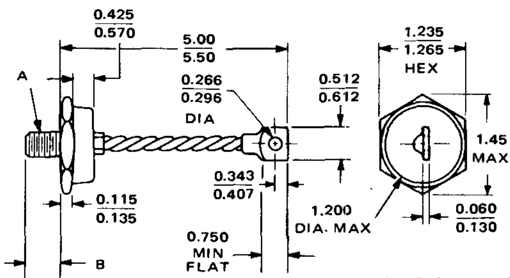
MOUNTING POSITION: Any

STUD MOUNTING TORQUES:

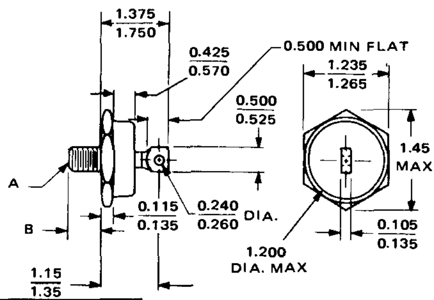
For Stud Mounted "SB" and "SL" rectifiers, 25 in-lb min., 30 in-lb max.

OUTLINE DIMENSIONS

OUTLINE 1 – MR1210SB THRU MR1219SB – CASE 168
MR1810SB THRU MR1819SB – CASE 190



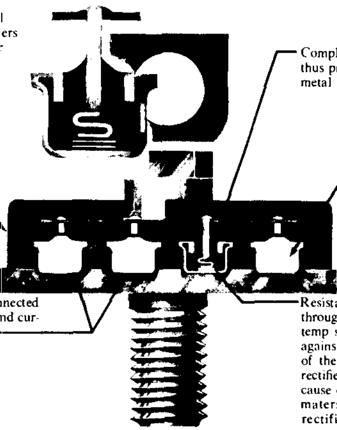
OUTLINE 2 – MR1210SL THRU MR1219SL – CASE 167
MR1810SL THRU MR1819SL – CASE 189



	A	B
MR1210 Series	No 10-32-UNF-2A	0.424/0.500
MR1810 Series	3/8-24-UNF-2A	0.593/0.657

CONSTRUCTIONAL FEATURES

Motorola's advanced and unique double-case, multiple cell construction offers numerous advantages which result in rectifiers possessing "designed-in" ruggedness, reliability and superior performance characteristics.



Complete seal strength is afforded by the outer case thus preventing any excessive stress on the glass-to-metal hermetic inner seal.

Internal, hermetically sealed, welded metal case rectifier cells. All individual cells are specially processed, tested and matched for similarity of forward characteristics to assure balanced current sharing and reliable parallel operation.

Void-free, molded external case for added mechanical strength and electrical isolation in addition to being corrosion resistant. Color coding of the external case provides easy polarity identification.

RED — CATHODE TO CASE

BLACK — ANODE TO CASE

Plated copper base and/or stud integrally connected to the inner cases for optimum heat transfer and current balance between cells.

Resistance to thermal fatigue of each cell is assured through the use of double back-up discs and high temp solder construction to protect the silicon die against stresses. In addition, the small junction areas of the individual paralleled cells result in a total rectifier which can better resist thermal fatigue because of the smaller excursion of dissimilar bonded materials as opposed to a large single-junction rectifier.

MV2201, MV2203 (SILICON)
MV2205, MV2209

VVC

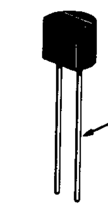
AFC SILICON EPICAP DIODES

. . . designed specifically for the high volume AFC applications of FM Radio and TV, utilizing the economical PLASTIC PACKAGE.

- Very High Q with Guaranteed Minimum Values
- Guaranteed Uniformity with Minimum and Maximum Tuning Ratio Limits, Assuring Fixed Design
- Nominal Capacitance Values – 6.8 pF Thru 33 pF – Providing Complete AFC Design Flexibility

VOLTAGE-VARIABLE CAPACITANCE DIODES

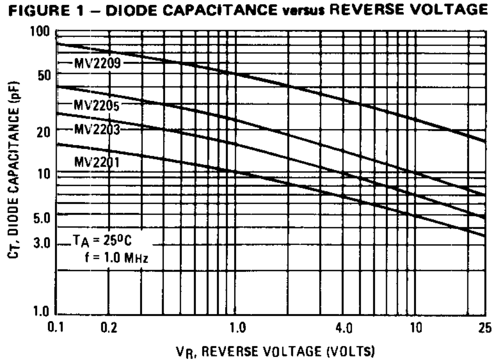
6.8–33 pF
25 VOLTS

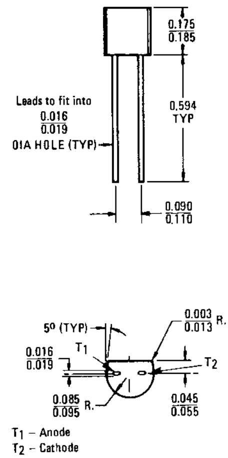


MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Reverse Voltage	V_R	25	Volts
Forward Current	I_F	200	mA
Device Dissipation @ $T_A = 25^oC$ Derate above 25^oC	P_D	280 2.8	mW mW/^oC
Junction Temperature	T_J	+125	^oC
Storage Temperature Range	T_{stg}	-65 to +150	^oC

FIGURE 1 – DIODE CAPACITANCE versus REVERSE VOLTAGE





CASE 182(1)

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic—All Types	Symbol	Min	Typ	Max	Unit
Reverse Breakdown Voltage (I_R = 10 μAdc)	BV_R	25		–	Vdc
Reverse Voltage Leakage Current (V_R = 10 Vdc, T_A = 25°C) (V_R = 10 Vdc, T_A = 85°C)	I_R	 – –	 – –	 0.5 5.0	μAdc
Forward Voltage Drop (I_F = 250 μAdc)	V_F	–	0.65	–	Vdc
Series Inductance (f = 250 MHz, lead length ≈ 1/16")	L_S	–	6.0	–	nH
Case Capacitance (f = 1.0 MHz, lead length ≈ 1/16")	C_C	–	0.18	–	pF

	C_T, Diode Capacitance V_R = 4.0 Vdc, f = 1.0 MHz pF		Q, Figure of Merit V_R = 4.0 Vdc, f = 50 MHz	TR, Tuning Ratio C_1/C_{10} f = 1.0 MHz	
Device	**Min**	**Max**	**Min**	**Min**	**Max**
MV2201	5.5	8.0	300	1.9	2.3
MV2203	8.5	11.5	200	2.0	2.4
MV2205	13	17	200	2.1	2.5
MV2209	29	37	150	2.1	2.5

FIGURE 2 – FIGURE OF MERIT versus REVERSE VOLTAGE

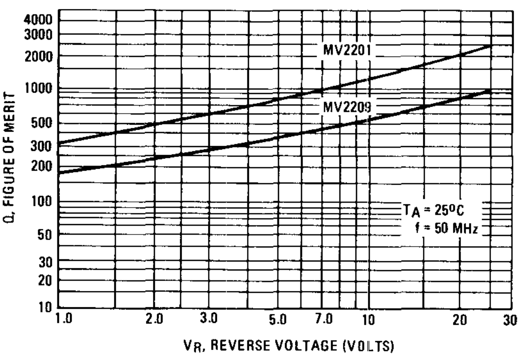


FIGURE 3 – FIGURE OF MERIT versus FREQUENCY

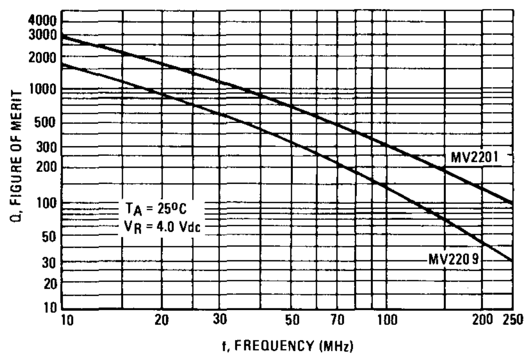
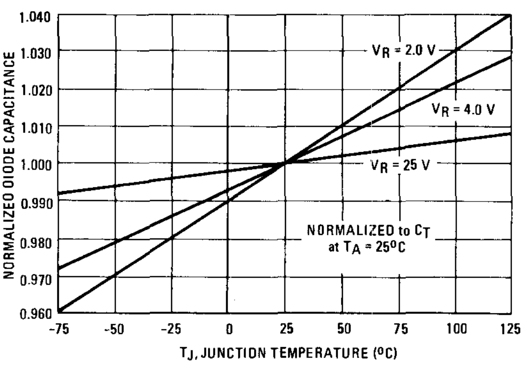


FIGURE 4 – NORMALIZED DIODE CAPACITANCE versus JUNCTION TEMPERATURE



NOTES ON TESTING AND SPECIFICATIONS

L_S is measured on a package having a short instead of a die, using an impedance bridge (Boonton Radio Model 250A RX Meter).

C_C is measured on a package without a die, using a capacitance bridge (Boonton Electronics Model 75A or equivalent).

Q is calculated by taking the G and C readings of an admittance bridge, such as Boonton Electronics Model 33AS8, at the specified frequency and substituting in the following equation:

$$Q = \frac{2\pi fC}{G}$$

[redacted]

INTRODUCTION

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Numerical index of EIA-registered device types, with major electrical specifications

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COMPLETE DATA SHEETS
IN-HOUSE NUMBERED DEVICE SPECIFICATIONS