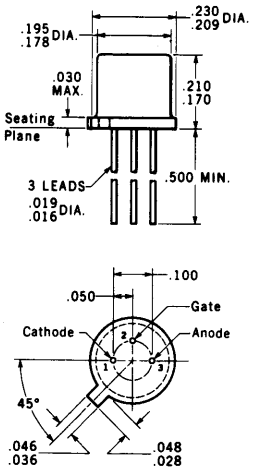
2N4108 • 2N4109 • 2N4110

PNPN SILICON CONTROLLED RECTIFIERS

DIFFUSED SILICON PLANAR DEVICES

- **OPERATION TO 125°C GUARANTEED WITH NO FORWARD OR REVERSE VOLTAGE DERATING.**
- **LOW FORWARD "ON" VOLTAGE GUARANTEED AT 3 POINTS.**
- **LOW FORWARD AND REVERSE LEAKAGES GUARANTEED.**
- **PLANAR RELIABILITY BUILT IN.**

PHYSICAL DIMENSIONS
in accordance with
JEDEC (TO-18) outline



NOTES: All dimensions in inches
Leads are gold-plated kovar
Anode internally connected to case
Package weight is 0.44 gram

ABSOLUTE MAXIMUM RATINGS (Note 1)

Maximum Temperatures

Storage Temperature	− 65°C to + 125°C
Operating Junction Temperature	− 65°C to + 125°C
Lead Temperature (Soldering, 10 sec. time limit)	+ 260°C Maximum

Maximum Power Dissipation

Average Gate Power Dissipation at 25°C Ambient Temperature (Note 2)	**0.1 Watt**

Maximum Currents

DC Forward Current at 25°C Case Temperature (Note 2)	1.0 Amp.
DC Forward Current at 25°C Ambient Temperature	235 mA
Surge Current at 25°C Ambient Temperature (Note 2)	**4.0 Amps.**
(½ cycle sine wave = 8.3 msec)	
Average Forward Current at 25°C Ambient Temperature 180° Conduction	180 mA

ELECTRICAL CHARACTERISTICS (25°C Free Air Temperature unless otherwise specified)

SYMBOL	CHARACTERISTICS		MIN	TYP	MAX	UNITS	TEST CONDITIONS
V_{FX}	Forward Blocking Voltage	2N4108	50			Volts	I_{FX} = **0.05 μA**, R_{GK} = 1.0 kΩ
	(T_A = − 65°C to + 125°C)	2N4109	100			Volts	
		2N4110	200			Volts	
V_{RO}	Reverse Blocking Voltage	2N4108	50			Volts	I_{RO} = **0.05 μA**, R_{GK} = ∞
	(T_A = − 65°C to + 125°C)	2N4109	100			Volts	
		2N4110	200			Volts	
I_{FX}	Forward Blocking Current (at rated V_{FX})			8	50	nA	R_{GK} = 1.0 kΩ
I_{FX} (125°C)	Forward Blocking Current (at rated V_{FX})			5	20	μA	R_{GK} = 1.0 kΩ
I_{RO}	Reverse Blocking Current (at rated V_{RO})			8	50	nA	R_{GK} = ∞
I_{RO} (125°C)	Reverse Blocking Current (at rated V_{RO})			5	20	μA	R_{GK} = ∞
I_{GT}	Gate Trigger Current			0.060	**0.2**	mA	V_{AK} = 10V, R_L = 100Ω
I_{GT} (−55°C)	Gate Trigger Current			0.110	2.0	mA	V_{AK} = 10V, R_L = 100Ω
V_{GT}	Gate Trigger Voltage			0.58	0.8	Volts	V_{AK} = 10V, R_L = 100Ω
V_{GT} (−55°C)	Gate Trigger Voltage			0.75	1.1	Volts	V_{AK} = 10V, R_L = 100Ω
V_{GT} (125°C)	Gate Trigger Voltage **(at rated V_{FX})**		0.2	0.4		Volts	R_L = 10 kΩ

Additional Electrical Characteristics on page 2

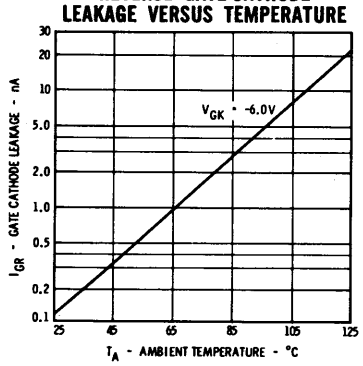
NOTES:
(1) These ratings are limiting values above which the serviceability of any semiconductor device may be impaired.
(2) These ratings give a maximum junction temperature of 125°C and junction to case thermal resistance of 44.5°C/Watt (derating factor of 22.5 mW/°C); junction to ambient thermal resistance of 350°C/W (derating factor of 2.84 mW/°C).

ELECTRICAL CHARACTERISTICS (25°C Free Air Temperature unless otherwise specified)

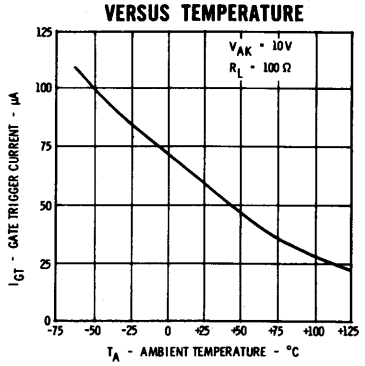
SYMBOL	CHARACTERISTICS	MIN	TYP	MAX	UNITS	TEST CONDITIONS
V_F	On Voltage		0.95	1.15	Volts	I_F = 175 mA
V_F	On Voltage		1.05	**1.2**	Volts	I_F = **250 mA**
V_F	On Voltage		1.2	**1.6**	Volts	I_F = **500 mA**
I_{HO}	Holding Current		0.7	2.0	mA	$R_G = \infty$, R_L = 1.0 KΩ
I_{GR}	Gate Leakage Current		0.13	25	nA	I_F = 0, V_{GK} = − 6.0 V
I_{GR} (125°C)	Gate Leakage Current		0.024	10	μA	I_F = 0, V_{GK} = − 6.0 V
t_{on}	Turn On Time		0.56	**1.5**	μS	$I_F \approx$ 200 mA, I_{GF} = 10 mA
t_{off}	Turn Off Time (see t_{off} circuit)		6.5	**15**	μS	$I_F = I_R \approx$ 200 mA
dv/dt	Critical Rate of Rise (at rated V_{FX})	75	200		Volts/μS	R_{GK} = 1 KΩ, R_L = 100 Ω

GATE CHARACTERISTICS

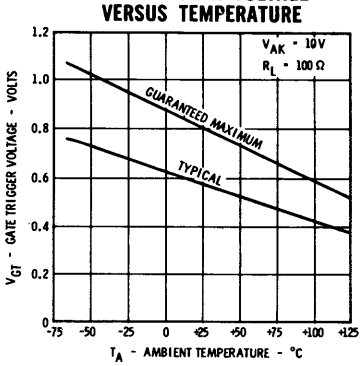
REVERSE GATE-CATHODE LEAKAGE VERSUS TEMPERATURE



GATE TRIGGER CURRENT VERSUS TEMPERATURE

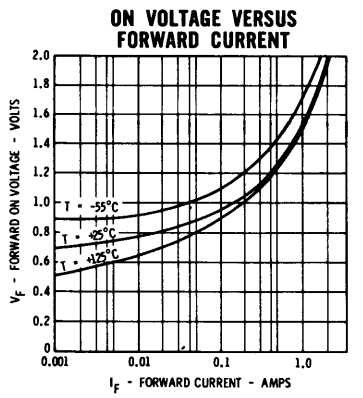


GATE TRIGGER VOLTAGE VERSUS TEMPERATURE

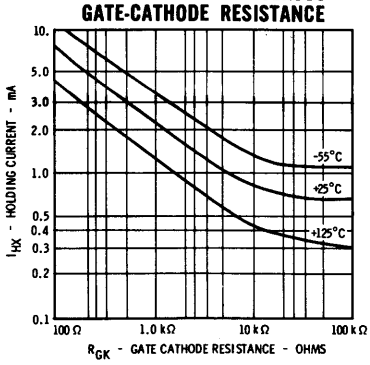


TYPICAL ELECTRICAL CHARACTERISTICS

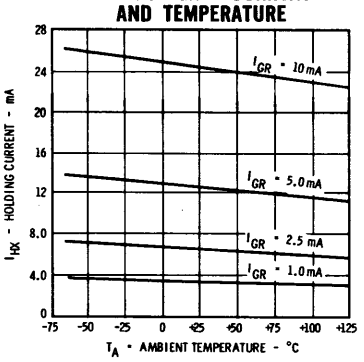
ON VOLTAGE VERSUS FORWARD CURRENT



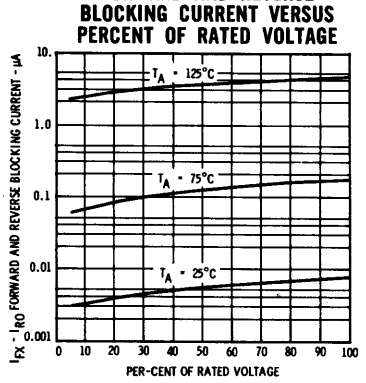
HOLDING CURRENT VERSUS GATE-CATHODE RESISTANCE



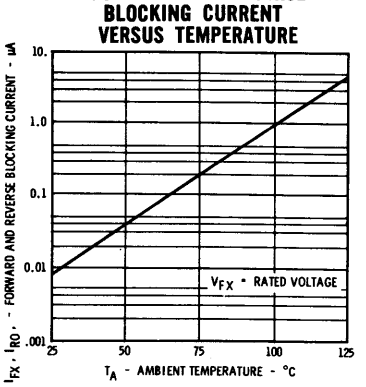
HOLDING CURRENT VERSUS REVERSE GATE CURRENT AND TEMPERATURE



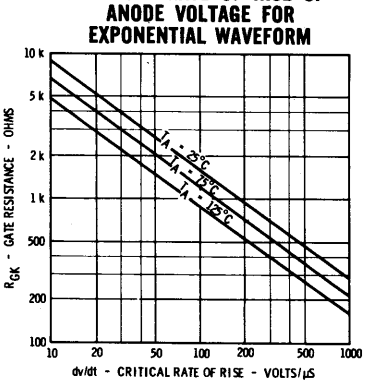
FORWARD AND REVERSE BLOCKING CURRENT VERSUS PERCENT OF RATED VOLTAGE



FORWARD AND REVERSE BLOCKING CURRENT VERSUS TEMPERATURE

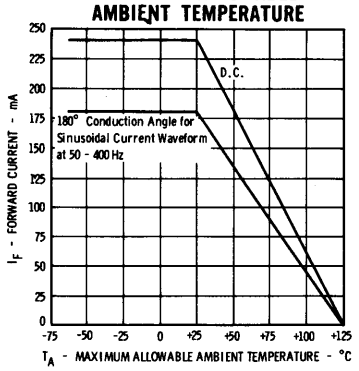


CRITICAL RATE OF RISE OF ANODE VOLTAGE FOR EXPONENTIAL WAVEFORM

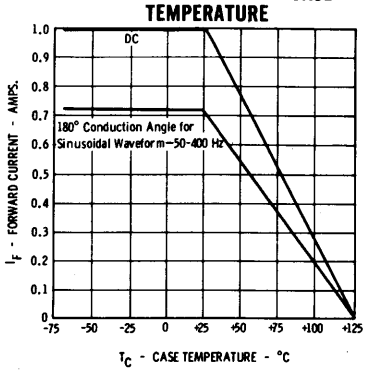


MAXIMUM RATINGS

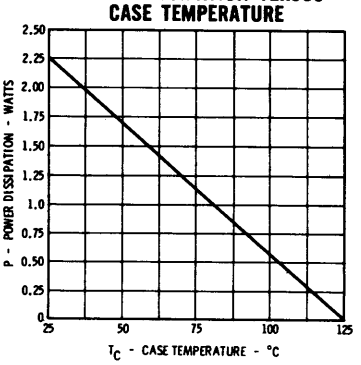
FORWARD CURRENT VERSUS MAXIMUM ALLOWABLE AMBIENT TEMPERATURE



FORWARD CURRENT VERSUS MAXIMUM ALLOWABLE CASE TEMPERATURE

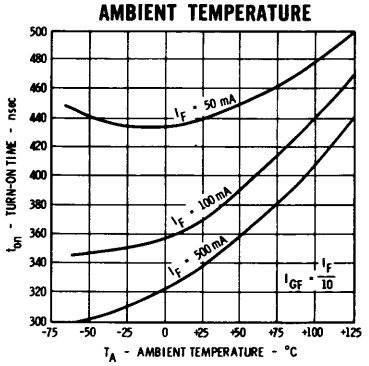


POWER DISSIPATION VERSUS CASE TEMPERATURE

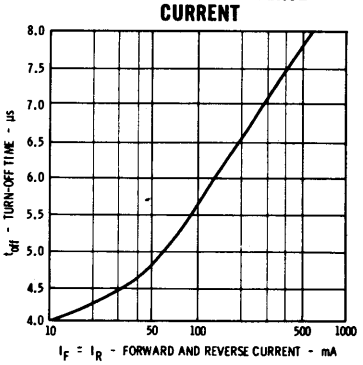


SWITCHING CHARACTERISTICS

TURN-ON TIME VERSUS AMBIENT TEMPERATURE

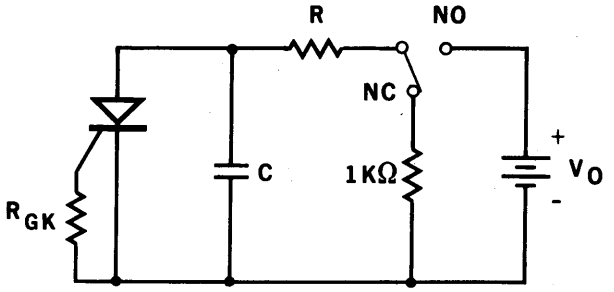


TURN-OFF TIME VERSUS FORWARD AND REVERSE CURRENT



$\frac{dv}{dt}$ CIRCUIT

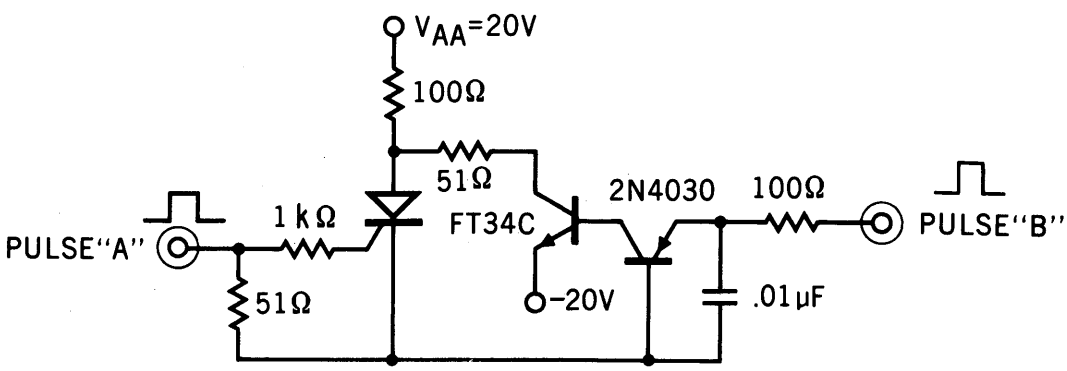
MERCURY RELAY



$$\frac{dv}{dt} = 0.632 \frac{V_O}{RC}$$

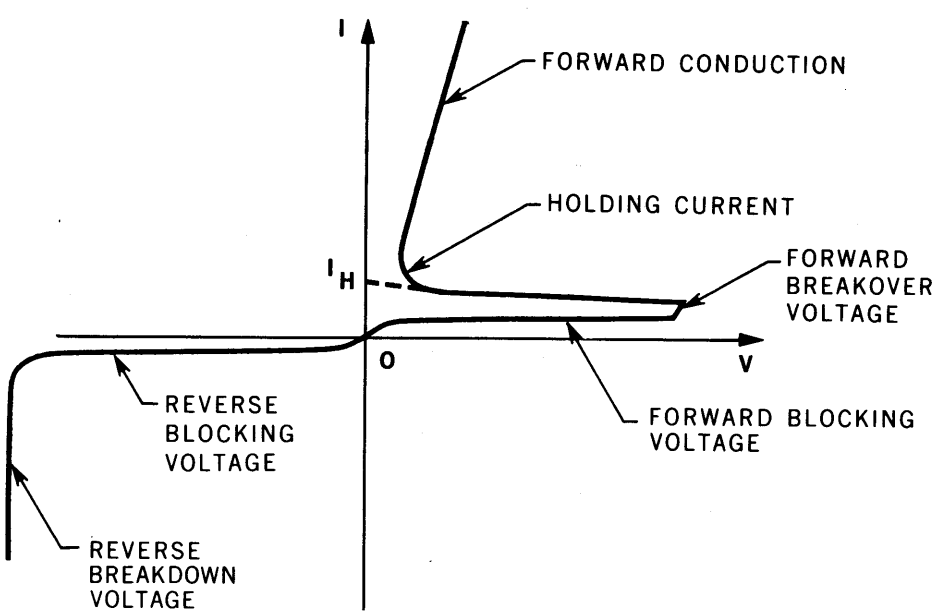
V_O = RATED VOLTAGE

t_{off} CIRCUIT



PULSE B DELAYED FROM PULSE A BY APPROXIMATELY 100 μs

ANODE CHARACTERISTIC



2N4115 • 2N4116

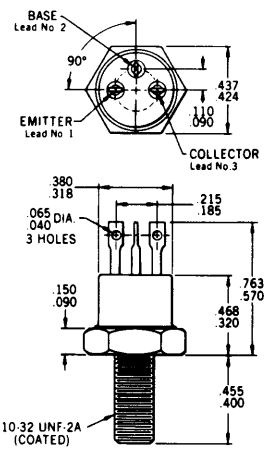
NPN POWER TRANSISTORS

DIFFUSED SILICON PLANAR EPITAXIAL TRANSISTORS

REPLACES FT7207A • FT7207B

- **HIGH POWER — 37 WATTS @ $T_C = 100°C$**
- **HIGH VOLTAGE (LV_{CEO}) — 80 VOLTS MIN.**
- **HIGH CURRENT (V_{CE} sat) — 1.5 VOLTS MAX. @ 5.0 AMPS.**
- **BETA GUARANTEED @ 3 POINTS — 50 mA, 2 AMPS. and 5 AMPS.**
- **HIGH (f_T) — 70 and 80 MHz MIN. @ 0.5 AMP.**
- **ISOLATED COLLECTOR PACKAGE**
- **SAFE AREA EXTENDED BY USE OF NICHROME THIN FILM EMITTER RESISTOR**

PHYSICAL DIMENSIONS
(in accordance with JEDEC TO-59 outline)



NOTES: All dimensions in inches
All leads electrically isolated from case
Package weight is 5.65 grams

ABSOLUTE MAXIMUM RATINGS [Note 1]

Maximum Temperatures	
Storage Temperature	−65°C to +200°C
Operating Junction Temperature	−65°C to +200°C
Lead Temperature (Soldering, 60 sec time limit)	300°C Maximum
Maximum Power Dissipation	
Total Dissipation at 100°C Case Temperature (See safe operating area and derating curves)	**37 Watts**
Thermal Resistance	2.7°C/W
Maximum Voltages	
V_{CBO} Collector to Base Voltage	120 Volts
V_{CEO} Collector to Emitter Voltage [Note 2]	80 Volts
V_{EBO} Emitter to Base Voltage	**8.0 Volts**

ELECTRICAL CHARACTERISTICS (25°C Case Temperature unless otherwise noted)

SYMBOL	CHARACTERISTIC	2N4115 MIN.	2N4115 TYP.	2N4115 MAX.	2N4116 MIN.	2N4116 TYP.	2N4116 MAX.	UNITS	TEST CONDITIONS
*h_{FE}	DC Pulse Current Gain [Note 3]	**40**	63	**120**	**100**	139	**300**		I_C = **2.0 A** V_{CE} = 5.0 V
h_{FE}	DC Pulse Current Gain [Note 3]	**20**	45		**40**	100			I_C = **5.0 A** V_{CE} = 5.0 V
V_{CE} (sat)	Pulsed Collector Saturation Voltage [Note 3]		0.5	**1.5**		0.5	**1.5**	Volts	I_C = **5.0 A** I_B = 0.5 A
V_{BE} (sat)	Pulsed Base Saturation Voltage [Note 3]		1.3	2.2		1.3	2.2	Volts	I_C = 5.0 A I_B = 0.5 A
*V_{CE} (sat)	Pulsed Collector Saturation Voltage [Note 3]		0.22	0.6		0.22	0.6	Volts	I_C = 2.0 A I_B = 0.2 A
*V_{BE} (sat)	Pulsed Base Saturation Voltage [Note 3]		0.95	1.3		0.95	1.3	Volts	I_C = 2.0 A I_B = 0.2 A
V_{CEO} (sust)	Collector to Emitter Sustaining Voltage [Notes 2 and 3]	**80**			**80**			Volts	I_C = 50 mA (pulsed) I_B = 0
BV_{CES}	Collector to Emitter Breakdown Voltage	120			120			Volts	I_C = 2.0 mA V_{BE} = 0
BV_{EBO}	Emitter to Base Breakdown Voltage	8.0			8.0			Volts	I_C = 0 I_E = 1.0 mA

Notes on page 2

Additional Electrical Characteristics on page 2

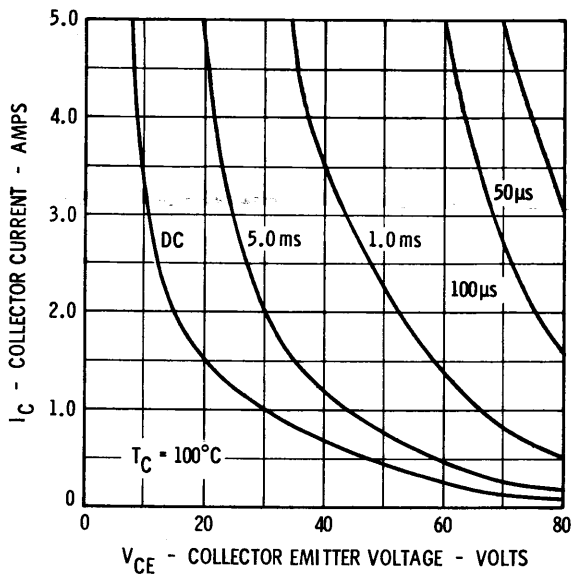
FAIRCHILD
SEMICONDUCTOR
A DIVISION OF FAIRCHILD CAMERA AND INSTRUMENT CORPORATION

313 FAIRCHILD DRIVE, MOUNTAIN VIEW, CALIFORNIA, (415) 962-5011, TWX: 910-379-6435

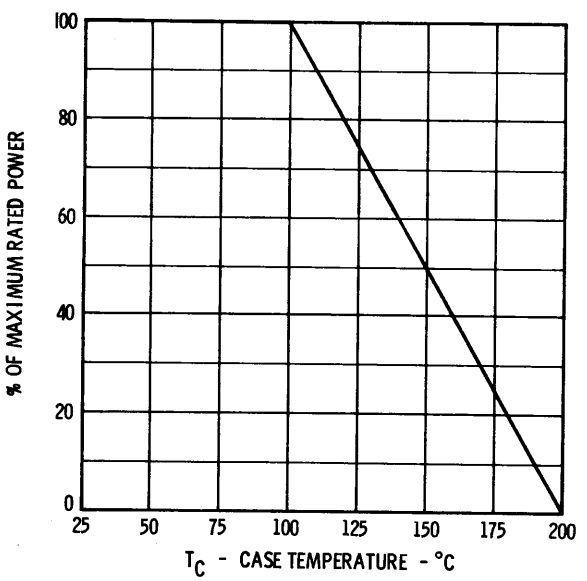
ELECTRICAL CHARACTERISTICS (25°C Case Temperature unless otherwise noted)

SYMBOL	CHARACTERISTIC	2N4115 MIN.	2N4115 TYP.	2N4115 MAX.	2N4116 MIN.	2N4116 TYP.	2N4116 MAX.	UNITS	TEST CONDITIONS
*I_{CES}	Collector Reverse Current			10			10	μA	V_{CE} = 60 V V_{BE} = 0
I_{CEO}	Collector Cutoff Current			50			50	μA	I_B = 0 V_{CE} = 40 V
I_{CEX} (150°C)	Collector Cutoff Current			100			100	μA	V_{CE} = 60 V V_{EB} = 2.0 V
I_{EBO}	Emitter Cutoff Current			25			25	μA	I_C = 0 V_{EB} = 6.0 V
h_{FE}	DC Pulse Current Gain [Note 3]	**20**	40		**40**	72			I_C = **50 mA** V_{CE} = 5.0 V
h_{FE} (−55°C)	DC Pulse Current Gain [Note 3]	15	34		35	82			I_C = 2.0 A V_{CE} = 5.0 V
h_{fe}	High Frequency Current Gain (**f = 20 MHz**)	**3.5**	6.75		**4.0**	9.75			I_C = 0.5 A V_{CE} = 5.0 V
C_{obo}	Output Capacitance		80	120		80	120	pF	I_E = 0 V_{CE} = 10 V
C_{ibo}	Input Capacitance		450	700		450	700	pF	I_C = 0 V_{EB} = 2.0 V
h_{fe}	Small Signal Current Gain (f = 1 kHz)	20			40				I_C = 50 mA V_{CE} = 5.0 V
V_{BE} (ON)	Pulsed Base Emitter ON Voltage [Note 3]			1.3			1.3	Volts	I_C = 2.0 A V_{CE} = 5.0 V

FORWARD BIASED SAFE OPERATING AREA



DERATING CURVE

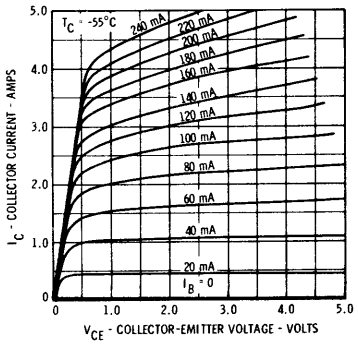


NOTES:
(1) These ratings are limiting values above which the serviceability of any semiconductor device may be impaired.
(2) This rating refers to a high-current point where collector to emitter voltage is lowest. For more information send for Fairchild Publication APP-4/2.
(3) Pulse conditions: length = 300 μs; duty cycle = 1%.

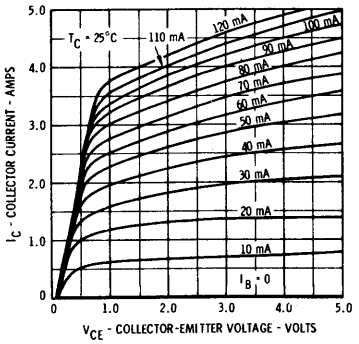
TYPICAL ELECTRICAL CHARACTERISTICS

2N4115

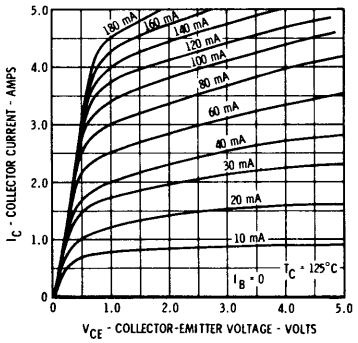
COLLECTOR CHARACTERISTICS*



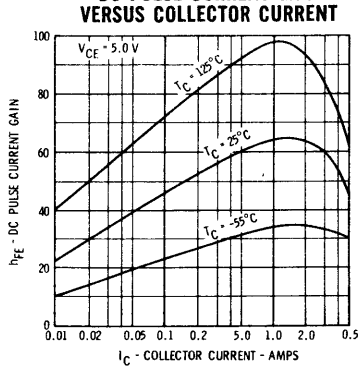
COLLECTOR CHARACTERISTICS*



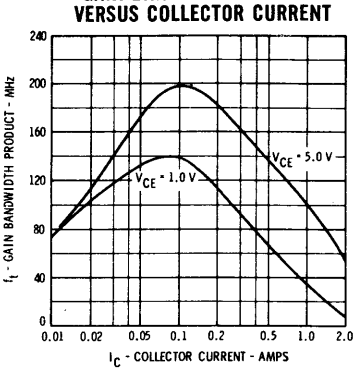
COLLECTOR CHARACTERISTICS*



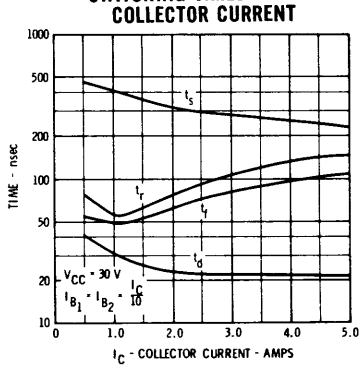
DC PULSE CURRENT GAIN VERSUS COLLECTOR CURRENT



GAIN BANDWIDTH PRODUCT VERSUS COLLECTOR CURRENT

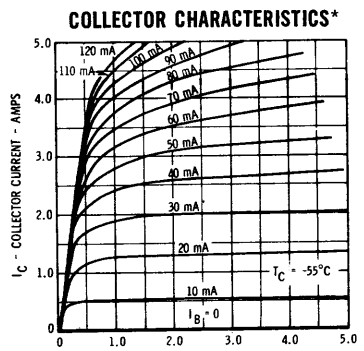


SWITCHING TIMES VERSUS COLLECTOR CURRENT

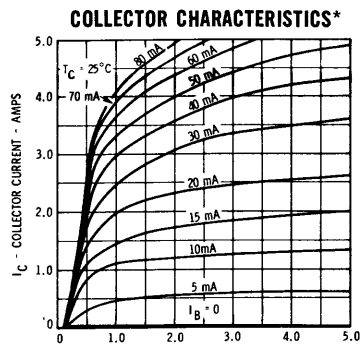


2N4116

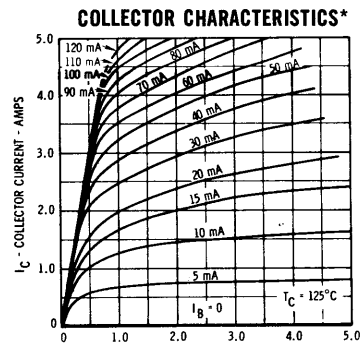
COLLECTOR CHARACTERISTICS*



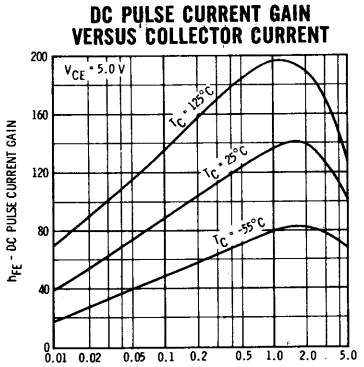
COLLECTOR CHARACTERISTICS*



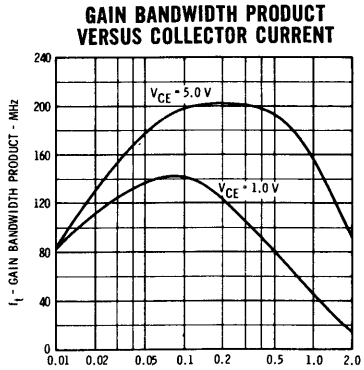
COLLECTOR CHARACTERISTICS*



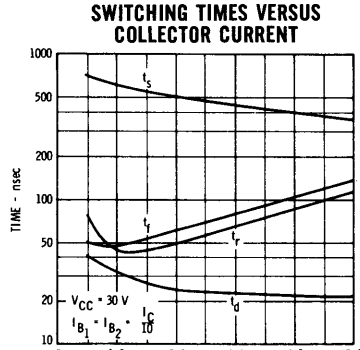
DC PULSE CURRENT GAIN VERSUS COLLECTOR CURRENT



GAIN BANDWIDTH PRODUCT VERSUS COLLECTOR CURRENT



SWITCHING TIMES VERSUS COLLECTOR CURRENT



* Single family characteristic on Transistor Curve Tracer.

2N4134 • 2N4135

NPN LOW NOISE RF AMPLIFIERS

DIFFUSED SILICON PLANAR* TRANSISTORS

- **LOW NOISE FIGURE -- 2.5 db MAX @ 60 MHz**
  5.0 db MAX @ 450 MHz
- **HIGH STABLE GAIN IN UNNEUTRALIZED AMPLIFIERS -- 20 db MIN @ 60 MHz**
  8 db MIN @ 450 MHz
- **LOW FEEDBACK CAPACITANCE -- 0.5 pF MAX**
- **GUARANTEED FORWARD AGC**

ABSOLUTE MAXIMUM RATINGS [Note 1]

Maximum Temperatures

Storage Temperature	−55°C to +200°C
Operating Junction Temperature	+200°C

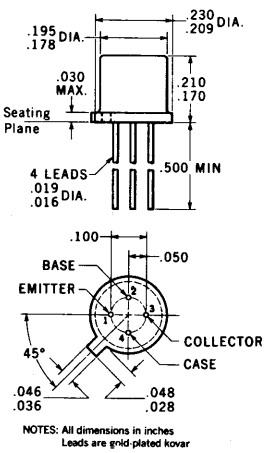
Maximum Power Dissipation

Total Dissipation at 25°C Case Temperature [Note 2]	0.3 Watt
at 25°C Ambient Temperature [Note 2]	0.2 Watt

Maximum Voltages

V_{CBO}	Collector to Base Voltage	30 Volts
V_{CEO}	Collector to Emitter Voltage [Note 3]	30 Volts
V_{EBO}	Emitter to Base Voltage	3.0 Volts

PHYSICAL DIMENSIONS
in accordance with
JEDEC (TO-72)



NOTES: All dimensions in inches
Leads are gold-plated kovar

ELECTRICAL CHARACTERISTICS (25°C Free Air Temperature Unless Otherwise Specified)

SYMBOL	CHARACTERISTIC		MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
NF	**Noise Figure (f = 450 MHz)** [Note 5]	(2N4135 only)			**5.0**	**dB**	I_E = 1.0 mA V_{CB} = 15 V, $R_S \approx$ 130 Ω
PG	**Power Gain (f = 450 MHz)** (Adjusted for min. Noise Figure; Note 5)	(2N4135 only)	**8.0**	**10**			I_E = 1.0 mA V_{CB} = 15 V
NF	**Noise Figure (f = 60 MHz)** [Note 6]			**2.0**	**2.5**	**dB**	I_E = 1.0 mA V_{CB} = 15 V, $R_S \approx$ 300 Ω
PG	**Power Gain, Neutralized (f = 60 MHz)** (Adjusted for min. Noise Figure; Note 6)		**17**	**21**	**24**	**dB**	I_E = 1.0 mA V_{CB} = 15 V
PG	**Power Gain, Unneutralized (f = 60 MHz)** [Note 7]		**20**	**23**	**25**	**dB**	I_E = 5.0 mA V_{AGC} = 13 V
V_{AGC}	**AGC Voltage for 30 db Gain Reduction (f = 60 MHz)** [Note 7]		**19**	**22**	**24.5**	**Volts**	V_{CC} = 28 V
$r_b'C_c$	Collector-Base Time Constant (f = 80 MHz)			2.5	5.0	ps	I_C = 4.0 mA V_{CE} = 10 V
f_{max}	Maximum Frequency of Oscillation			3.25		GHz	I_E = 4.0 mA V_{CB} = 15 V
C_{cb}	**Reverse Transfer Capacity Common Emitter**		**0.25**	**0.37**	**0.50**	**pF**	I_E = 0 **V_{CE} = 10 V** f = 1.0 MHz (Emitter & Can Guarded)
h_{fe}	High Frequency Current Gain (f = 100 MHz)	(2N4135 only)	4.25		8.0		I_C = 4.0 mA V_{CE} = 10 V
h_{fe}	High Frequency Current Gain (f = 100 MHz)	(2N4134 only)	3.5		8.0		I_C = 4.0 mA V_{CE} = 10 V
h_{FE}	DC Pulse Current Gain [Note 4]		25		200		I_C = 4.0 mA V_{CE} = 10 V
h_{FE} (−55°C)	DC Pulse Current Gain [Note 4]		10				I_C = 4.0 mA V_{CE} = 10 V
V_{CEO} (sust)	Collector to Emitter Sustaining Voltage [Notes 3 and 4]		30			Volts	I_C = 1.0 mA I_B = 0
BV_{CBO}	Collector to Base Breakdown Voltage		30			Volts	I_C = 1.0 mA I_E = 0
BV_{EBO}	Emitter to Base Breakdown Voltage		3.0			Volts	I_C = 0 I_E = 100 μA
V_{BE} (sat)	Base Saturation Voltage				0.92	Volt	I_C = 10 mA I_B = 5.0 mA
V_{CE} (sat)	Collector Saturation Voltage				3.0	Volts	I_C = 10 mA I_B = 5.0 mA
I_{CBO} (150°C)	Collector Cutoff Current				50	μA	I_E = 0 V_{CB} = 10 V
I_{CBO} (25°C)	Collector Cutoff Current				50	nA	I_E = 0 V_{CB} = 10 V

* Planar is a patented Fairchild process.

FAIRCHILD
SEMICONDUCTOR
A DIVISION OF FAIRCHILD CAMERA AND INSTRUMENT CORPORATION

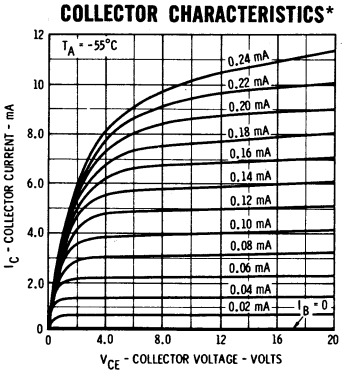
313 FAIRCHILD DRIVE, MOUNTAIN VIEW, CALIFORNIA, (415) 962-5011, TWX: 910-379-6435

NOTES:

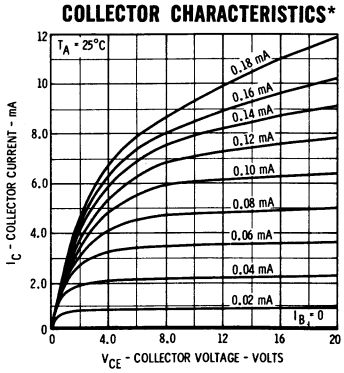
(1) These ratings are limiting values above which the serviceability of any individual semiconductor device may be impaired.
(2) These ratings give a maximum junction temperature of 200°C and junction to case thermal resistance of 583°C/Watt (derating factor 1.72 mW/°C); junction to ambient thermal resistance of 875°C/Watt (derating factor of 1.14 mW/°C).
(3) Rating refers to a high-current point where collector to emitter voltage is lowest.
(4) Pulse Conditions: length = 300 μs; duty cycle = 1%.
(5) Test conditions are as shown in Figure 1. Noise Figure referenced to AIL type 70 Hot-Cold noise standard. Noise Figure includes second stage contribution of 5.0 db.
(6) Test conditions are as shown in Figure 2. Amplifier Gain is measured with amplifier input tuned for minimum noise figure. Neutralization is used to minimize input bandpass skewing. With neutralization network removed, amplifier gain will be 2 to 3 db lower, but noise figure will not change measurably.
(7) Test conditions are as shown in Figure 3.
(8) Socket Capacitance is typically 0.5 pF and will degrade amplifier gain and stability. Best performance is obtained by omitting sockets and soldering or clipping transistor to the ground plane. If a socket is required, a shield should be used between the base and collector socket pins.

TYPICAL ELECTRICAL CHARACTERISTICS

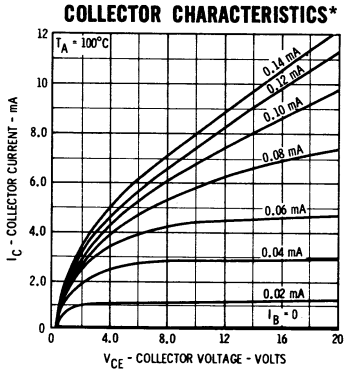
COLLECTOR CHARACTERISTICS*



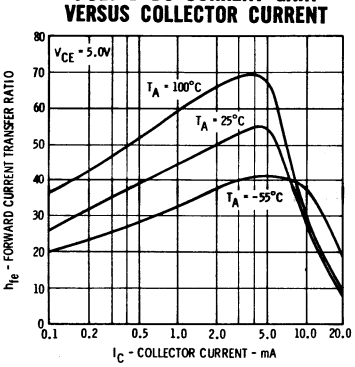
COLLECTOR CHARACTERISTICS*



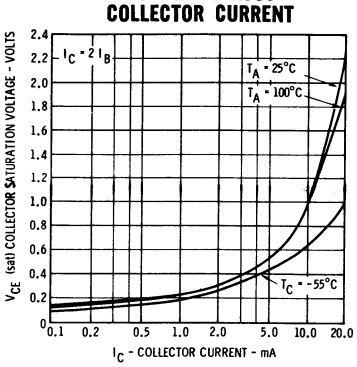
COLLECTOR CHARACTERISTICS*



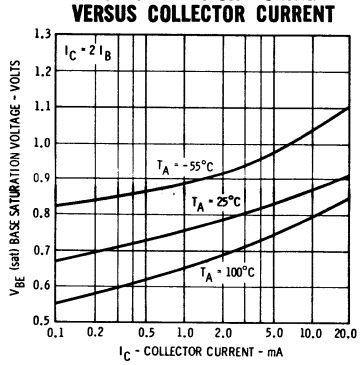
PULSED DC CURRENT GAIN VERSUS COLLECTOR CURRENT



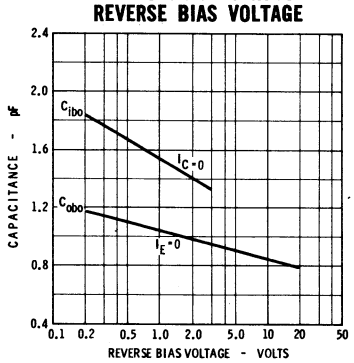
COLLECTOR SATURATION VOLTAGE VERSUS COLLECTOR CURRENT



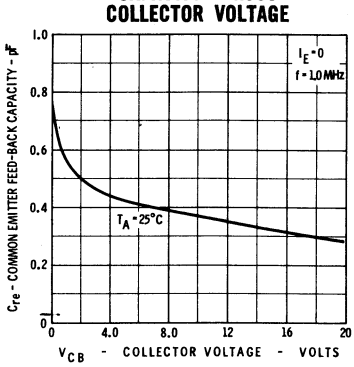
BASE SATURATION VOLTAGE VERSUS COLLECTOR CURRENT



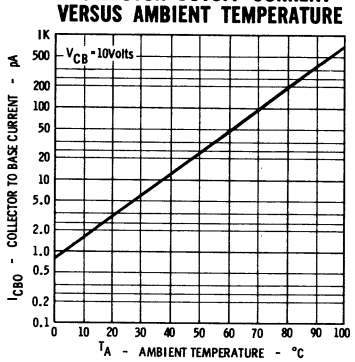
INPUT AND OUTPUT CAPACITANCE VERSUS REVERSE BIAS VOLTAGE



COMMON EMITTER FEED-BACK CAPACITY VERSUS COLLECTOR VOLTAGE

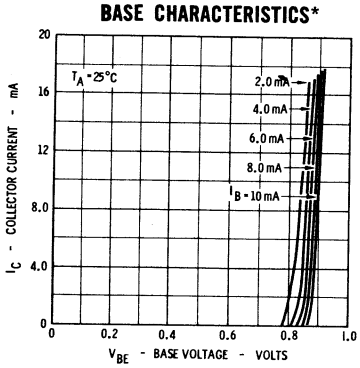


COLLECTOR CUTOFF CURRENT VERSUS AMBIENT TEMPERATURE

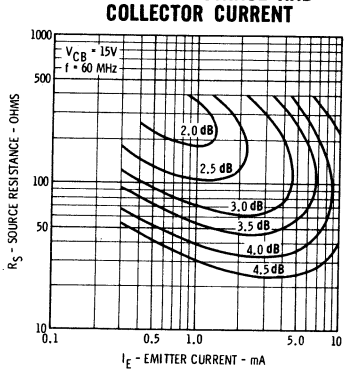


* Single family characteristic on Transistor Curve Tracer.

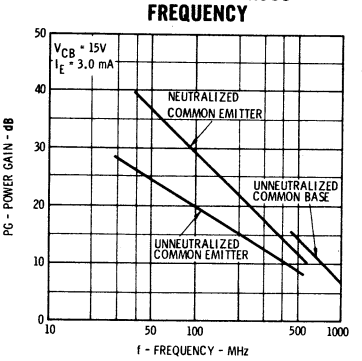
BASE CHARACTERISTICS*



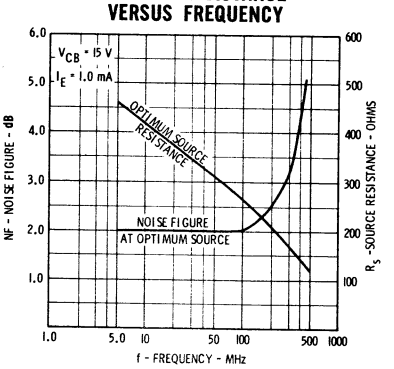
NOISE FIGURE VERSUS SOURCE RESISTANCE AND COLLECTOR CURRENT



POWER GAIN VERSUS FREQUENCY

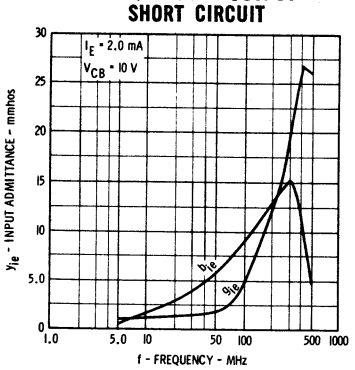


NOISE FIGURE AND SOURCE RESISTANCE VERSUS FREQUENCY

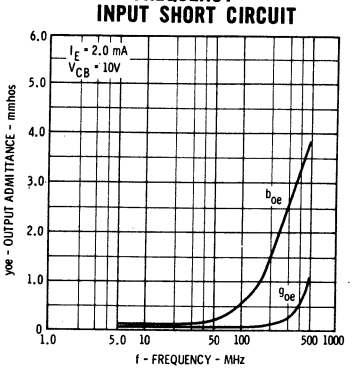


TYPICAL "Y" PARAMETERS

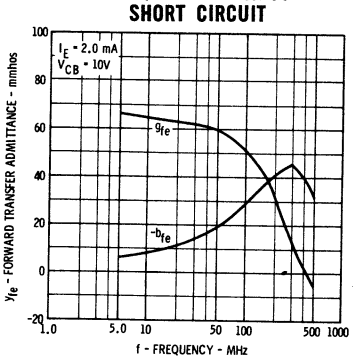
INPUT ADMITTANCE VERSUS FREQUENCY — OUTPUT SHORT CIRCUIT



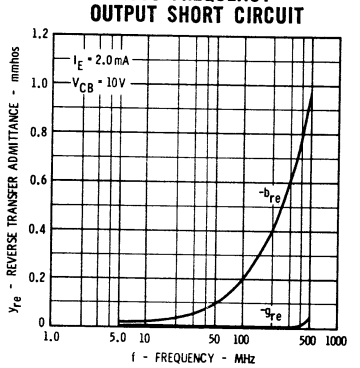
OUTPUT ADMITTANCE VERSUS FREQUENCY — INPUT SHORT CIRCUIT



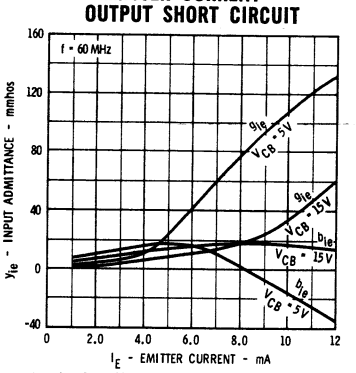
FORWARD TRANSFER ADMITTANCE VERSUS FREQUENCY — INPUT SHORT CIRCUIT



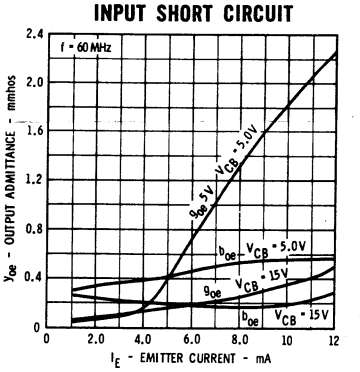
REVERSE TRANSFER ADMITTANCE VERSUS FREQUENCY — OUTPUT SHORT CIRCUIT



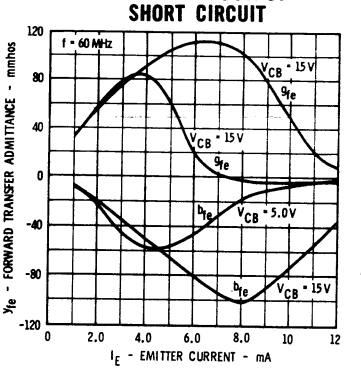
INPUT ADMITTANCE VERSUS EMITTER CURRENT — OUTPUT SHORT CIRCUIT



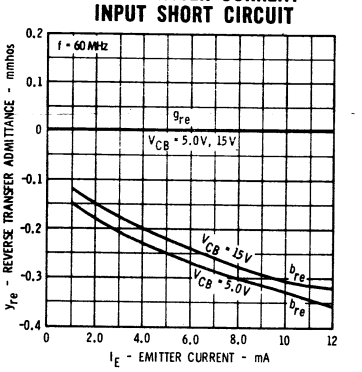
OUTPUT ADMITTANCE VERSUS EMITTER CURRENT — INPUT SHORT CIRCUIT



FORWARD TRANSFER ADMITTANCE VERSUS EMITTER CURRENT — OUTPUT SHORT CIRCUIT

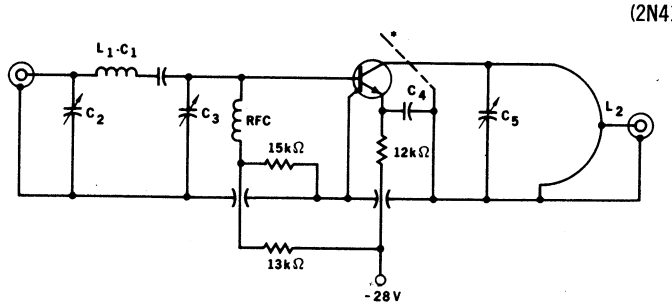


REVERSE TRANSFER ADMITTANCE VERSUS EMITTER CURRENT — INPUT SHORT CIRCUIT



* Single family characteristic on Transistor Curve Tracer.

FIG. 1 450 MHz NOISE FIGURE AND POWER GAIN CIRCUIT
(2N4135 only)



L_1 - C_1 300 pF, PORCELAIN CAPACITOR: CAPACITOR LEADS FORM L_1; LEAD DIAMETER 0.025, LENGTH 1-3/8" FROM INPUT CONNECTOR TO BASE PIN OF TRANSISTOR (VITRAMON VY 12C301 OR EQUIVALENT)

L_2 - 1 TURN, #22 TINNED WIRE 1/2" DIAMETER, 5/16" LONG, CENTER TAP

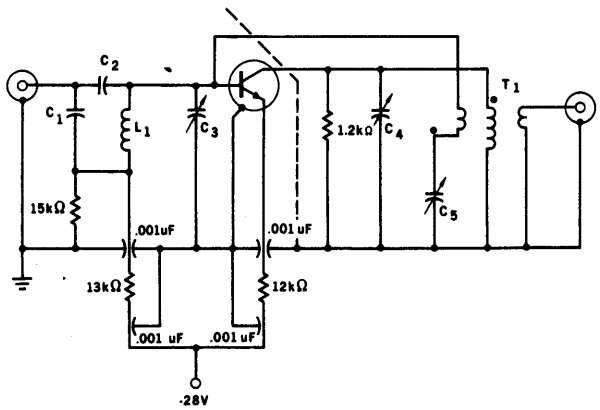
C_2, C_3, C_5 0.8 - 10 pF, AIR VARIABLE (JOHANSEN 2950 OR EQUIVALENT)

C_4 500 pF, UNCASED CERAMIC (CENTRALAB DA121 OR EQUIVALENT)

RFC 6" #30 ENAMEL WIRE, CLOSE WOUND, 1/16" DIAMETER

FEEDTHROUGH CAPACITORS ARE 1000 pF CERAMIC (ALLEN-BRADLEY FASC OR EQUIVALENT)

FIG. 2 60 MHz NOISE FIGURE AND POWER GAIN CIRCUIT



C_1 - 62 pF DIPPED MICA CAPACITOR

C_2 - 51 pF DIPPED MICA CAPACITOR

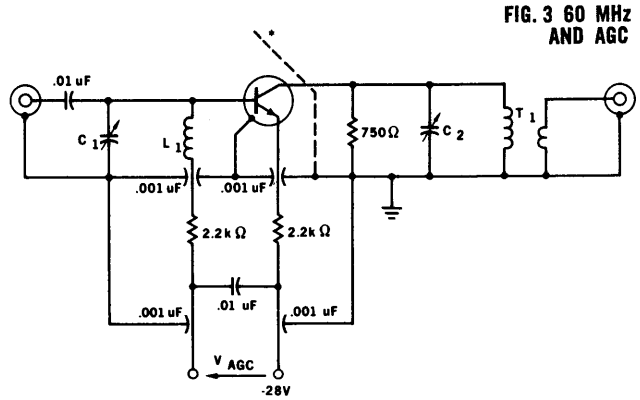
C_3, C_4, C_5 - 0.8 - 10 pF, AIR VARIABLE, (JOHANSEN 2950 OR EQUIVALENT)

APPROXIMATE CAPACITANCE,

L_1 - 5 TURNS NUMBER 18 ENAMEL WIRE, AIR WOUND, 5/16" INSIDE DIAMETER, 3/8" LONG, INDUCTANCE 0.14 μH.

T_1 - PRIMARY: 14 TURNS NUMBER 24 ENAMEL WIRE SPACED EVENLY AROUND 0.156" I. D. TOROID (ARNOLD A4-310-125 SF OR EQUIVALENT) INDUCTANCE 0.82 μH, SECONDARY: 3 TURNS, NEUTRALIZATION WINDING: 3 T CLOSE WOUND BYPASS AND FEEDTHROUGH CAPACITORS ARE 1000 pF CERAMIC (ALLEN-BRADLEY FASC OR EQUIVALENT)

FIG. 3 60 MHz POWER GAIN AND AGC CIRCUIT



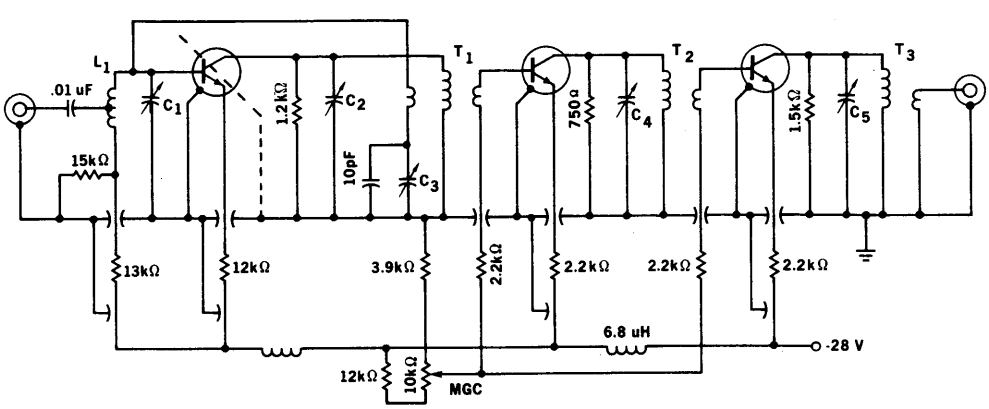
*See Note 8

L_1 - 7 TURNS, NUMBER 22 ENAMEL WIRE WOUND ON 0.156" I. D. TOROID FORM, ARNOLD ENGINEERING COMPANY, TYPE A4-310-125-SF, OR EQUIVALENT, INDUCTANCE 0.21 μH.

T_1 - PRIMARY: 14 TURNS, NUMBER 24 ENAMEL WIRE WOUND ON TOROID, INDUCTANCE 0.82 μH. SECONDARY: 3 T, NUMBER 22 ENAMEL WIRE WOUND ON COLD END OF PRIMARY

C_1, C_2 - 0.8 - 10 pF, AIR VARIABLE, (JOHANSEN 2950 OR EQUIVALENT) BYPASS AND FEEDTRHOUGH CAPACITOR ARE 1000 pF CERAMIC (ALLEN-BRADLEY FASC OR EQUIVALENT)

60 MHz I.F. AMPLIFIER WITH MANUAL GAIN CONTROL



CENTER FREQUENCY: 60 MHz

3 dB BANDWIDTH: 10.5 MHz

SPOT NOISE FIGURE: 1.8 ± 0.1 dB

GAIN: 62 dB

AGC RANGE: 60 dB

SUPPLY CURRENT: 15 mA; 21 mA @ 60 dB AGC

L_1 - 15 TURNS NUMBER 30 ENAMEL WIRE, CENTER TAPPED, WOUND ON 0.156" I. D. TOROID (MICROMETALS T30-13 OR EQUIVALENT) INDUCTANCE 0.32 μH

T_1 - PRIMARY 14 TURNS NUMBER 24 ENAMEL WIRE SPACED EVENLY AROUND 0.156" I. D. TOROID (ARNOLD A4-310-125 SF OR EQUIVALENT) INDUCTANCE 0.82 μH
SECONDARY: 1 TURN, NEUTRALIZATION WINDING: 1 TURN

T_2 - AS T_1 WITHOUT NEUTRALIZATION WINDING

T_3 - PRIMARY: SAME AS T_1, SECONDARY: 3 TURNS

C_1, C_2, C_3, C_4, C_5 - 0.8 to 10 pF AIR VARIABLE (JOHANSEN 2950 OR EQUIVALENT)

Q_1, Q_2, Q_3 - 2N4134 OR 2N4135

NEUTRALIZATION TECHNIQUE: APPLY 60 MHz SIGNAL TO AMPLIFIER INPUT. DISCONNECT EMITTER RESISTOR OF Q_1. ADJUST C_3 FOR MINIMUM FEEDTHROUGH POWER. GAIN LOSS WITH ZERO EMITTER CURRENT IN Q_1 SHOULD BE GREATER THAN 45 dB.

BYPASS AND FEEDTHROUGH CAPACITORS ARE 1000 pF CERAMIC (ALLEN-BRADLEY FASC OR EQUIVALENT).

2N4137

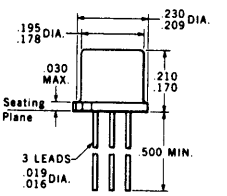
NPN HIGH-SPEED SATURATED SWITCH

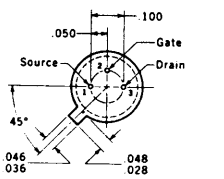
DIFFUSED SILICON PLANAR EPITAXIAL TRANSISTOR

FEATURES

- **HIGH FREQUENCY CURRENT GAIN -- f_T = 500 MHz Min.**
- **HIGH VOLTAGE -- LV_{CEO} = 20 VOLT Min.**
- **LOW CAPACITY -- C_{obo} = 4.0 pf Max.**
- **LOW CHARGE STORAGE TIME -- τ_s = 13 ns Max.**

PHYSICAL DIMENSIONS
in accordance with
JEDEC (TO-18) outline





NOTES All dimensions in inches
Leads are gold plated kovar
Gate internally connected to case
Package weight is 0.43 gram

ABSOLUTE MAXIMUM RATINGS [Note 1]

Maximum Temperatures		
Storage Temperature		−65°C to +200°C
Operating Temperature		200°C Maximum
Lead Temperature (Soldering, 60 sec Time Limit)		300°C Maximum
Maximum Power Dissipation		
Total Dissipation at 25°C Case Temperature [Notes 2 and 3]		1.2 Watts
at 100°C Case Temperature [Notes 2 and 3]		0.68 Watt
at 25°C Ambient Temperature [Notes 2 and 3]		0.36 Watt
Maximum Voltages and Currents		
V_{CBO}	Collector to Base Voltage	40 Volts
V_{CES}	Collector to Emitter Voltage	40 Volts
V_{CEO}	Collector to Emitter Voltage [Note 4]	20 Volts
V_{EBO}	Emitter to Base Voltage	4.5 Volts
I_C	Collector Current (10 μsec Pulse)	500 mA
I_C	DC Collector Current	200 mA

ELECTRICAL CHARACTERISTICS (25°C Free Air Temperature unless otherwise noted)

SYMBOL	CHARACTERISTIC	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS	
h_{FE}	DC Pulse Current Gain [Note 5]	40	66	120		I_C = 10 mA	V_{CE} = 1.0 V
h_{FE} (−55°C)	**DC Pulse Current Gain [Note 5]**	**20**	**50**			**I_C = 10 mA**	**V_{CE} = 0.35 V**
V_{BE} (sat)	Pulsed Base Saturation Voltage [Note 5]	0.72	0.8	0.85	Volts	I_C = 10 mA	I_B = 1.0 mA
V_{BE} (sat)	**Pulsed Base Saturation Voltage (−55°C to +125°C)** [Note 5]	0.59		1.02	Volts	I_C = 10 mA	I_B = 1.0 mA
V_{BE} (sat)	Pulsed Base Saturation Voltage [Note 5]		0.9	1.15	Volts	I_C = 30 mA	I_B = 3.0 mA
V_{BE} (sat)	Pulsed Base Saturation Voltage [Note 5]		1.1	1.6	Volts	I_C = 100 mA	I_B = 10 mA
V_{CE} (sat)	**Pulse Collector Saturation Voltage (125°C)** [Note 5]		**0.19**	**0.3**	**Volts**	**I_C = 10 mA**	**I_B = 1.0 mA**
I_{CES}	Collector Reverse Current		0.05	0.4	μA	V_{BE} = 0	V_{CE} = 20 V
I_{CBO} (150°C)	Collector Cutoff Current		10	30	μA	I_E = 0	V_{CB} = 20 V
BV_{CES}	Collector to Emitter Breakdown Voltage	40			Volts	I_C = 10 μA	V_{BE} = 0
BV_{CBO}	Collector to Base Breakdown Voltage	40			Volts	I_C = 10 μA	I_E = 0
V_{CEO} (sust)	**Collector to Emitter Sustaining Voltage** [Notes 4 and 5]	**20**			**Volts**	**I_C = 10 mA** (pulsed)	**I_B = 0**
BV_{EBO}	Emitter to Base Breakdown Voltage	4.5			Volts	I_E = 10 μA	I_C = 0

NOTES:

(1) These ratings are limiting values above which the serviceability of any individual semiconductor device may be impaired.

(2) These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.

(3) These ratings give a maximum junction temperature of 200°C and junction-to-case thermal resistance of 146°C/watt (derating factor of 6.85 mW/°C). Junction-to-ambient thermal resistance of 486°C/watt (derating factor of 2.06 mW/°C).

(4) Ratings refer to a high-current point where collector-to-emitter voltage is lowest.

(5) Pulse Conditions: length = 300 μsec; duty cycle = 1%.

(6) See switching circuits for exact value of I_C, I_{B1}, and I_{B2}.

FAIRCHILD
SEMICONDUCTOR
A DIVISION OF FAIRCHILD CAMERA AND INSTRUMENT CORPORATION

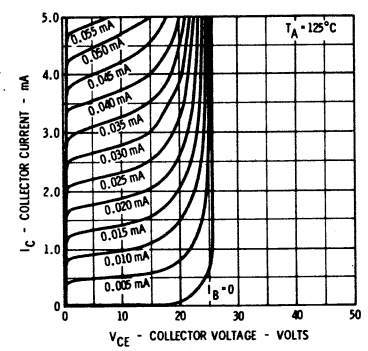
313 FAIRCHILD DRIVE, MOUNTAIN VIEW, CALIFORNIA, (415) 962-5011, TWX: 910-379-6435

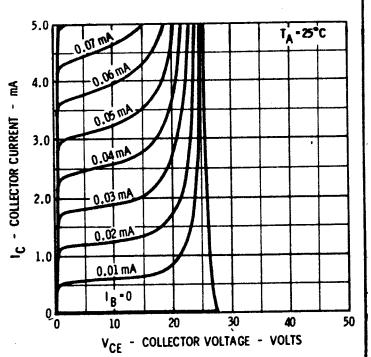
ELECTRICAL CHARACTERISTICS (25°C Free Air Temperature unless otherwise noted)

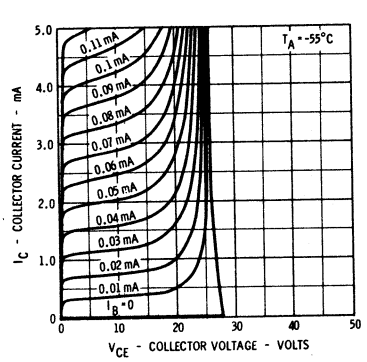
SYMBOL	CHARACTERISTIC	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
h_{FE}	**DC Pulse Current Gain** [Note 5]	**40**	**63**	**120**		I_C = **10 mA** V_{CE} = **0.35 V**
h_{FE}	DC Pulse Current Gain [Note 5]	30	71			I_C = 30 mA V_{CE} = 0.4 V
h_{FE}	DC Pulse Current Gain [Note 5]	20				I_C = 100 mA V_{CE} = 1.0 V
V_{CE} (sat)	**Pulsed Collector Saturation Voltage** [Note 5]		**0.14**	**0.2**	**Volts**	I_C = **10 mA** I_B = 1.0 mA
V_{CE} (sat)	Pulsed Collector Saturation Voltage [Note 5]		0.12	0.18	Volts	I_C = 10 mA I_B = 3.3 mA
V_{CE} (sat)	Pulsed Collector Saturation Voltage [Note 5]		0.17	0.25	Volts	I_C = 30 mA I_B = 3.0 mA
V_{CE} (sat)	Pulsed Collector Saturation Voltage [Note 5]		0.28	0.5	Volts	I_C = 100 mA I_B = 10 mA
V_{BE} (sat)	**Pulsed Base Saturation Voltage** [Note 5]	0.74	0.85	1.0	Volts	I_C = 10 mA I_B = 3.3 mA
h_{fe}	**High Frequency Current Gain (f = 100 mc)**	**5.0**	**6.75**			I_C = **10 mA** V_{CE} = 10 V
C_{ob}	**Output Capacitance**		**2.3**	**4.0**	**pf**	I_E = 0 V_{CB} = **5.0 V**
τ_s	**Charge Storage Time Constant** [Note 6]		**6.0**	**13**	**nsec**	$I_C = I_{B1} \approx$ **10 mA**, $I_{B2} \approx -$**10 mA**
t_{on}	Turn On Time [Note 6]		9.0	12	nsec	$I_C \approx$ 10 mA $I_{B1} \approx$ 3.3 mA
t_{off}	Turn Off Time [Note 6]		7.0	12	nsec	$I_C \approx$ 10 mA, $I_{B1} \approx$ 3.3 mA, $I_{B2} \approx -$3.3 mA

TYPICAL COLLECTOR AND BASE CHARACTERISTICS

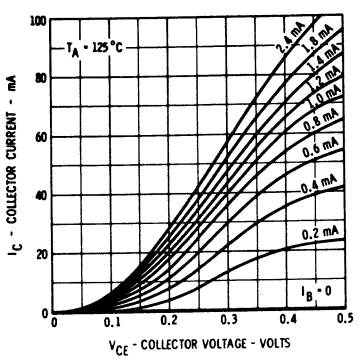
ACTIVE REGION

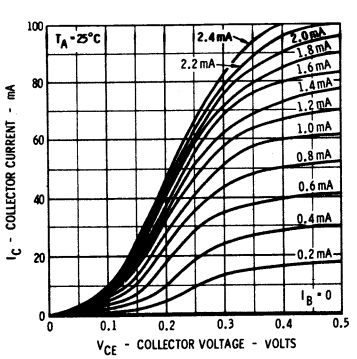


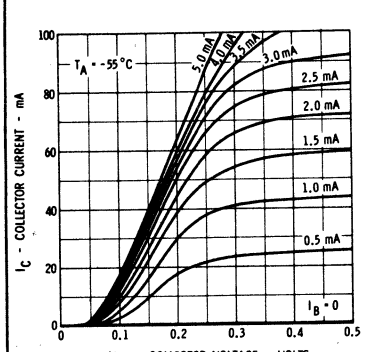


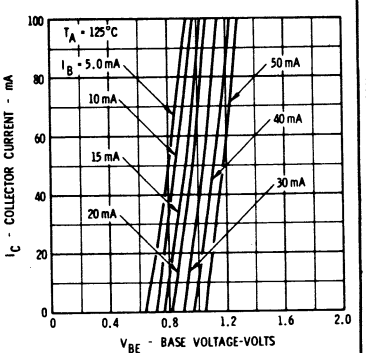


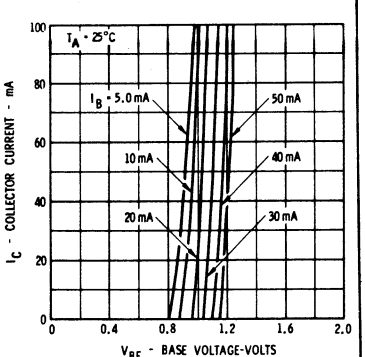
SATURATION REGION

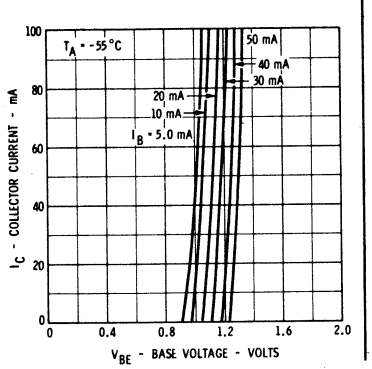




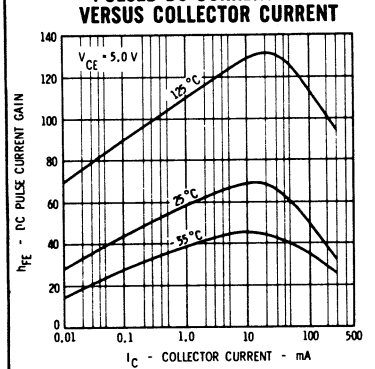




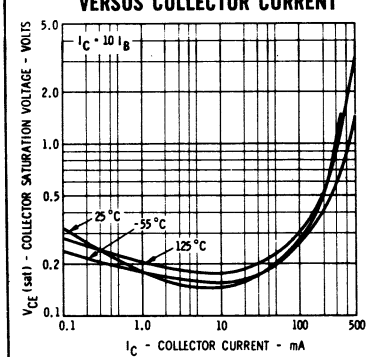




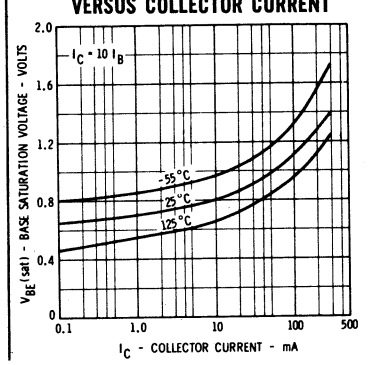
PULSED DC CURRENT GAIN VERSUS COLLECTOR CURRENT



COLLECTOR SATURATION VOLTAGE VERSUS COLLECTOR CURRENT

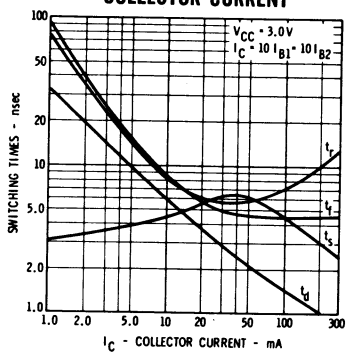


BASE SATURATION VOLTAGE VERSUS COLLECTOR CURRENT

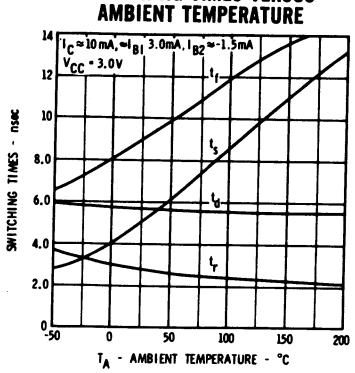


TYPICAL ELECTRICAL CHARACTERISTICS

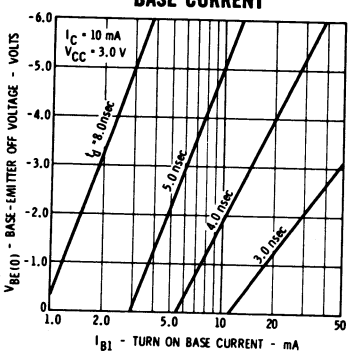
SWITCHING TIMES VERSUS COLLECTOR CURRENT



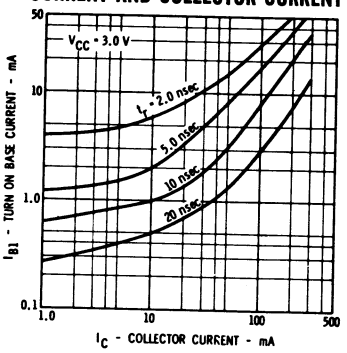
SWITCHING TIMES VERSUS AMBIENT TEMPERATURE



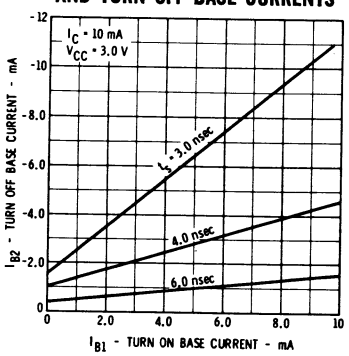
DELAY TIME VERSUS BASE-EMITTER OFF VOLTAGE AND TURN ON BASE CURRENT



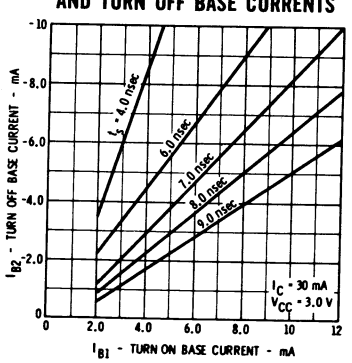
RISE TIME VERSUS TURN ON BASE CURRENT AND COLLECTOR CURRENT



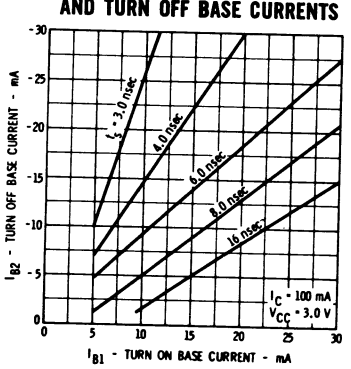
STORAGE TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS



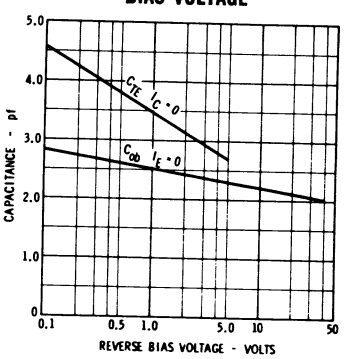
STORAGE TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS



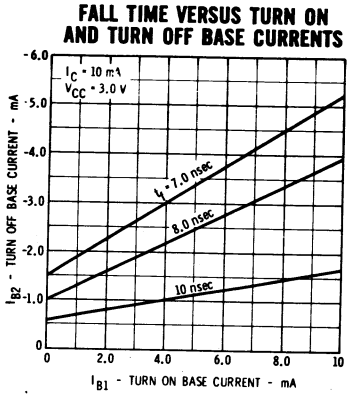
STORAGE TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS



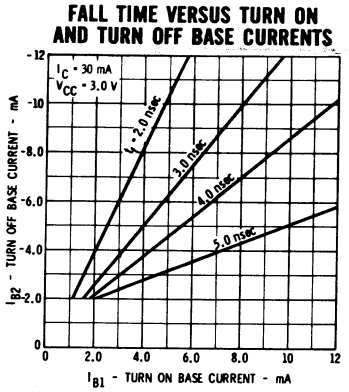
EMITTER TRANSITION AND OUTPUT CAPACITANCES VERSUS REVERSE BIAS VOLTAGE



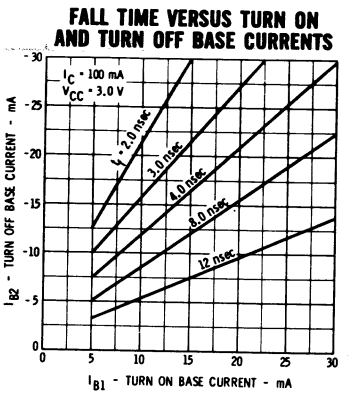
FALL TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS



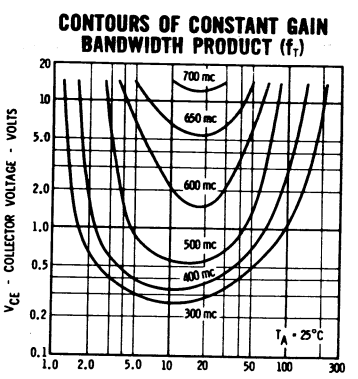
FALL TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS



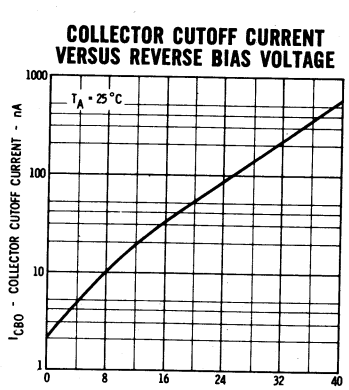
FALL TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS



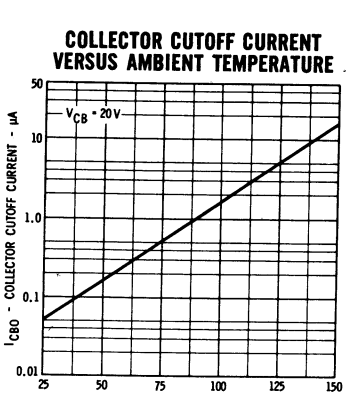
CONTOURS OF CONSTANT GAIN BANDWIDTH PRODUCT (f_T)



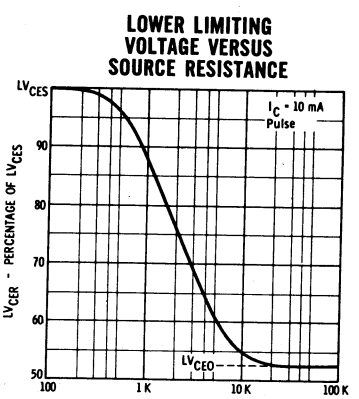
COLLECTOR CUTOFF CURRENT VERSUS REVERSE BIAS VOLTAGE



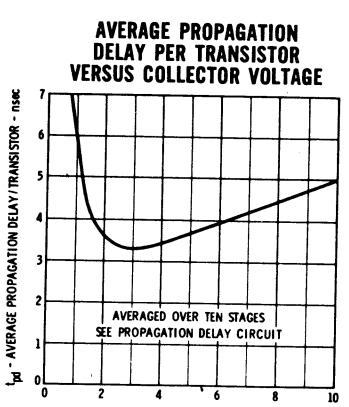
COLLECTOR CUTOFF CURRENT VERSUS AMBIENT TEMPERATURE



LOWER LIMITING VOLTAGE VERSUS SOURCE RESISTANCE

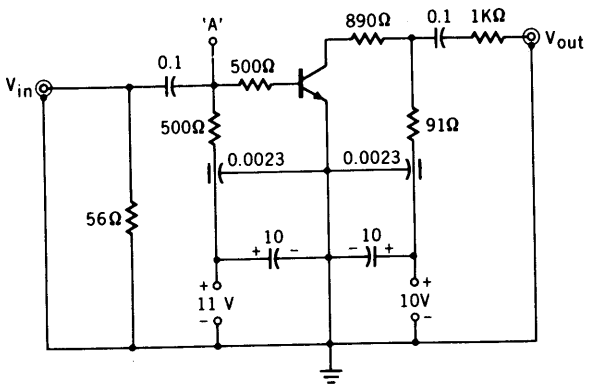


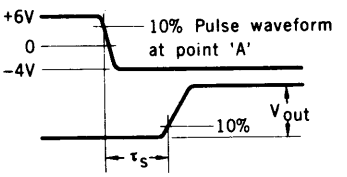
AVERAGE PROPAGATION DELAY PER TRANSISTOR VERSUS COLLECTOR VOLTAGE



CHARGE STORAGE TIME MEASUREMENT CIRCUIT

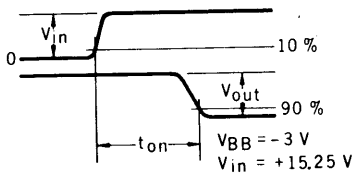
Pulse Generator
V_{in} Rise Time < 1 nsec
Source Impedance = 50Ω
PW ≥ 300 nsec
Duty Cycle < 2 %



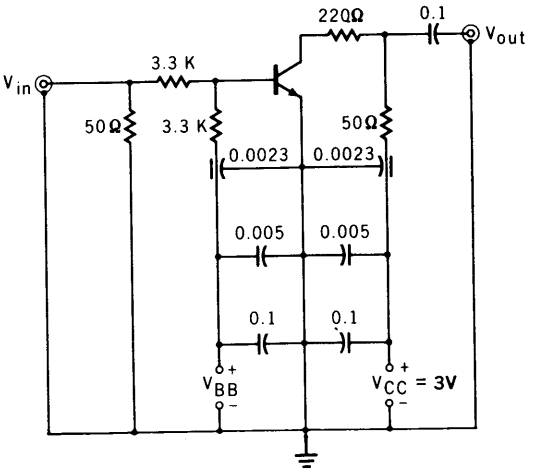


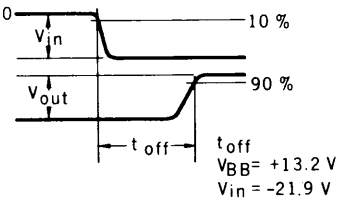
To Sampling Oscilloscope
Input Impedance = 50Ω
Rise Time ≤ 1 nsec

t_{ON} — t_{OFF} MEASUREMENT CIRCUIT



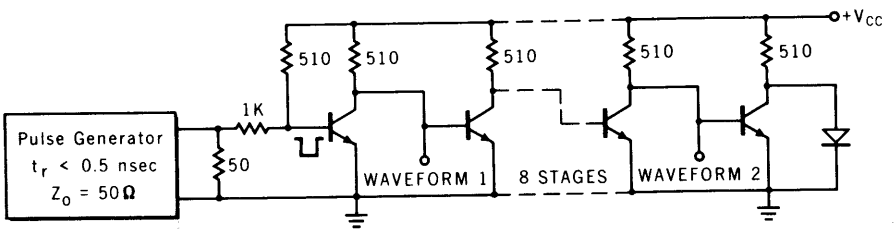
Pulse Generator
V_{in} Rise Time < 1 nsec
Source Impedance = 50Ω
PW ≥ 300 nsec
Duty Cycle < 2 %





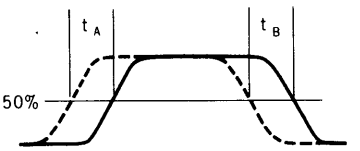
To Sampling Oscilloscope
Input Impedance = 50Ω
Rise Time ≤ 1 nsec

CIRCUIT FOR MEASUREMENT OF PROPAGATION DELAY



$\bar{t}pd = \frac{t_A + t_B}{20}$

$\bar{t}pd$ = Average Propagation per Transistor



Waveforms 1 and 2 Superimposed

2N4212 THROUGH 2N4218

PNPN SILICON CONTROLLED RECTIFIERS

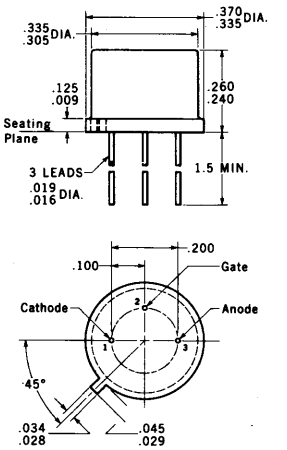
DIFFUSED SILICON PLANAR* THYRISTORS

- **FORWARD CURRENT RATING OF 1.25 AMPS D.C. AT $T_C = 85°C$**
- **BLOCKING VOLTAGE CAPABILITY THROUGH 300 VOLTS**
- **MAXIMUM GATE TRIGGER CURRENT OF 100 μA AT $T_C = 25°C$**
- **RELIABLE PLANAR*CONSTRUCTION**

ABSOLUTE MAXIMUM RATINGS (Note 1)

Maximum Temperatures			
†Storage Temperature		T_{stg}	−65°C to +150°C
†Operating Junction Temperature		T_J	−65°C to +125°C
Maximum Currents			
rms Forward Current	$T_C = 85°C$	$I_{F(rms)}$	1.6 Amps
(180° Conduction Angle) (Note 2)	$T_A = 25°C$		490 mA
Continuous Forward Current	$T_C = 85°C$	$I_{F(DC)}$	1.25 Amps
	$T_A = 25°C$		355 mA
Average Forward Current	†$T_C = 85°C$	$I_{F(AV)}$	1.0 Amp
(180° Conduction Angle)(Note 2)	†$T_C = 105°C$		0.5 Amp
	$T_A = 25°C$		310 mA
†Surge Current	$T_C = 85°C$	$I_{FM(surge)}$	15 Amps
(½ cycle sine wave, 60 Hz peak)			
†Peak Forward Gate Current	$T_C = 25°$	I_{GFM}	0.1 Amp
(180° Conduction Angle)			
Maximum Gate Power ($T_C = 85°C$)			
†Peak Gate Power Dissipation		P_{GM}	0.1 Watt
†Average Gate Power Dissipation		$P_{GM(AV)}$	0.01 Watt
Maximum Voltages ($T_C = -65°C$ to 125°C)			
†Peak Reverse Gate Voltage		V_{GRM}	6.0 Volts
†Peak Forward and Reverse Blocking Voltages		V_{FM}, V_{RM}	**2N4212** 25 Volts
			2N4213 50 Volts
			2N4214 100 Volts
			2N4215 150 Volts
			2N4216 200 Volts
			2N4217 250 Volts
			2N4218 300 Volts

PHYSICAL DIMENSIONS
in accordance with
JEDEC (TO-5) outline



NOTES:
All dimensions in inches.
Leads are gold-plated Kovar.
Anode internally connected to case.
Package weight is 1.23 grams

ELECTRICAL CHARACTERISTICS (25°C Case Temperature unless otherwise noted)

SYMBOL	CHARACTERISTIC	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS	
I_{FX}	Forward Blocking Current		40	200	nA	V_{AK} = Rated V_{FM}	$R_{GK} = 1.0\ k\Omega$
†I_{FX}(125°C)	Forward Blocking Current		20	200	μA	V_{AK} = Rated V_{FM}	$R_{GK} = 1.0\ k\Omega$
I_{RX}	Reverse Blocking Current		40	200	nA	V_{AK} = Rated V_{RM}	$R_{GK} = 1.0\ k\Omega$
†I_{RX}(125°C)	Reverse Blocking Current		20	200	μA	V_{AK} = Rated V_{RM}	$R_{GK} = 1.0\ k\Omega$
I_{GT}	Gate Trigger Current		40	100	μA	$V_{AA} = 7.0$ V	$R_L = 100\ \Omega$
†I_{GT}(−65°C)	Gate Trigger Current		120	300	μA	$V_{AA} = 7.0$ V	$R_L = 100\ \Omega$
V_{GT}	Gate Trigger Voltage		0.58	0.7	Volt	$V_{AA} = 7.0$ V, $R_{GK} = 1.0\ k\Omega$,	$R_L = 100\ \Omega$
†V_{GT}(−65°C)	Gate Trigger Voltage		0.8	1.0	Volt	$V_{AA} = 7.0$ V, $R_{GK} = 1.0\ k\Omega$,	$R_L = 100\ \Omega$
†V_{GT}(125°C)	Gate Trigger Voltage	0.1	0.21		Volt	V_{AA} = Rated V_{FM}, $R_{GK} = 1.0\ k\Omega$,	$R_L = 100\ \Omega$
I_{HX}	Holding Current		0.9		mA	$V_{AA} = 7.0$ V	$R_{GK} = 1.0\ k\Omega$
†I_{HX}(−65°C)	Holding Current		1.75	7.0	mA	$V_{AA} = 7.0$ V	$R_{GK} = 1.0\ k\Omega$
I_{GR}	Reverse Gate Current		.005	1.0	μA	$V_{GK} = -6.0$ V	$I_A = 0$
†V_F	On Voltage (Note 4)		1.7	2.0	Volts	$I_F = 3.14$ A	
dV/dt	Critical Rate of Rise of Anode Voltage		150		V/μs	V_{AA} = Rated V_{FM}	$R_{GK} = 500\ \Omega$

†JEDEC Registered Values.

*Planar is a patented Fairchild process.

NOTES:
(1) These ratings are limiting values above which the reliability of the device may be impaired.
(2) These ratings give a maximum junction temperature of 125°C with the maximum average power dissipation and a maximum junction to case thermal resistance of 18°C/Watt and a junction to ambient thermal resistance of 225°C/Watt.
(3) Ambient temperature derating curves are derived with no external heat sink connected.
(4) Pulse Conditions: length = 1ms max; duty cycle ≤ 1%.

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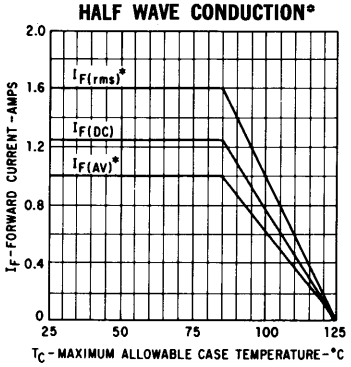
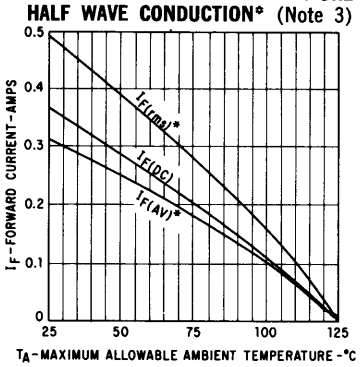
MAXIMUM RATINGS

FORWARD CURRENT VERSUS MAXIMUM ALLOWABLE CASE TEMPERATURE HALF WAVE CONDUCTION*



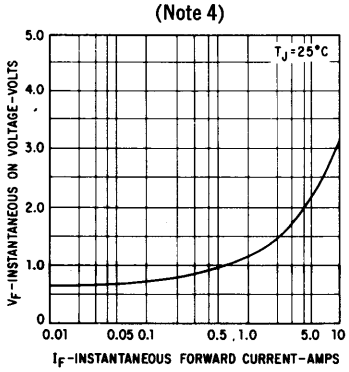
FORWARD CURRENT VERSUS MAXIMUM ALLOWABLE AMBIENT TEMPERATURE HALF WAVE CONDUCTION* (Note 3)



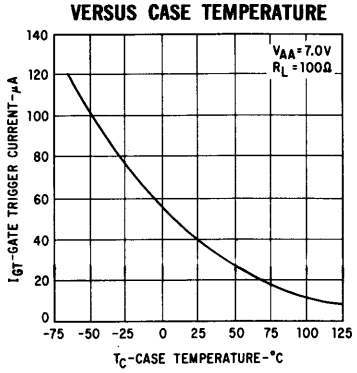
*180° Conduction Angle for Sinusoidal Current Waveform; 50 to 400 Hz.

TYPICAL ELECTRICAL CHARACTERISTICS

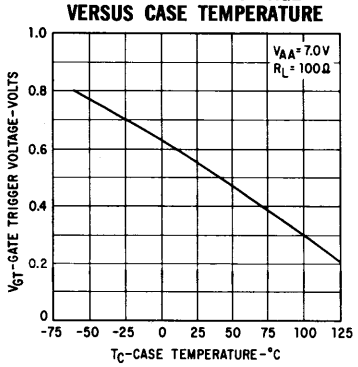
INSTANTANEOUS ON VOLTAGE VERSUS FORWARD CURRENT (Note 4)



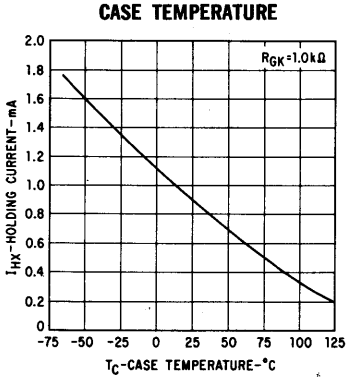
GATE TRIGGER CURRENT VERSUS CASE TEMPERATURE



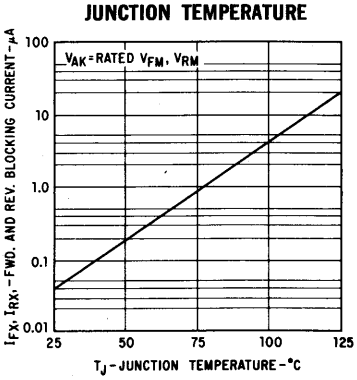
GATE TRIGGER VOLTAGE VERSUS CASE TEMPERATURE



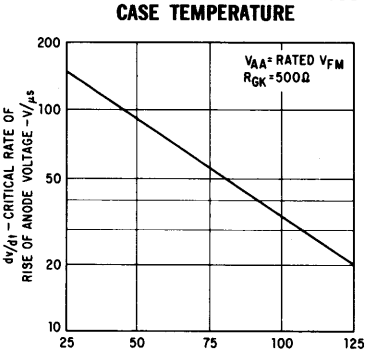
HOLDING CURRENT VERSUS CASE TEMPERATURE



FORWARD AND REVERSE BLOCKING CURRENT VERSUS JUNCTION TEMPERATURE



ALLOWABLE CRITICAL RATE OF RISE OF ANODE VOLTAGE VERSUS CASE TEMPERATURE



2N4251

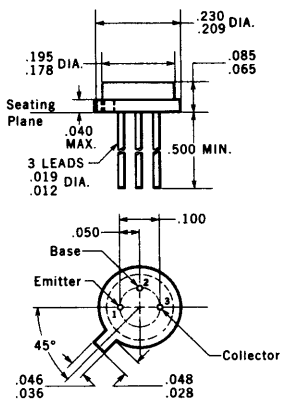
NPN RADIATION RESISTANT SWITCH

DIFFUSED SILICON PLANAR* EPITAXIAL TRANSISTOR

FEATURES

- **HIGH FREQUENCY — f_T = 1.3 GHz Min.**
- **HIGH h_{FE} @ I_C = 10 mA — 100 Min., 180 Typ., 300 Max.**
- **LOW V_{CE}(sat) @ I_C = 10 mA — 50 mV Typ., 150 mV Max.**
- **LOW C_{obo} @ V_{CB} = 10 V — 2.0 pF Max.**
- **LOW C_{ibo} @ V_{EB} = 0.5 V — 4.0 pF Max.**
- **GUARANTEED PERFORMANCE AFTER FAST NEUTRON DOSE (10^{15} nvt)**

PHYSICAL DIMENSIONS
in accordance with
JEDEC (TO-46) outline



NOTES: All dimensions in inches
Leads are gold-plated kovar
Collector internally connected to case
Package weight is 0.36 gram

ABSOLUTE MAXIMUM RATINGS

Maximum Temperatures (Note 1)

Storage Temperature	−55°C to +200°C
Operating Junction Temperature	+200°C Maximum
Lead Temperature (Soldering, 10 seconds Time Limit)	+300°C Maximum

Maximum Voltages (Note 1)

V_{CBO} Collector to Base Voltage	15 Volts
V_{CEO} Collector to Emitter Voltage	10 Volts
V_{EBO} Emitter to Base Voltage	4.5 Volts

Maximum Power Dissipation (Note 2 and 3)

Total Dissipation at	
25°C Case Temperature	1.3 Watts
25°C Ambient Temperature	0.25 Watt

ELECTRICAL CHARACTERISTICS (25°C Free Air Temperature unless otherwise noted)

SYMBOL	CHARACTERISTICS	PRE-IRRADIATION MIN.	PRE-IRRADIATION TYP.	PRE-IRRADIATION MAX.	POST-IRRADIATION MIN.	POST-IRRADIATION TYP.	POST-IRRADIATION MAX.	UNITS	TEST CONDITIONS	
V_{CEO}(sust)	Collector to Emitter Sustaining Voltage (Note 4 and 6)	10	12		10	20		Volts	I_C = 10 mA (pulsed)	I_B = 0
BV_{CES}	Collector to Emitter Breakdown Voltage	15	23		15	25		Volts	I_C = 1.0 mA	I_B = 0
BV_{EBO}	Emitter to Base Breakdown Voltage	4.5	5.5		4.5	5.6		Volts	I_C = 0	I_E = 1.0 mA
h_{FE}	**DC Pulse Current Gain** (Note 4)	**32**	78		**5.0**	7.0			**I_C = 100 μA**	**V_{CE} = 5.0 V**
h_{FE}	**DC Pulse Current Gain** (Note 4)	**62**	124		**9.0**	12			**I_C = 1.0 mA**	**V_{CE} = 5.0 V**
h_{FE}	**DC Pulse Current Gain** (Note 4)	**100**	180	300	**15**	20			**I_C = 10 mA**	**V_{CE} = 5.0 V**
h_{FE}	**DC Pulse Current Gain** (Note 4)	**94**	170		**14**	17			**I_C = 100 mA**	**V_{CE} = 5.0 V**
h_{FE} (−55°C)	**DC Pulse Current Gain** (Note 4)	**50**	90		**8.0**	12			**I_C = 10 mA**	**V_{CE} = 5.0 V**
V_{CE} (sat)	Pulsed Collector Saturation Voltage (Note 4)		0.05	0.15		0.18	0.25	Volts	I_C = 10 mA	I_B = 1.0 mA
V_{BE} (sat)	Pulsed Base Saturation Voltage (Note 4)		0.80	0.90		0.80	0.90	Volts	I_C = 10 mA	I_B = 1.0 mA
h_{fe}	**High Frequency Current Gain** (f = 100 MHz)	**13**	15		**10**	13			**I_C = 10 mA**	**V_{CE} = 5.0 V**
C_{obo}	**Common Base, Open Circuit Output Capacitance**			**2.0**			**2.0**	pF	I_E = 0	**V_{CB} = 10 V**
C_{ibo}	**Common Base, Open Circuit Input Capacitance**			**4.0**			**4.0**	pF	I_C = 0	**V_{EB} = 0.5 V**
I_{CBO}	Collector Cutoff Current		0.005	1.0		0.1	10.0	μA	I_E = 0	V_{CB} = 10 V
I_{CBO} (150°C)	Collector Cutoff Current			10			10	μA	I_E = 0	V_{CB} = 10 V
t_{on}	Turn On Time (see Figure 1)		13	20		13	20	ns	I_C = 10 mA	I_{B1} = 1.0 mA
t_{off}	Turn Off Time (see Figure 1)		49	60		5.0	60	ns	I_C = 10 mA	I_{B1} = 1.0 mA, I_{B2} = 1.0 mA
τ_s	Charge Storage Time (see Figure 2)		60	80		4.0	80	ns	I_C = 10 mA	I_{B1} = 10 mA, I_{B2} = 10 mA

* Planar is a patented Fairchild process.

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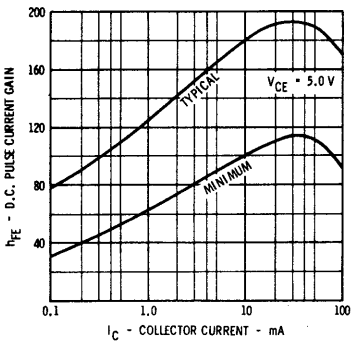
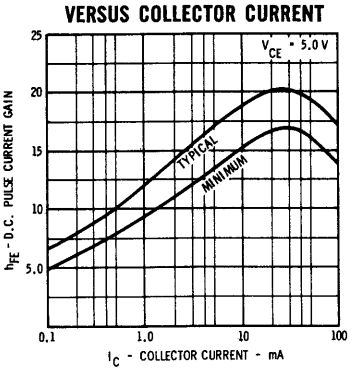
TYPICAL ELECTRICAL CHARACTERISTICS

PRE-IRRADIATION D.C. PULSE CURRENT GAIN VERSUS COLLECTOR CURRENT



POST-IRRADIATION D.C. PULSE CURRENT GAIN VERSUS COLLECTOR CURRENT



TYPICAL D.C. PULSE CURRENT GAIN VERSUS FAST-NEUTRON FLUX DOSAGE

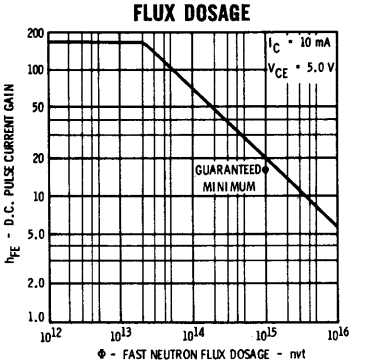


FIGURE 1

t_{on}, t_{off} TEST CIRCUIT

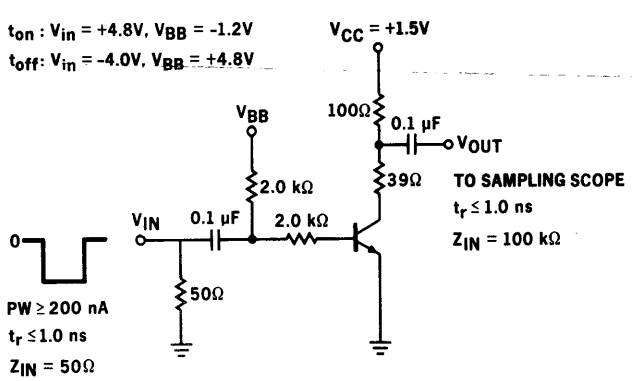
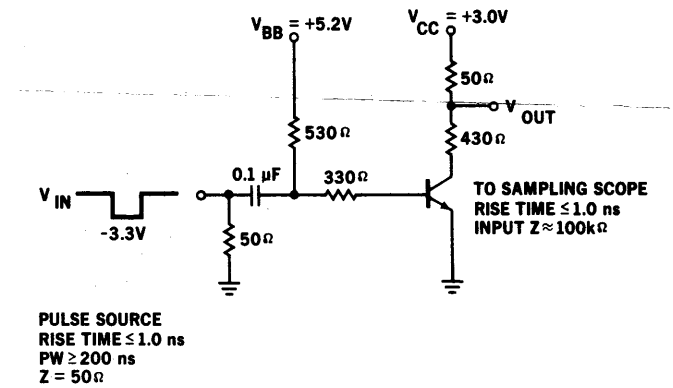


FIGURE 2

τ_s - TEST CIRCUIT



NOTES:

(1) These ratings are limiting values above which the serviceability of any individual semiconductor device may be impaired.
(2) These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.
(3) These ratings based on maximum junction temperature of 200°C and junction to case thermal resistance of 135°C/watt (derating factor of 7.43 mW/°C) and junction to ambient thermal resistance of 700°C/watt (derating factor of 1.43 mW/°C).
(4) Pulse conditions: length = 300 μs; duty cycle = 1%.
(5) Post-irradiation characteristics after an integrated fast (>100 KEV) neutron flux of 10^{15} nvt (neutrons per cm^2).
(6) This rating refers to a high-current point where collector to emitter voltage is lowest.

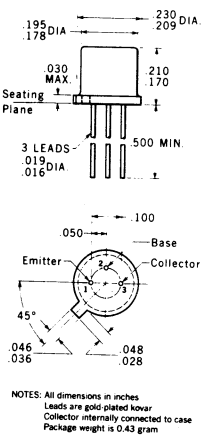
2N4359

PNP LOW-NOISE, LOW-LEVEL AMPLIFIER

DIFFUSED SILICON PLANAR* TRANSISTOR

- **LOW NOISE . . . . . NF = 4.0 dB (MAX) AT 1.0 kHz**
- **HIGH BETA . . . . . h_{FE} = 50-500 AT 10 μA**
- **EXCELLENT BETA LINEARITY . . . FROM 10 μA TO 50 mA**
- **HIGH BREAKDOWN VOLTAGE . . . LV_{CEO} = 45 VOLTS (MIN)**

PHYSICAL DIMENSIONS
in accordance with
JEDEC (TO-18) outline



NOTES: All dimensions in inches
Leads are gold-plated kovar
Collector internally connected to case
Package weight is 0.43 gram

ABSOLUTE MAXIMUM RATINGS [Note 1]

Maximum Temperatures

Storage Temperature	−65°C to +200°C
Operating Junction Temperature	200°C
Lead Temperature (Soldering, 60 Sec. Time Limit)	300°C

Maximum Power Dissipation

Total Dissipation at 25°C Case Temperature [Notes 2 and 3]	1.2 Watts
at 25°C Ambient Temperature [Notes 2 and 3]	0.36 Watt

Maximum Voltages

V_{CBO}	Collector to Base Voltage	−45 Volts
V_{CEO}	Collector to Emitter Voltage [Note 4]	−45 Volts
V_{EBO}	Emitter to Base Voltage	−5.0 Volts

ELECTRICAL CHARACTERISTICS (25°C Free Air Temperature Unless Otherwise Noted)

SYMBOL	CHARACTERISTIC	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS	
h_{FE}	**DC Current Gain**	**50**	**210**	**500**		**I_C = 10 μA**	**V_{CE} = −5.0 V**
h_{FE}	DC Current Gain	50	260			I_C = 100 μA	V_{CE} = −5.0 V
h_{FE}	**DC Current Gain**	**50**	**310**	**600**		**I_C = 1.0 mA**	**V_{CE} = −5.0 V**
h_{FE}	DC Pulse Current Gain [Note 5]	50	340			I_C = 10 mA	V_{CE} = −5.0 V
h_{FE} (0°C)	DC Current Gain	35	160			I_C = 10 μA	V_{CE} = −5.0 V
V_{CEO} (sust)	**Collector to Emitter Sustaining Voltage**	**−45**			**Volts**	**I_C = 5.0 mA**	**I_B = 0**
h_{fe}	High Frequency Current Gain (f = 20 MHz)	1.0	6.0	10		I_C = 1.0 mA	V_{CE} = −5.0 V
NF	Wide Band Noise Figure (f = 10 Hz to 10 kHz)		1.7	5.0	dB	I_C = 20 μA	V_{CE} = −5.0 V
						R_S = 10 kΩ Power Bandwidth = 15.7 kHz	
NF	Narrow Band Noise Figure (f = 10 kHz)		1.0	3.0	dB	I_C = 20 μA	V_{CE} = −5.0 V
						R_S = 10 kΩ Power Bandwidth = 1.5 kHz	
NF	**Narrow Band Noise Figure (f = 1.0 kHz)**		**1.5**	**4.0**	**dB**	**I_C = 20 μA**	**V_{CE} = −5.0 V**
						R_S = 10 kΩ, Power Bandwidth = 150 Hz	
BV_{CBO}	Collector to Base Breakdown Voltage	−45			Volts	I_C = 10 μA	I_E = 0
BV_{EBO}	Emitter to Base Breakdown Voltage	−5.0			Volts	I_C = 0	I_E = 100 μA
I_{CBO}	Collector Reverse Current		0.35	10	nA	I_E = 0	V_{CB} = −25 V
I_{EBO}	Emitter Cutoff Current		2.0	20	nA	I_C = 0	V_{EB} = −3.0 V
C_{obo}	Open Circuit Output Capacitance (f = 1.0 MHz)		4.0	6.0	pF	I_E = 0	V_{CB} = −5.0 V
C_{ibo}	Open Circuit Input Capacitance (f = 1.0 MHz)		14	18	pF	I_C = 0	V_{EB} = −0.5 V
I_{CBO} (85°C)	Collector Reverse Current		0.05	2.0	μA	I_E = 0	V_{CB} = −25 V
V_{CE} (sat)	Pulsed Collector Saturation Voltage [Note 5]		−0.13	−0.25	Volts	I_C = 10 mA	I_B = 1.0 mA
V_{BE} (sat)	Pulsed Base Saturation Voltage [Note 5]		−0.76	−0.90	Volts	I_C = 10 mA	I_B = 1.0 mA

* Planar is a patented Fairchild process.

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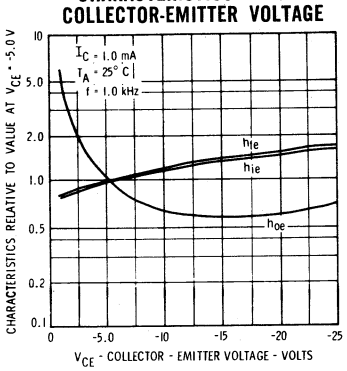
SMALL SIGNAL CHARACTERISTICS ($f = 1.0$ kHz)

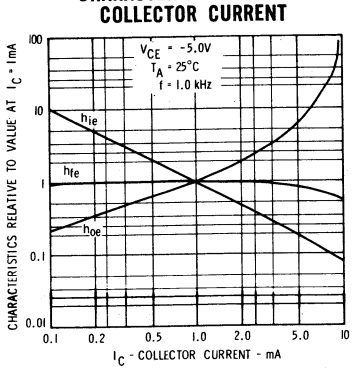
SYMBOL	CHARACTERISTICS	MIN.	MAX.	UNITS	TEST CONDITIONS
h_{fe}	Small Signal Current Gain	50	700		$I_C = 1.0$ mA $V_{CE} = -5.0$ V
h_{ie}	Input Resistance	1.0	20	k ohms	$I_C = 1.0$ mA $V_{CE} = -5.0$ V
h_{oe}	Output Conductance	5.0	60	μmhos	$I_C = 1.0$ mA $V_{CE} = -5.0$ V
h_{re}	Voltage Feedback Ratio		10	$x10^{-4}$	$I_C = 1.0$ mA $V_{CE} = -5.0$ V

TYPICAL ELECTRICAL CHARACTERISTICS

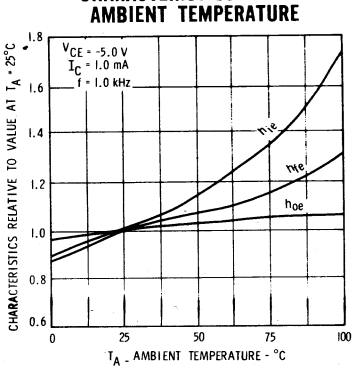
COMMON EMITTER CHARACTERISTICS VERSUS COLLECTOR-EMITTER VOLTAGE



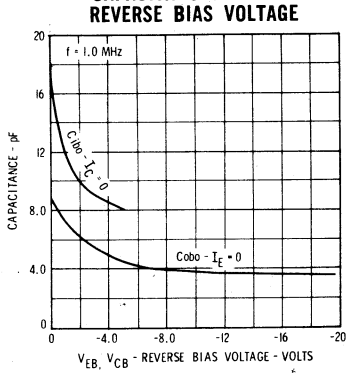
COMMON EMITTER CHARACTERISTICS VERSUS COLLECTOR CURRENT



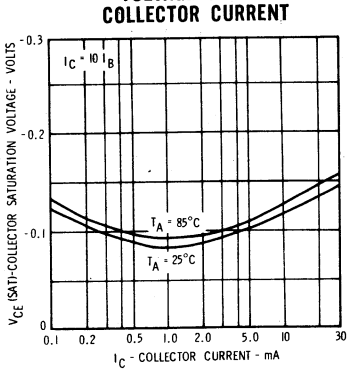
COMMON EMITTER CHARACTERISTICS VERSUS AMBIENT TEMPERATURE



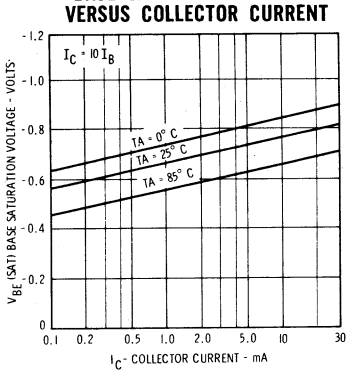
INPUT AND OUTPUT CAPACITANCES VERSUS REVERSE BIAS VOLTAGE



COLLECTOR SATURATION VOLTAGE VERSUS COLLECTOR CURRENT

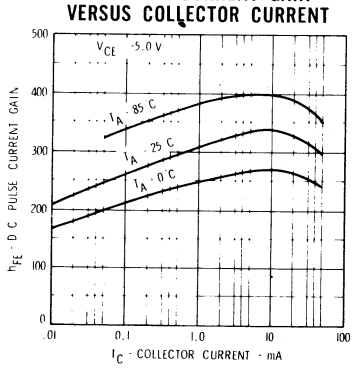


BASE SATURATION VOLTAGE VERSUS COLLECTOR CURRENT

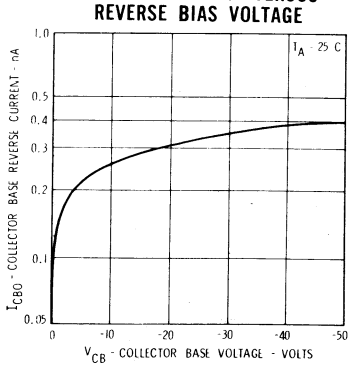


TYPICAL ELECTRICAL CHARACTERISTICS

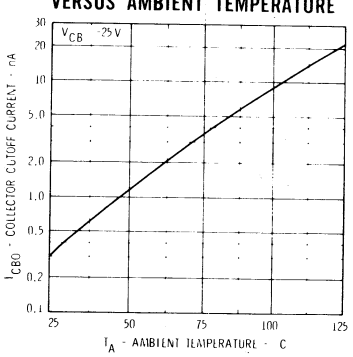
DC PULSE-CURRENT GAIN VERSUS COLLECTOR CURRENT



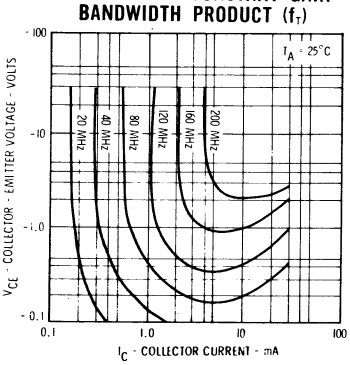
COLLECTOR-BASE DIODE REVERSE CURRENT VERSUS REVERSE BIAS VOLTAGE



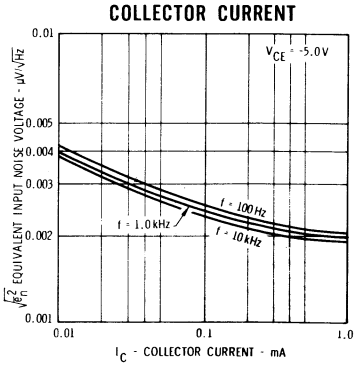
COLLECTOR CUTOFF CURRENT VERSUS AMBIENT TEMPERATURE



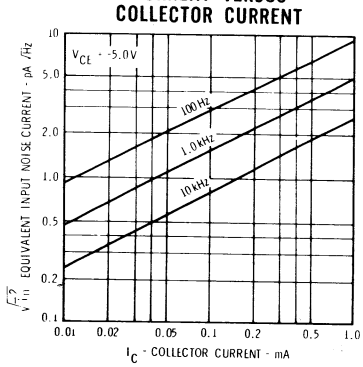
CONTOURS OF CONSTANT GAIN BANDWIDTH PRODUCT (f_T)



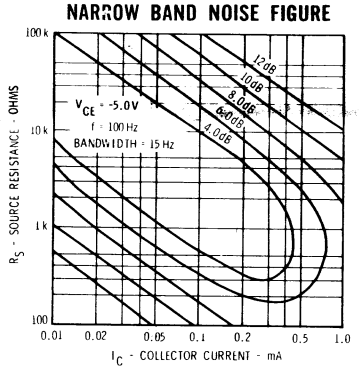
EQUIVALENT INPUT NOISE VOLTAGE VERSUS COLLECTOR CURRENT



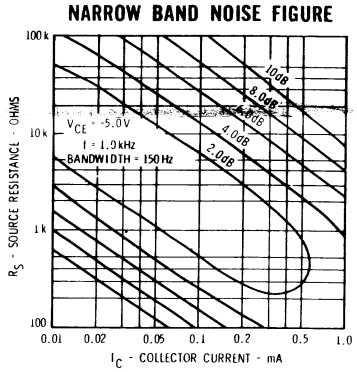
EQUIVALENT INPUT NOISE CURRENT VERSUS COLLECTOR CURRENT



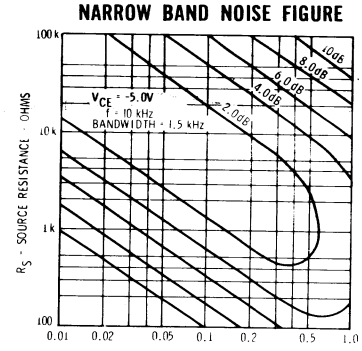
CONTOURS OF CONSTANT NARROW BAND NOISE FIGURE



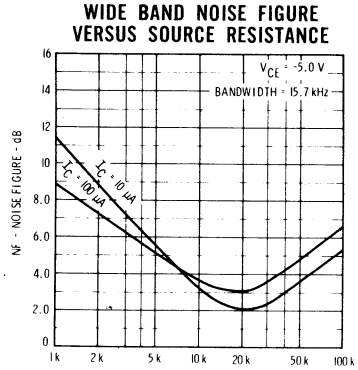
CONTOURS OF CONSTANT NARROW BAND NOISE FIGURE



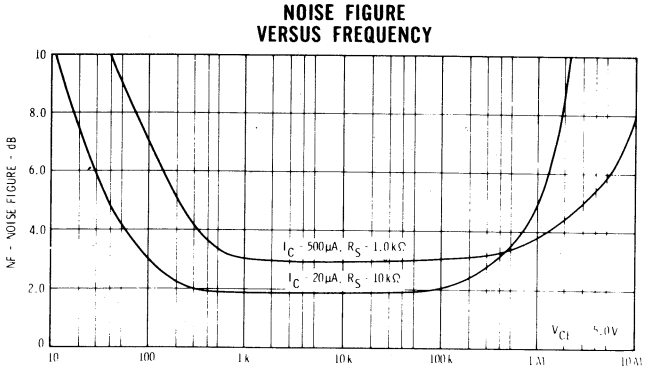
CONTOURS OF CONSTANT NARROW BAND NOISE FIGURE



WIDE BAND NOISE FIGURE VERSUS SOURCE RESISTANCE

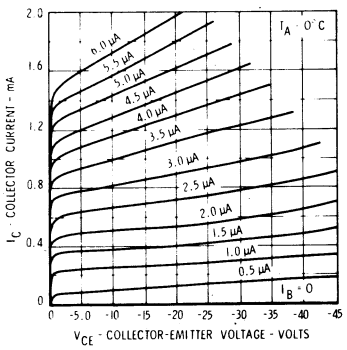


NOISE FIGURE VERSUS FREQUENCY

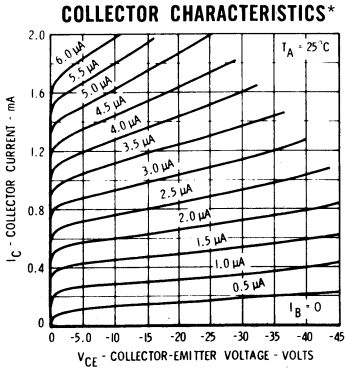


TYPICAL ELECTRICAL CHARACTERISTICS

COLLECTOR CHARACTERISTICS*



COLLECTOR CHARACTERISTICS*



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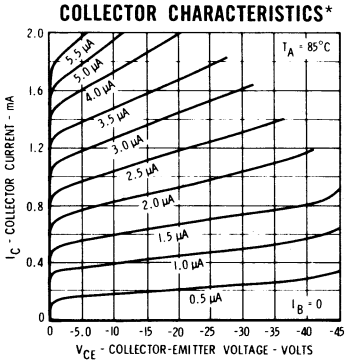

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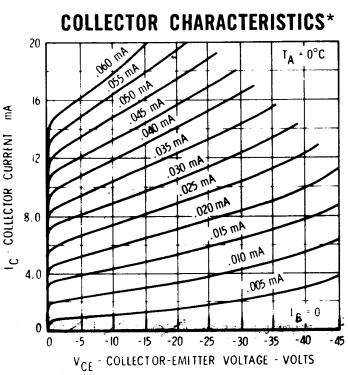

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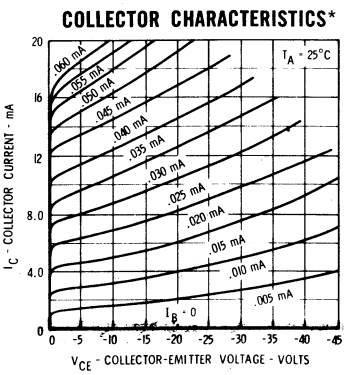

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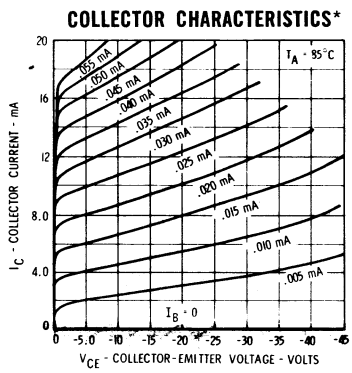

NOTES:

(1) These ratings are limiting values above which the serviceability of any individual semiconductor device may be impaired.

(2) These are steady state limits. The factory should be consulted on applications involving pulsed or low-duty cycle operations.

(3) These ratings give a maximum junction temperature of 200°C and junction to case thermal resistance of 146°C/Watt (derating factor of 6.85 mW/°C); junction to ambient thermal resistance of 486°C/Watt (derating factor of 2.06 mW/°C).

(4) This rating refers to a high-current point where collector to emitter voltage is lowest.

(5) Pulse Conditions: length = 300 μs; duty cycle = 1%.

* Single family characteristic on Transistor Curve Tracer.