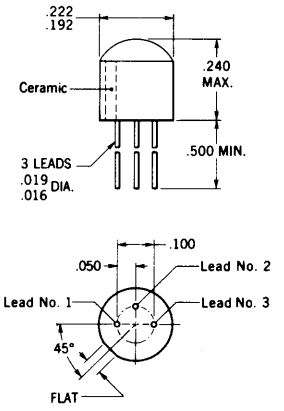
2N4436 • 2N4437

NPN CLASS-C RF AMPLIFIERS AND HIGH CURRENT SWITCHES

DIFFUSED SILICON PLANAR* EPITAXIAL TRANSISTORS

- **HIGH GAIN -- 400 mW RF POWER OUT @ 30 MHz**
- **HIGH BETA -- 100 MIN @ 150 mA, 25 MIN @ 500 mA**
- **HIGH f_T -- 250 MHz MIN @ 50 mA**
- **FAST SWITCHING -- 60 ns MAX t_{on} AND 150 ns MAX t_{off} @ 300 mA**
- **LOW $V_{CE(sat)}$ -- 0.22 V MAX @ 150 mA, 0.35 V TYP. @ 500 mA**

PHYSICAL DIMENSIONS
Epoxy package
TO-106



NOTES: All dimensions in inches
All leads electrically isolated from case
Package weight is 0.31 gram

ABSOLUTE MAXIMUM RATINGS [Note 1]

Maximum Temperatures

Storage Temperature	−55°C to +125°C
Operating Junction Temperature	125°C
Lead Temperature (Soldering, 10 second time limit)	260°C

Maximum Power Dissipation

Total Dissipation at 25°C Case Temperature [Notes 2 and 3]	0.5 Watt
at 25°C Ambient Temperature [Notes 2 and 3]	0.2 Watt

Maximum Voltages

V_{CBO}	Collector to Base Voltage	60 Volts
V_{CEO}	Collector to Emitter Voltage [Note 4]	30 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
G_{PE}	**Amplifier Power Gain (f = 30 MHz)** [Note 7]		**10**	**12**		**dB**	I_C = 0 V_{CE} = 15 V (zero signal)
η	Collector Efficiency (f = 30 MHz) [Note 7]		60	75		%	I_C = 0 V_{CE} = 15 V (zero signal)
h_{fe}	**High Frequency Current Gain (f = 100 MHz)**		**2.5**		**8.0**		I_C = **50 mA** V_{CE} = **5.0 V**
h_{FE}	**DC Pulse Current Gain** [Note 5]	**2N4436**	**40**	**75**	**120**		I_C = 150 mA V_{CE} = 10 V
		2N4437	**100**	**220**	**300**		I_C = 150 mA V_{CE} = 10 V
h_{FE}	DC Pulse Current Gain [Note 5]	2N4436	15	62			I_C = 500 mA V_{CE} = 10 V
		2N4437	25	125			I_C = 500 mA V_{CE} = 10 V
t_{on}	Turn On Time [Note 6]			14	60	ns	$I_C \approx$ 300 mA $I_{B1} \approx$ 30 mA
t_{off}	Turn Off Time [Note 6]			80	150	ns	$I_C \approx$ 300 mA $I_{B1} \approx$ 30 mA $I_{B2} \approx$ 30 mA

* Planar is a patented Fairchild process.

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 125°C and junction to case thermal resistance of 200°C/watt (derating factor of 5.0 mW/°C); junction to ambient thermal resistance of 500°C/watt (derating factor of 2.0 mW/°C).
(4) This rating refers to a high current point where collector to emitter voltage is lowest.
(5) Pulse Conditions: length = 300μs; duty cycle = 1%.
(6) See switching circuit for exact values of I_C, I_{B1}, and I_{B2}.
(7) P_{IN} = 40 mW. See Test Circuit.

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

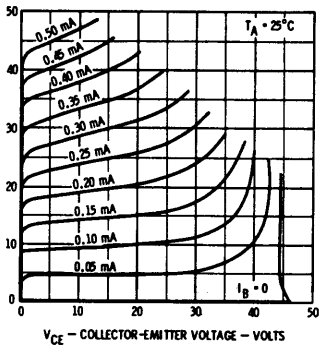
SYMBOL	CHARACTERISTIC	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
BV_{CBO}	Collector to Base Breakdown Voltage	60			Volts	$I_C = 10\ \mu A$ $I_E = 0$
$V_{CEO(sust)}$	Collector to Emitter Sustaining Voltage [Notes 4 and 5]	30			Volts	$I_C = 10$ mA (pulsed) $I_B = 0$
BV_{EBO}	Emitter to Base Breakdown Voltage	5.0			Volts	$I_C = 0$ $I_E = 10\ \mu A$
C_{obo}	Output Capacitance (f = 1.0 MHz)			8.0	pF	$I_E = 0$ $V_{CB} = 10$ V
$V_{CE(sat)}$	**Pulsed Collector Saturation Voltage** [Note 5]		**0.13**	**0.22**	**Volts**	**$I_C = 150$ mA $I_B = 15$ mA**
$V_{BE(sat)}$	Pulsed Emitter Saturation Voltage [Note 5]			1.10	Volts	$I_C = 150$ mA $I_B = 15$ mA
I_{CES}	Collector Reverse Current			0.05	μA	$V_{CE} = 50$ V $V_{EB} = 0$
I_{CES} (65°C)	Collector Reverse Current			1.0	μA	$V_{CE} = 50$ V $V_{EB} = 0$

TYPICAL ELECTRICAL CHARACTERISTICS

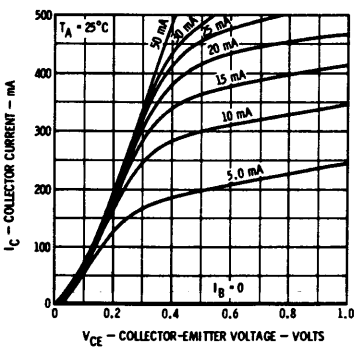
COLLECTOR CHARACTERISTICS*

2N4436

ACTIVE REGION

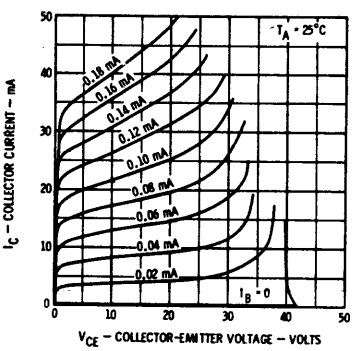


SATURATION REGION

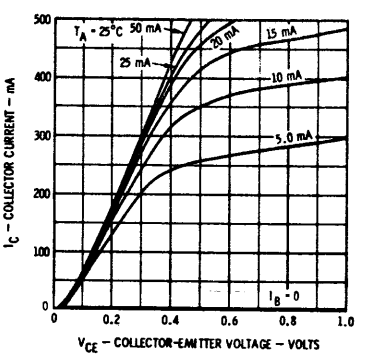


2N4437

ACTIVE REGION

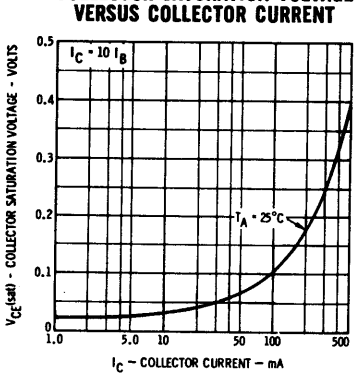


SATURATION REGION

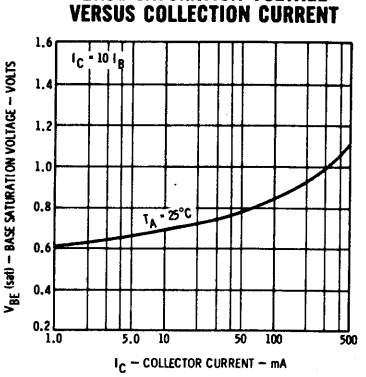


* Single family characteristic on Transistor Curve Tracer.

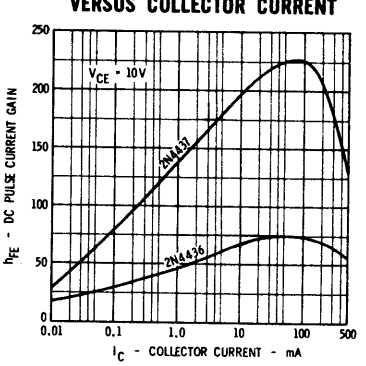
COLLECTOR SATURATION VOLTAGE VERSUS COLLECTOR CURRENT



BASE SATURATION VOLTAGE VERSUS COLLECTION CURRENT

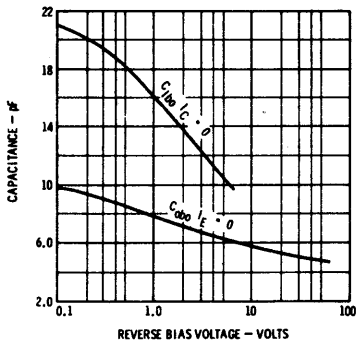


PULSE DC CURRENT GAIN VERSUS COLLECTOR CURRENT

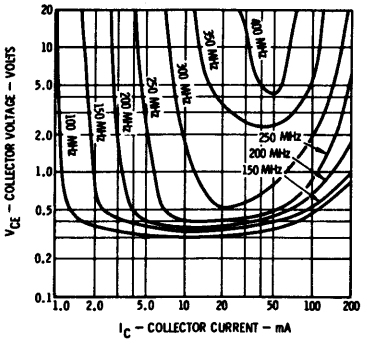


TYPICAL ELECTRICAL CHARACTERISTICS

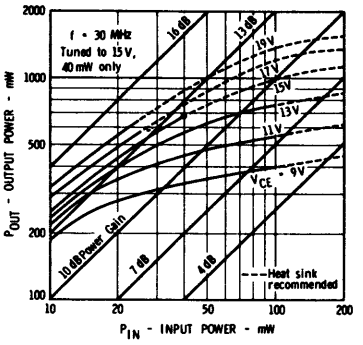
EMITTER TRANSITION AND OUTPUT CAPACITANCE VERSUS REVERSE BIAS VOLTAGE



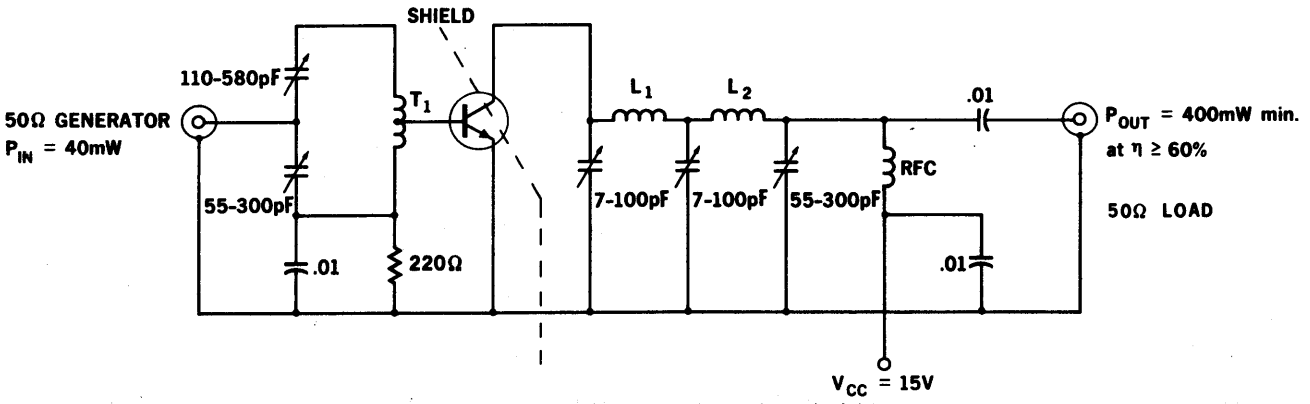
CONTOURS OF CONSTANT GAIN BANDWIDTH PRODUCT (f_T)



TYPICAL POWER IN VERSUS POWER OUT



30MHz AMPLIFIER TEST CIRCUIT



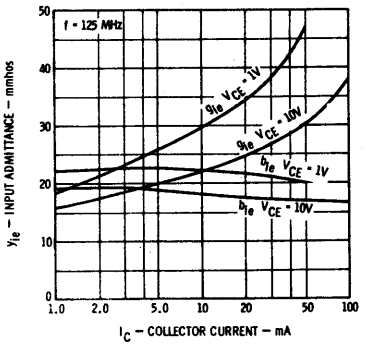
T_1 - 4 Turns no. 20 Wire, ¾" Dia. x ¼" Long, Midtapped.

L_1 and L_2 - 4 Turns no. 20 Wire, ½" Dia. x ¼" Long.

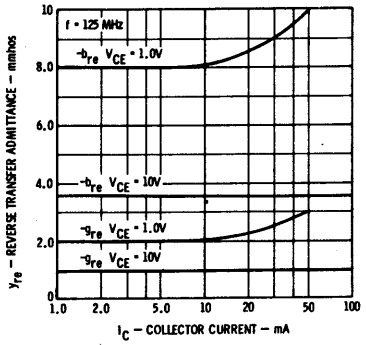
Variable Capacitors are Compression Mica.

R_G = 140Ω, R_L = 260Ω as seen by transistor.

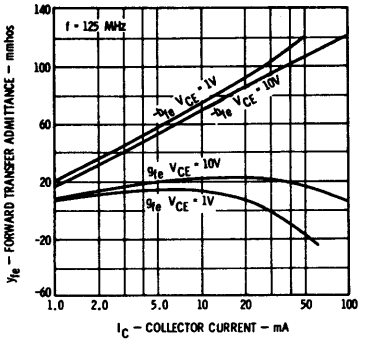
INPUT ADMITTANCE VERSUS COLLECTOR CURRENT (OUTPUT SHORT CIRCUIT)



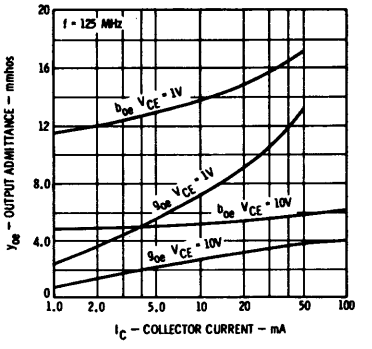
REVERSE TRANSFER ADMITTANCE VERSUS COLLECTOR CURRENT (INPUT SHORT CIRCUIT)



FORWARD TRANSFER ADMITTANCE VERSUS COLLECTOR CURRENT (OUTPUT SHORT CIRCUIT)



OUTPUT ADMITTANCE VERSUS COLLECTOR CURRENT (INPUT SHORT CIRCUIT)

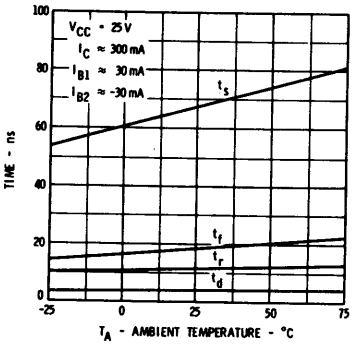


TYPICAL ELECTRICAL CHARACTERISTICS

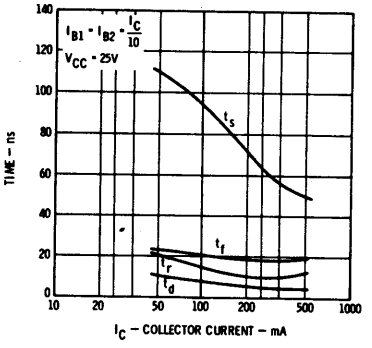
TYPICAL SMALL SIGNAL CHARACTERISTICS
($f = 1$ kHz, $V_{CE} = 10$ V)

Symbol	Characteristic	2N4436 $I_C = 10$ mA	2N4436 50 mA	2N4437 10 mA	2N4437 50 mA	Units
h_{ie}	Input Resistance	460	350	950	880	Ohms
h_{oe}	Output Conductance	55	405	83	660	μmhos
h_{re}	Voltage Feedback Ratio	130	500	205	1500	$x10^{-6}$
h_{fe}	Small Signal Current Gain	90	97	170	220	

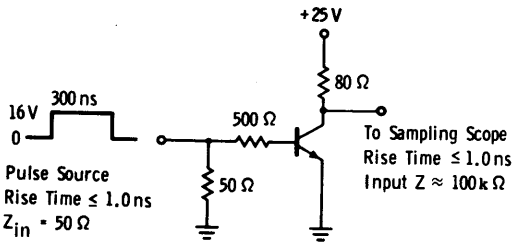
SWITCHING TIMES VERSUS AMBIENT TEMPERATURE



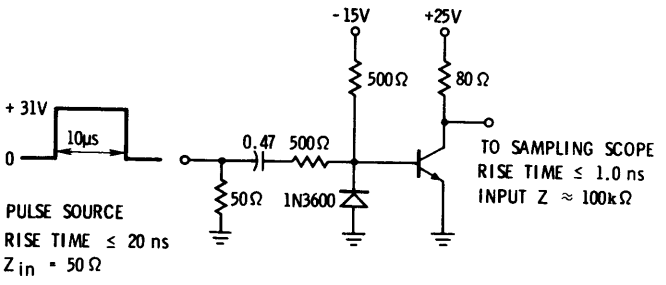
SWITCHING TIMES VERSUS COLLECTOR CURRENT



TURN-ON TEST CIRCUIT



TURN-OFF TEST CIRCUIT



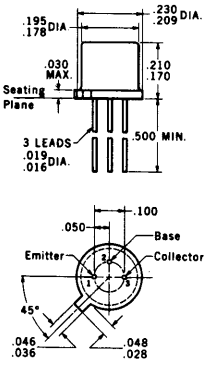
2N4872

PNP RADIATION RESISTANT SWITCH

DIFFUSED SILICON PLANAR* II EPITAXIAL TRANSISTOR

- **GUARANTEED PERFORMANCE AFTER NEUTRON IRRADIATION OF 3 X 10^{14} nvt (> 10 keV.)**
- **HIGH FREQUENCY . . . . . f_T = 800 MHz (MIN.) - AFTER RADIATION**
- **ULTRA-FAST SWITCHING . . . . t_{on} = 20 ns (MAX.) @ I_C = 10 mA - AFTER RADIATION**
  . . . . t_{off} = 20 ns (MAX.) @ I_C = 10 mA - AFTER RADIATION
- **LOW SATURATION VOLTAGE . . V_{CE}(sat) = 0.2 V (MAX.) @ I_C = 10 mA - AFTER RADIATION**
- **EXCELLENT BETA . . . . . h_{FE} = 15 (MIN.) @ I_C = 10 mA - AFTER RADIATION**
- **LOW CAPACITANCE . . . . . C_{obo} = 3.0 pF (MAX.) - AFTER RADIATION**
  . . . . . C_{ibo} = 3.5 pF (MAX.) - AFTER RADIATION

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, 10 seconds time limit)	+300°C

Maximum Power Dissipation

Total Dissipation at 25°C Case Temperature (Note 2 and 3)	0.7 Watt
at 25°C Ambient Temperature (Note 2 and 3)	0.3 Watt

Maximum Voltages and Currents

V_{CBO}	Collector to Base Voltage	−12 Volts
V_{CES}	Collector to Emitter Voltage	−12 Volts
V_{CEO}	Collector to Emitter Voltage (Note 4)	−12 Volts
V_{EBO}	Emitter to Base Voltage	−4.5 Volts
I_C	Collector Current	50 mA

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

SYMBOL	CHARACTERISTIC	PRE-IRRADIATION MIN.	PRE-IRRADIATION TYP.	PRE-IRRADIATION MAX.	POST-IRRADIATION 3X10^{14} nvt(>10 keV) MIN.	POST-IRRADIATION 3X10^{14} nvt(>10 keV) TYP.	POST-IRRADIATION 3X10^{14} nvt(>10 keV) MAX.	UNITS	TEST CONDITIONS	
h_{fe}	**High Frequency Current Gain (f = 100 MHz)**	**9.0**	**10**		**8.0**	**9.0**			I_C = 10 mA	V_{CE} = −10 V
C_{obo}	**Common Base, Open Circuit Output Capacitance**		**2.0**	**3.0**		**2.0**	**3.0**	**pF**	I_E = 0	V_{CB} = −5.0 V
C_{ibo}	**Common Base, Open Circuit Input Capacitance**		**2.4**	**3.5**		**2.4**	**3.5**	**pF**	I_C = 0	V_{EB} = −0.5 V
t_{on}	**Turn On Time** (Note 6)		11	15		15	20	ns	$I_C \approx$ 10 mA	$I_{B1} \approx$ 1.0 mA
t_{off}	**Turn Off Time** (Note 6)		**15**	**20**		**9.0**	**20**	**ns**	$I_C \approx$ 10 mA	$I_{B1} = I_{B2} \approx$ 1.0 mA
τ_S	Charge Storage Time Constant (Note 6)		14	20		6.0	20	ns	$I_C \approx$ 10 mA	$I_{B1} = I_{B2} \approx$ 10 mA
BV_{CBO}	Collector to Base Breakdown Voltage	−12			−12			Volts	I_C = 0.1 mA	I_B = 0
V_{CEO}(sust)	Collector to Emitter Sustaining Voltage (Note 4)	−12	−17		−12	−19		Volts	I_C = 3.0 mA	I_B = 0
BV_{CES}	Collector to Emitter Breakdown Voltage	−12	−20		−12	−20		Volts	I_C = 0.1 mA	I_B = 0
BV_{EBO}	Emitter to Base Breakdown Voltage	−4.5	−5.0		−4.5	−5.0		Volts	I_C = 0	I_E = 0.1 mA
I_{CES}	Collector Reverse Current		0.04	10		0.4	10	nA	V_{CE} = −6.0V	V_{BE} = 0
I_{CES}(125°C)	Collector Reverse Current		0.02	5.0		0.2	5.0	μA	V_{CE} = −6.0V	V_{BE} = 0
h_{FE}	**DC Pulse Current Gain** (Note 5)	**50**	**65**	**120**	**15**	**20**			I_C = 10 mA	V_{CE} = −0.3 V
h_{FE}(−55°C)	**DC Pulse Current Gain** (Note 5)	**20**	**30**		**6.0**	**8.0**			I_C = 10 mA	V_{CE} = −0.3 V
V_{CE}(sat)	Collector Saturation Voltage		−0.08	−0.13		−0.17	−0.2	Volts	I_C = 1.0 mA	I_B = 0.1 mA
V_{CE}(sat)	**Pulsed Collector Saturation Voltage** (Note 5)		**−0.11**	**−0.15**		**−0.17**	**−0.2**	**Volts**	I_C = 10 mA	I_B = 1.0 mA
V_{CE}(sat)	Pulsed Collector Saturation Voltage (Note 5)		−0.28	−0.5		−0.5	−0.7	Volts	I_C = 50 mA	I_B = 5.0 mA
V_{BE}(sat)	Base Saturation Voltage		−0.73	−0.8		−0.73	−0.8	Volts	I_C = 1.0 mA	I_B = 0.1 mA
V_{BE}(sat)	Pulsed Base Saturation Voltage (Note 5)	−0.8	−0.88	−0.95	−0.8	−0.88	−0.95	Volts	I_C = 10 mA	I_B = 1.0 mA
V_{BE}(sat)	Pulsed Base Saturation Voltage (Note 5)		−1.15	−1.5		−1.15	−1.5	Volts	I_C = 50 mA	I_B = 5.0 mA

*Planar is a patented Fairchild process.

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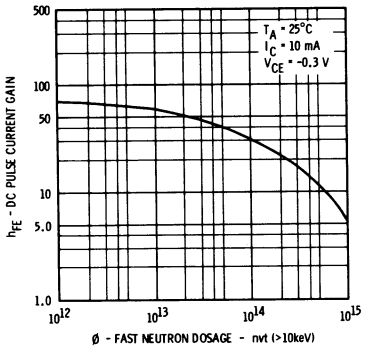
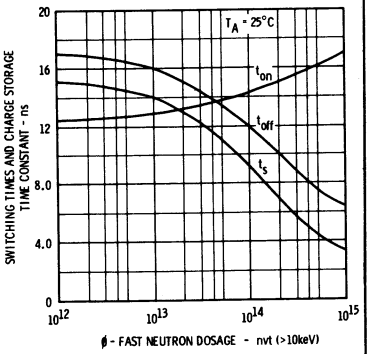
TYPICAL ELECTRICAL CHARACTERISTICS

POST-IRRADITION

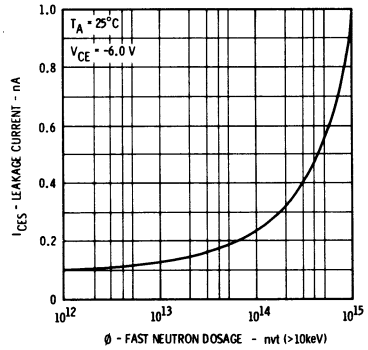
DC PULSE CURRENT GAIN VERSUS FAST NEUTRON DOSAGE



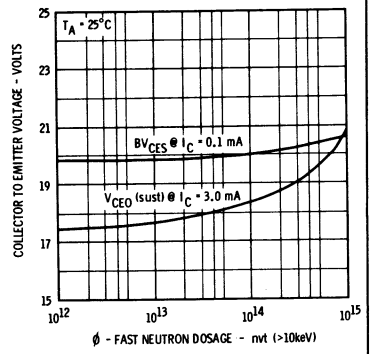
SWITCHING TIMES AND CHARGE STORAGE TIME CONSTANT VERSUS FAST NEUTRON DOSAGE



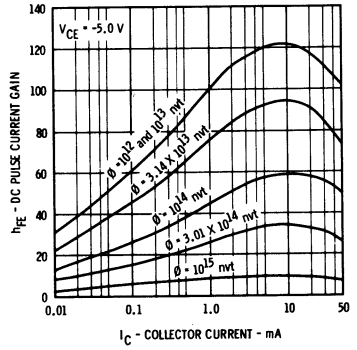
LEAKAGE CURRENT VERSUS FAST NEUTRON DOSAGE



COLLECTOR TO EMITTER VOLTAGES VERSUS FAST NEUTRON DOSAGE

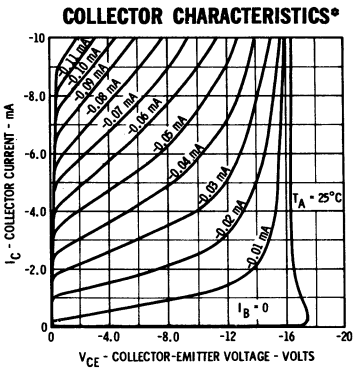


DC PULSE CURRENT GAIN VERSUS COLLECTOR CURRENT AND FAST NEUTRON DOSAGE

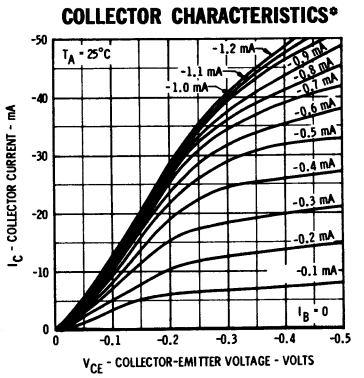


PRE-IRRADIATION

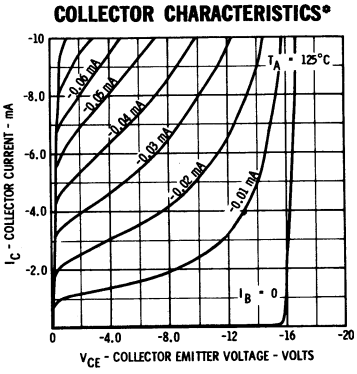
COLLECTOR CHARACTERISTICS*



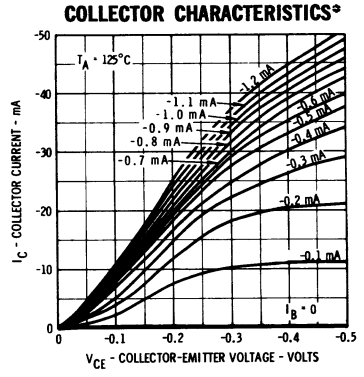
COLLECTOR CHARACTERISTICS*



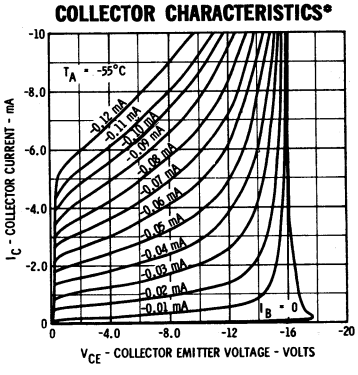
COLLECTOR CHARACTERISTICS*



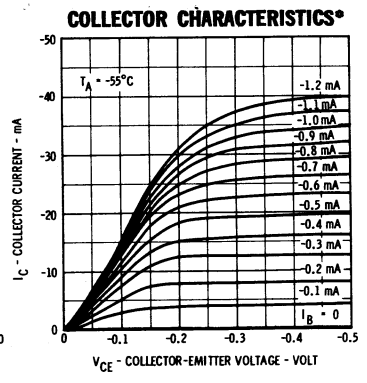
COLLECTOR CHARACTERISTICS*



COLLECTOR CHARACTERISTICS*



COLLECTOR CHARACTERISTICS*



* Single family characteristic on Transistor Curve Tracer.

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 are based on a maximum junction temperature of 200°C and junction to ambient thermal resistance of 586°C/Watt (derating factor of 1.72mW/°C); Junction to case thermal resistance of 250°C/Watt (derating factor of 4.0 mW/°C).

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

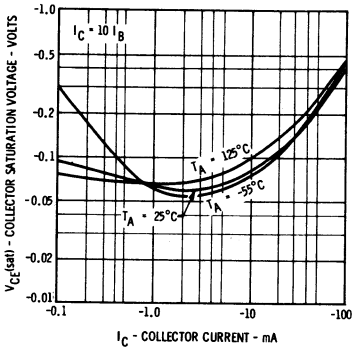
(5) Pulse Conditions: length = 300 μs; duty cycle = 1%.

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

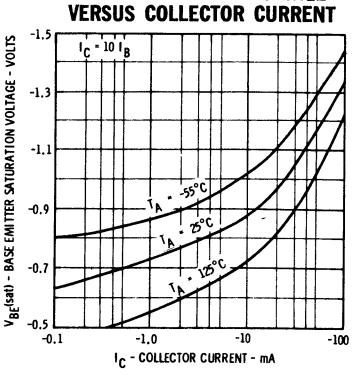
TYPICAL ELECTRICAL CHARACTERISTICS

PRE-IRRADIATION

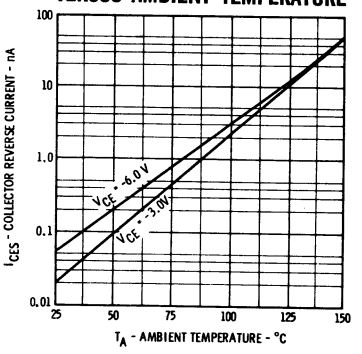
COLLECTOR SATURATION VOLTAGE VERSUS COLLECTOR CURRENT



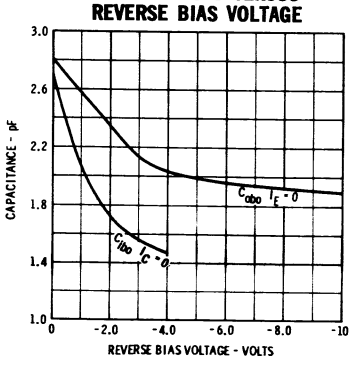
BASE SATURATION VOLTAGE VERSUS COLLECTOR CURRENT



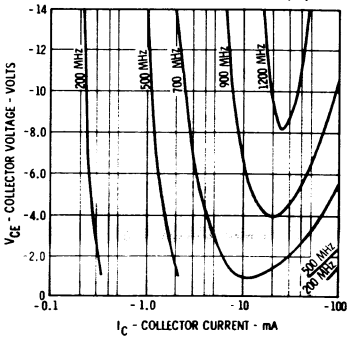
COLLECTOR REVERSE CURRENT VERSUS AMBIENT TEMPERATURE



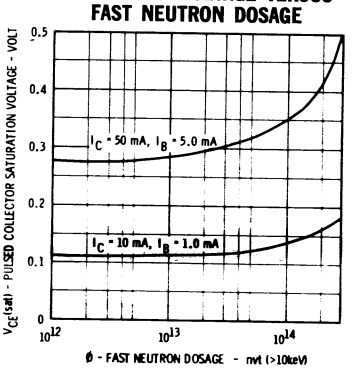
INPUT AND OUTPUT CAPACITANCES VERSUS REVERSE BIAS VOLTAGE



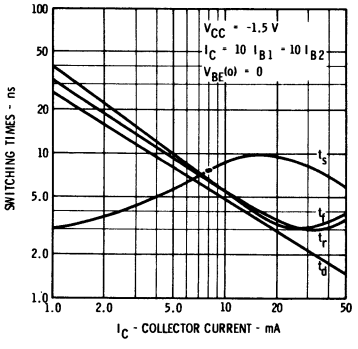
CONTOURS OF CONSTANT GAIN BANDWIDTH PRODUCT (f_T)



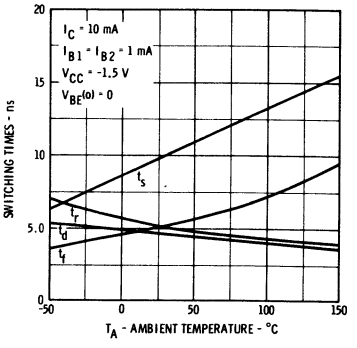
PULSED COLLECTOR SATURATION VOLTAGE VERSUS FAST NEUTRON DOSAGE



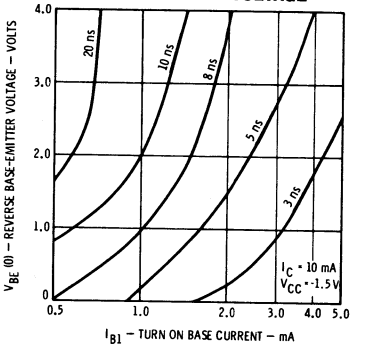
SWITCHING TIMES VERSUS COLLECTOR CURRENT



SWITCHING TIMES VERSUS AMBIENT TEMPERATURE



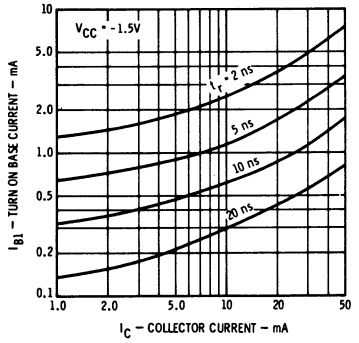
DELAY TIME VERSUS TURN ON BASE CURRENT AND REVERSE BASE EMITTER VOLTAGE



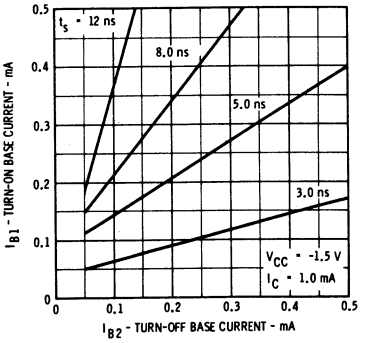
TYPICAL ELECTRICAL CHARACTERISTICS

PRE-IRRADIATION

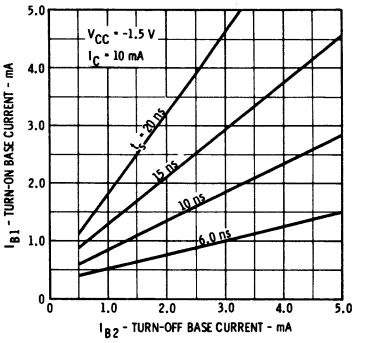
RISE TIME VERSUS COLLECTOR AND TURN ON BASE CURRENTS



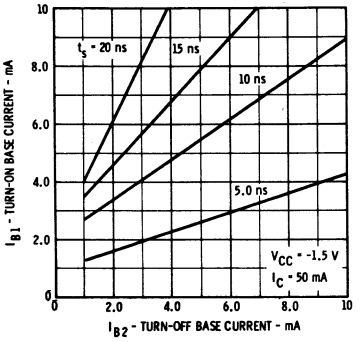
STORAGE TIME VERSUS TURN-ON AND TURN-OFF BASE CURRENTS



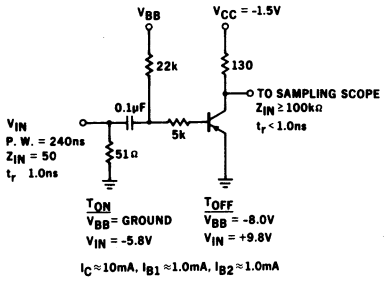
STORAGE TIME VERSUS TURN-ON AND TURN-OFF BASE CURRENTS



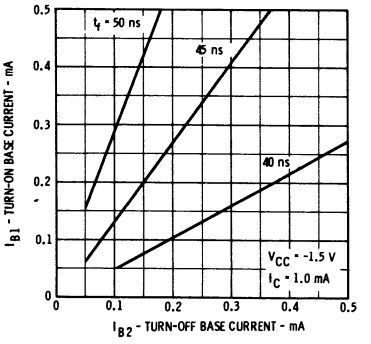
STORAGE TIME VERSUS TURN-ON AND TURN-OFF BASE CURRENTS



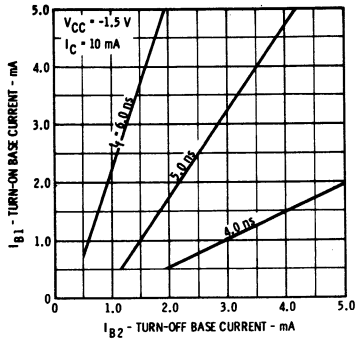
TURN ON AND TURN OFF TEST CIRCUIT



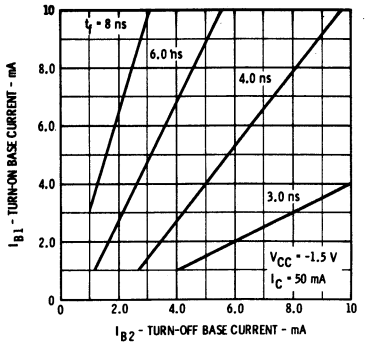
FALL TIME VERSUS TURN-ON AND TURN-OFF BASE CURRENTS



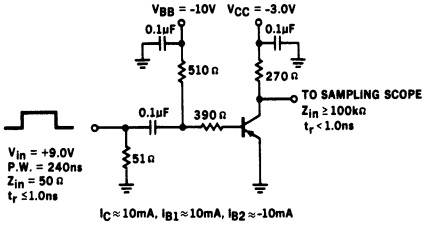
FALL TIME VERSUS TURN-ON AND TURN-OFF BASE CURRENTS



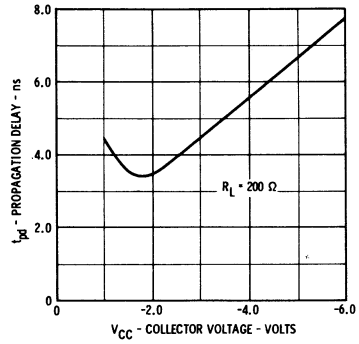
FALL TIME VERSUS TURN-ON AND TURN-OFF BASE CURRENTS



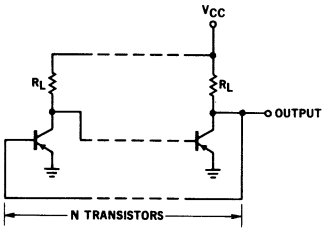
CHARGE STORAGE TIME TEST CIRCUIT



PROPAGATION DELAY TIME VERSUS COLLECTOR SUPPLY VOLTAGE



FIVE STAGE RING OSCILLATOR FOR MEASUREMENT OF PROPAGATION DELAY



$$t_{pd} = \frac{1}{2Nf_{osc}}$$

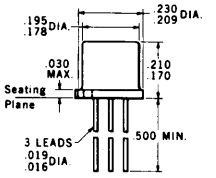
2N4873

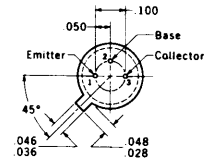
RADIATION RESISTANT HIGH-SPEED NPN SATURATED SWITCH

DIFFUSED SILICON PLANAR* EPITAXIAL TRANSISTOR

- **GUARANTEED PERFORMANCE AFTER FAST NEUTRON DOSAGE (3 x 10^{14} nvt >10 keV)**
- **FAST SWITCHING — 13 ns MAX. τ_s @ 10 mA**
- **HIGH h_{FE} — 19 MIN. @ 10 mA, 1.0 V (110 MIN. PREIRRADIATION)**
- **HIGH f_T —600 MHz MIN. @ 10 mA**
- **LOW V_{CE} (sat) — 0.3 V MAX. @ 10 mA**
- **15 VOLT MIN. LV_{CEO}**

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 seconds time limit)	+300°C

Maximum Power Dissipation

Total Dissipation at 25°C Case Temperature [Note 2 and 3]	1.2 Watts
at 100°C Case Temperature [Note 2 and 3]	0.68 Watt
at 25°C Ambient Temperature [Note 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]	15 Volts
V_{EBO}	Emitter to Base Voltage	4.5 Volts
I_C	DC Collector Current	200 mA

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

SYMBOL	CHARACTERISTIC	PRE-IRRADIATION MIN.	PRE-IRRADIATION TYP.	PRE-IRRADIATION MAX.	POST-IRRADIATION (3 x 10^{14} nvt >10 keV) MIN.	POST-IRRADIATION (3 x 10^{14} nvt >10 keV) TYP.	POST-IRRADIATION (3 x 10^{14} nvt >10 keV) MAX.	UNITS	TEST CONDITIONS
V_{CEO} (sust)	**Collector to Emitter Sustaining Voltage** [Note 4 and 5]	**15**	**16**		**15**	**22**		Volts	**I_C = 10 mA I_B = 0**
BV_{CES}	Collector to Emitter Breakdown Voltage	40	48		40	45		Volts	I_C = 10 μA V_{BE} = 0
BV_{CBO}	Collector to Base Breakdown Voltage	40			40			Volts	I_C = 10 μA I_E = 0
BV_{EBO}	Emitter to Base Breakdown Voltage	4.5	6.0		4.5	6.0		Volts	I_E = 10 μA I_C = 0
h_{FE}	**DC Pulse Current Gain** [Note 5]	**110**	**120**	**150**	**19**	**21**			**I_C = 10 mA V_{CE} = 1.0 V**
h_{FE}	DC Pulse Current Gain [Note 5]	70	80		15	17			I_C = 100 mA V_{CE} = 1.0 V
h_{FE} (−55°C)	DC Pulse Current Gain [Note 5]	35			6.0				I_C = 10 mA V_{CE} = 1.0 V
h_{fe}	**High Frequency Current Gain (f = 100 MHz)**	**7.0**	**9.4**		**6.0**	**8.0**			**I_C = 10 mA V_{CE} = 10 V**

*Planar is a patented Fairchild process.

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 μs; duty cycle ≤2%.

(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

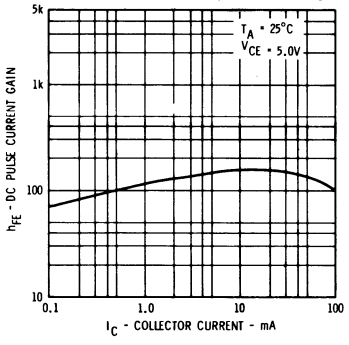
313 FAIRCHILD DRIVE, MOUNTAIN VIEW, CALIFORNIA, (415) 962-5011, TWX: 910-379-6435

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

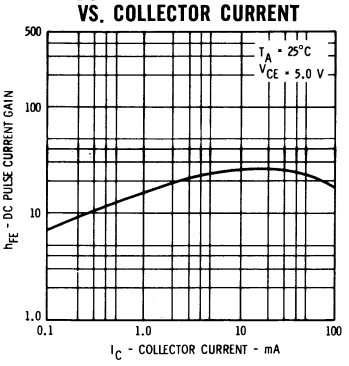
SYMBOL	CHARACTERISTIC	PRE-IRRADIATION MIN.	PRE-IRRADIATION TYP.	PRE-IRRADIATION MAX.	POST-IRRADIATION (3×10^{14} nvt $>$10 keV) MIN.	POST-IRRADIATION TYP.	POST-IRRADIATION MAX.	UNITS	TEST CONDITIONS
V_{CE} (sat)	**Pulsed Collector Saturation Voltage** [Note 5]		**0.15**	**0.20**		**0.20**	**0.30**	Volts	I_C = **10 mA** I_B = **1.0 mA**
V_{CE} (sat)	Pulsed Collector Saturation Voltage [Note 5]		0.13	0.18		0.17	0.28	Volts	I_C = 10 mA I_B = 3.3 mA
V_{BE} (sat)	Pulsed Base Saturation Voltage [Note 5]	0.72	0.80	0.87	0.72	0.81	0.87	Volts	I_C = 10 mA I_B = 1.0 mA
V_{BE} (sat)	Pulsed Base Saturation Voltage [Note 5]	0.74	0.85	1.0	0.74	0.85	1.0	Volts	I_C = 10 mA I_B = 3.3 mA
I_{CES}	Collector Reverse Current		0.01	0.40		0.01	0.40	μA	V_{CE} = 20 V V_{BE} = 0
C_{obo}	Common-Base, Open Circuit Output Capacitance			4.0			4.0	pF	V_{CB} = 5.0 V I_E = 0
τ_S	**Charge Storage Time Constant** [Note 6]		**6.0**	**13**		**6.0**	**13**	**ns**	$I_C = I_{B1} \approx$ **10 ma,** $I_{B2} \approx -$**10 mA**
t_{on}	Turn On Time [Note 6]		9.0	12		10	13	ns	$I_C \approx$ 10 mA $I_{B1} \approx$ 3.3 mA
t_{off}	Turn Off Time [Note 6]		13	18		12	18	ns	$I_C \approx$ 10 mA $I_{B1} \approx$ 3.3 mA $I_{B2} \approx -$3.3 mA
I_{CES} (125°C)	Collector Cutoff Current			50				μA	V_{CB} = 20 V I_E = 0

TYPICAL ELECTRICAL CHARACTERISTICS

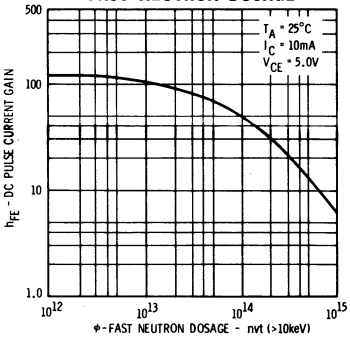
PRE-IRRADIATION DC PULSE CURRENT GAIN VERSUS COLLECTOR CURRENT



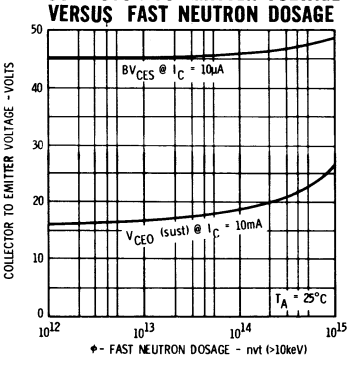
POST-IRRADIATION (3×10^{14} nvt $>$10 keV) DC PULSE CURRENT GAIN VS. COLLECTOR CURRENT



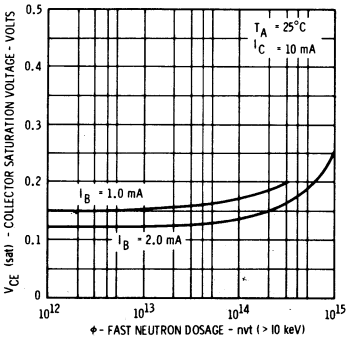
DC PULSE CURRENT GAIN VERSUS FAST NEUTRON DOSAGE



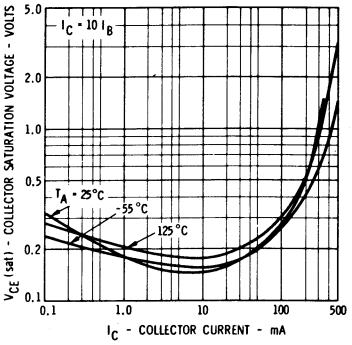
COLLECTOR TO EMITTER VOLTAGE VERSUS FAST NEUTRON DOSAGE



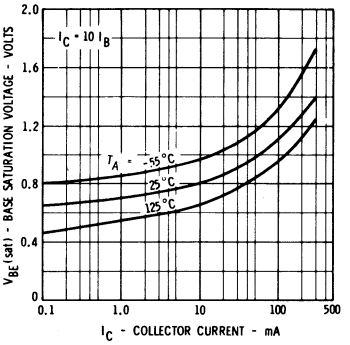
COLLECTOR SATURATION VOLTAGE VERSUS FAST NEUTRON DOSAGE



COLLECTOR SATURATION VOLTAGE VERSUS COLLECTOR CURRENT

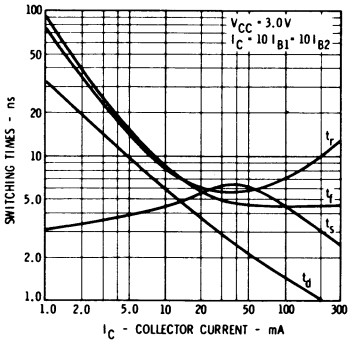


BASE SATURATION VOLTAGE VERSUS COLLECTOR CURRENT

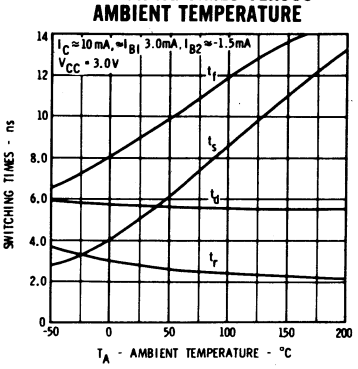


TYPICAL ELECTRICAL CHARACTERISTICS

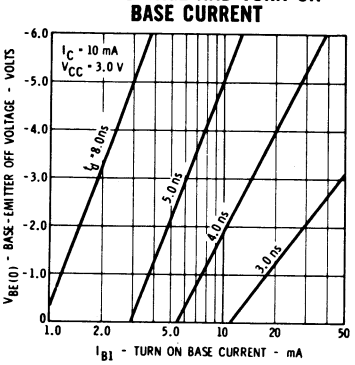
SWITCHING TIMES VERSUS COLLECTOR CURRENT



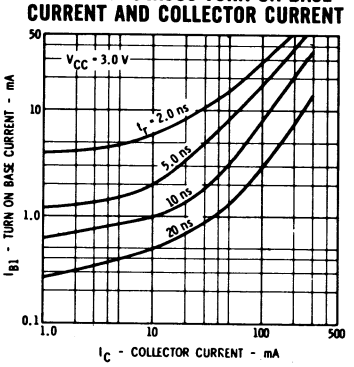
SWITCHING TIMES VERSUS AMBIENT TEMPERATURE



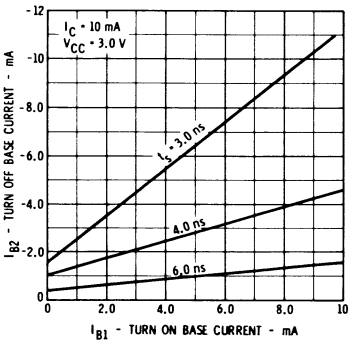
DELAY TIME VERSUS BASE-EMITTER OFF VOLTAGE AND TURN ON BASE CURRENT



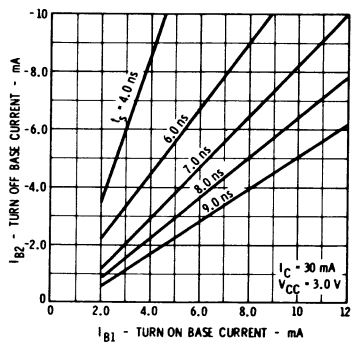
RISE TIME VERSUS TURN ON BASE CURRENT AND COLLECTOR CURRENT



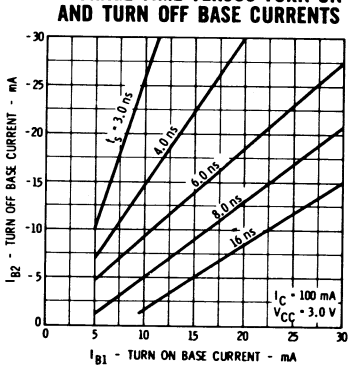
STORAGE TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS



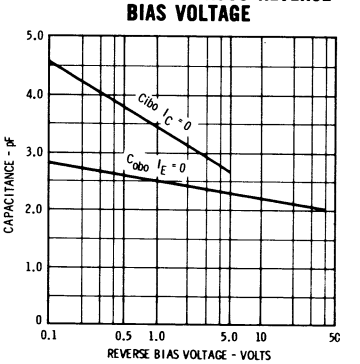
STORAGE TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS



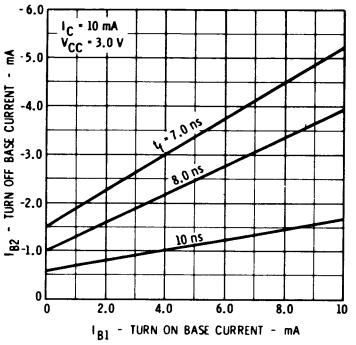
STORAGE TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS



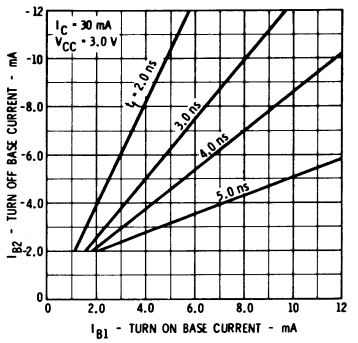
EMITTER TRANSITION AND OUTPUT CAPACITANCES VERSUS REVERSE BIAS VOLTAGE



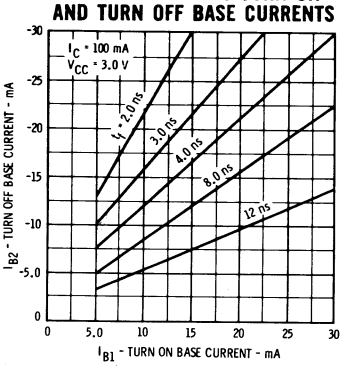
FALL TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS



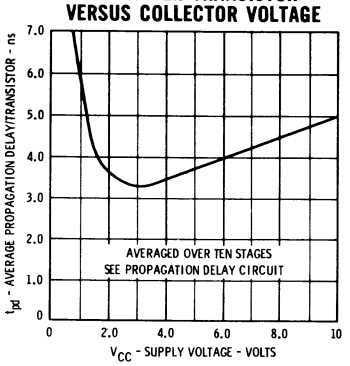
FALL TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS



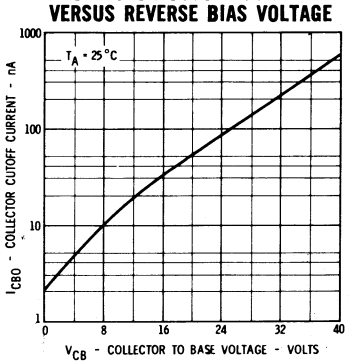
FALL TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS



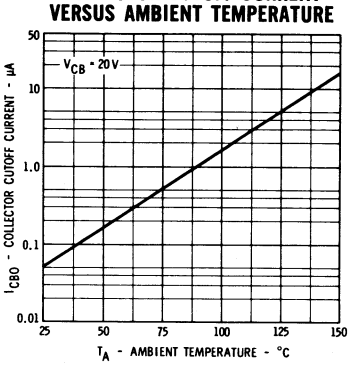
AVERAGE PROPAGATION DELAY PER TRANSISTOR VERSUS COLLECTOR VOLTAGE



COLLECTOR CUTOFF CURRENT VERSUS REVERSE BIAS VOLTAGE

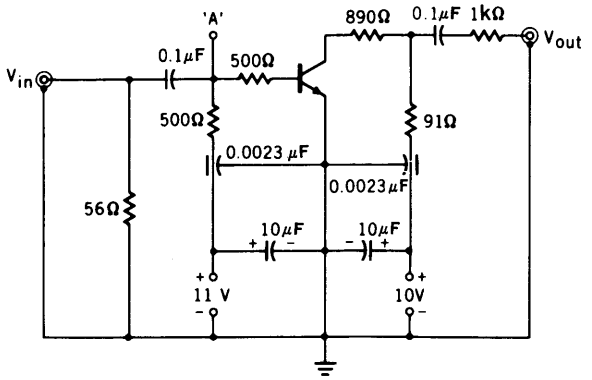


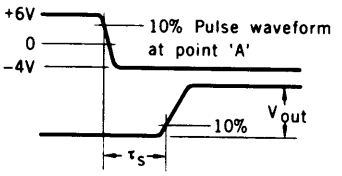
COLLECTOR CUTOFF CURRENT VERSUS AMBIENT TEMPERATURE



CHARGE STORAGE TIME MEASUREMENT CIRCUIT

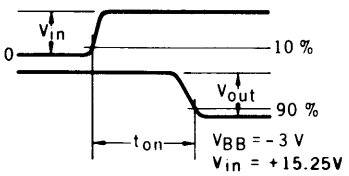
Pulse Generator
V_{in} Rise Time < 1 ns
Source Impedance = 50Ω
PW ≥ 300 ns
Duty Cycle < 2 %



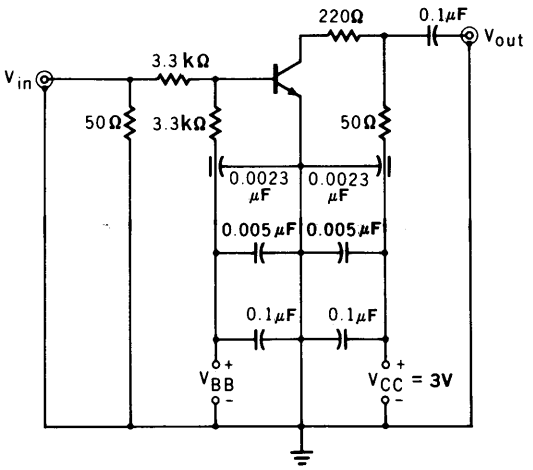


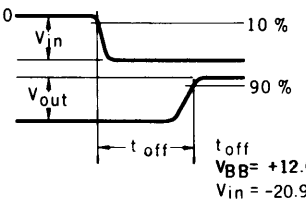
To Sampling Oscilloscope
Input Impedance = 50Ω
Rise Time ≤ 1 ns

t_{ON} — t_{OFF} MEASUREMENT CIRCUIT



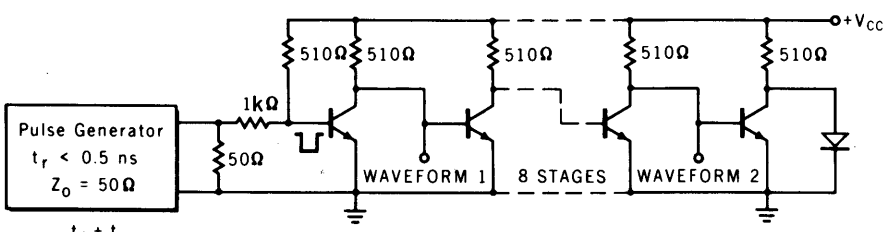
Pulse Generator
V_{in} Rise Time < 1 ns
Source Impedance = 50Ω
PW ≥ 300 ns
Duty Cycle < 2 %





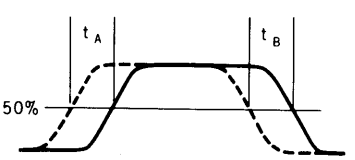
To Sampling Oscilloscope
Input Impedance = 50Ω
Rise Time ≤ 1 ns

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

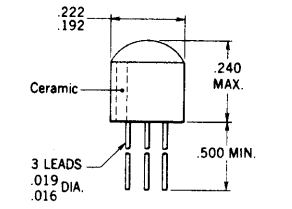
2N4888 • 2N4889

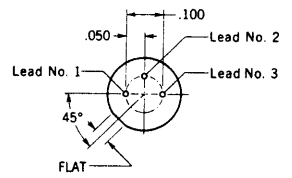
PNP LOW NOISE HIGH VOLTAGE AMPLIFIER

DIFFUSED SILICON PLANAR* TRANSISTORS

- **VERY HIGH VOLTAGE (LV_{CEO}) -- 150 VOLTS (Min.)**
- **LOW NOISE FIGURE -- 3.0 dB (Max.) @ 1.0 kHz**
- **LOW OUTPUT CAPACITANCE (C_{obo}) -- 4.0 pF (Max.)**
- **HIGH BETA (h_{FE}) -- 80–300 @ 10 mA**
- **EXCELLENT BETA LINEARITY FROM 10 μA to 50 mA**

PHYSICAL DIMENSIONS
Epoxy package
TO-106





NOTES: All dimensions in inches
Leads are gold-plated kovar
Package weight is 0.68 gram

ABSOLUTE MAXIMUM RATINGS [Note 1]

Maximum Temperatures

Storage Temperature	−55°C to +125°C
Operating Junction Temperature	+125°C
Soldering Temperature (10 second time limit)	+260°C

Maximum Power Dissipation

Total Dissipation at 25°C Case Temperature [Note 2]	**0.8 Watt**
at 75°C Case Temperature [Note 2]	**0.4 Watt**
at 25°C Ambient Temperature [Note 2]	**0.3 Watt**

Maximum Voltages

V_{CBO}	Collector to Base Voltage	−150 Volts
V_{CEO}	Collector to Emitter Voltage [Note 3]	−150 Volts
V_{EBO}	Emitter to Base Voltage	−6.0 Volts

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

SYMBOL	CHARACTERISTIC	2N4888 MIN.	2N4888 TYP.	2N4888 MAX.	2N4889 MIN.	2N4889 TYP.	2N4889 MAX.	UNITS	TEST CONDITIONS
V_{CEO}	**Collector to Emitter Sustaining Voltage**	−150			**−150**			**Volts**	**I_C = 2.0 mA I_B = 0**
BV_{CBO}	Collector to Base Breakdown Voltage	−150			−150			Volts	I_C = 100 μA I_E = 0
NF	Narrow Band Noise Figure (f = 100 Hz)					3.0	10	dB	I_C = 250 μA V_{CE} = −5.0 V R_S = 1.0 kΩ B.W. = 15 Hz
NF	**Narrow Band Noise Figure (f = 1.0 kHz)**					**0.8**	**3.0**	**dB**	**I_C = 30 μA V_{CE} = −5.0 V R_S = 10 kΩ B.W. = 150 Hz**
NF	Narrow Band Noise Figure (f = 10 kHz)					1.5	3.0	dB	I_C = 250 μA V_{CE} = −5.0 V R_S = 1.0 kΩ B.W. = 1.5 kHz
NF	Wide Band Noise Figure (f = 10 Hz to 10 kHz)					2.0	4.0	dB	I_C = 250 μA V_{CE} = −5.0 V R_S = 1.0 kΩ B.W. = 15.7 kHz
NF	Narrow Band Noise Figure (f = 1.0 MHz)					2.0	4.0	dB	I_C = 1.0 mA V_{CE} = −10 V R_S = 1.0 kΩ B.W. = 2.0 kHz
h_{FE}	**DC Pulse Current Gain** [Note 4]		30		**60**	**135**			**I_C = 100 μA V_{CE} = −10 V**
h_{FE}	**DC Pulse Current Gain** [Note 4]	30	40		**70**	**150**			**I_C = 1.0 mA V_{CE} = −10 V**
h_{FE}	**DC Pulse Current Gain** [Note 4]	40	45	400	**80**	**150**	**300**		**I_C = 10 mA V_{CE} = −10 V**
C_{obo}	**Common-Base, Open Circuit Output Capacitance (f = 1.0 MHz)**		2.5	4.0		**2.5**	**4.0**	**pF**	**V_{CB} = −20 V I_E = 0**

* 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

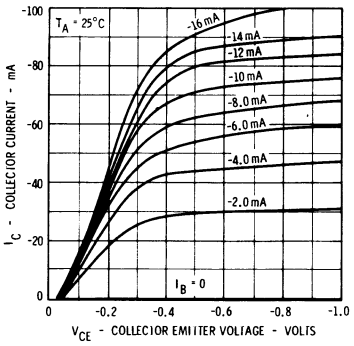
ELECTRICAL CHARACTERISTICS (25°C Free Air Temperature unless otherwise noted)

SYMBOL	CHARACTERISTIC	2N4888 MIN.	2N4888 TYP.	2N4888 MAX.	2N4889 MIN.	2N4889 TYP.	2N4889 MAX.	UNITS	TEST CONDITIONS
I_{CBO}	Collector Cutoff Current		0.7	50		0.7	10	nA	$V_{CB} = -100$ V $I_E = 0$
I_{CBO} (65°C)	Collector Cutoff Current		0.01	2.5		0.01	0.5	μA	$V_{CB} = -100$ V $I_E = 0$
V_{CE} (sat)	Pulsed Collector Saturation Voltage [Note 4]		−0.1	−0.5		−0.1	−0.5	Volts	$I_C = 10$ mA $I_B = 1.0$ mA
BV_{EBO}	Emitter to Base Breakdown Voltage	−6.0			−6.0			Volts	$I_E = 10\mu$A $I_C = 0$
I_{EBO}	Emitter Cutoff Current		0.4	50		0.4	10	nA	$V_{EB} = -4.0$ V $I_C = 0$
V_{BE} (on)	Pulsed Base Emitter On Voltage [Note 4]		−0.66	−0.8		−0.59	−0.7	Volts	$I_C = 1.0$ mA $V_{CE} = -10$ V
V_{BE} (sat)	Pulsed Base Saturation Voltage [Note 4]		−0.74	−0.9		−0.74	−0.9	Volts	$I_C = 10$ mA $I_B = 1.0$ mA
C_{ibo}	Common-Base, Open-Circuit Input Capacitance		11	30		11	25	pF	$V_{EB} = -0.5$ V $I_C = 0$
h_{fe}	**High Frequency Current Gain (f = 20 MHz)**	1.5	1.8	8.0	**2.0**	**3.3**	**8.0**		**$I_C = 1.0$ mA $V_{CE} = -10$ V**

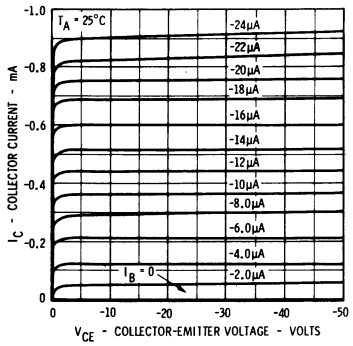
NOTES:
(1) These ratings are limiting values above which the serviceability of any individual semiconductor device may be impaired.
(2) These ratings give a maximum junction temperature of 125°C and junction to case thermal resistance of 125°C/Watt (derating factor of 8.0 mW/°C); junction to ambient thermal resistance of 333°C/Watt (derating factor of 3.0 mW/°C).
(3) This rating refers to a high current point where collector to emitter voltage is lowest.
(4) Pulse Conditions: length = 300 μs; duty cycle = 1%.

2N4888
TYPICAL ELECTRICAL CHARACTERISTICS

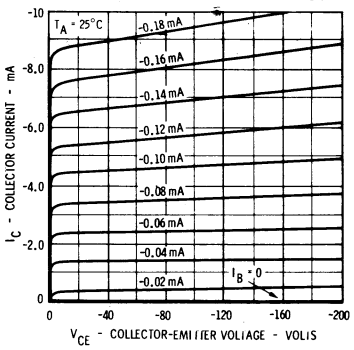
COLLECTOR CHARACTERISTICS



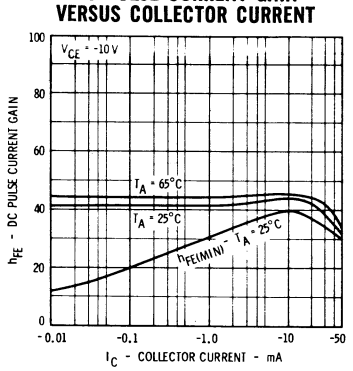
COLLECTOR CHARACTERISTICS



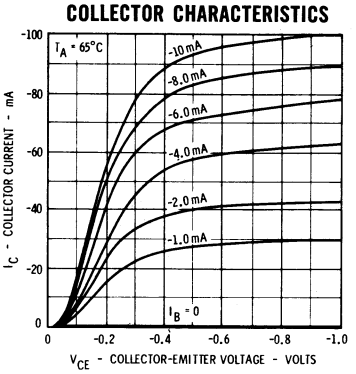
COLLECTOR CHARACTERISTICS



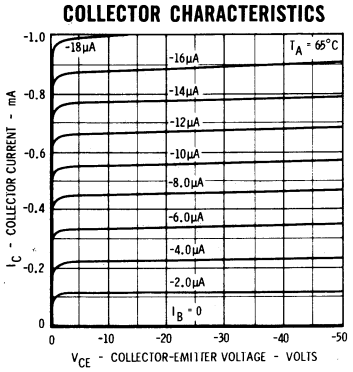
DC PULSE CURRENT GAIN VERSUS COLLECTOR CURRENT



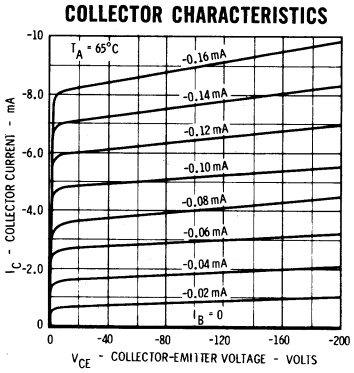
COLLECTOR CHARACTERISTICS



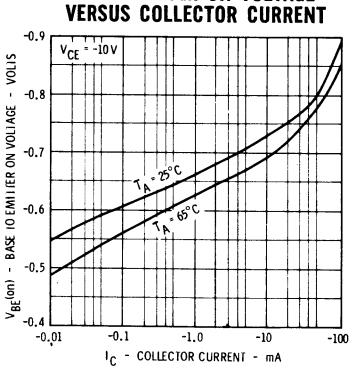
COLLECTOR CHARACTERISTICS



COLLECTOR CHARACTERISTICS

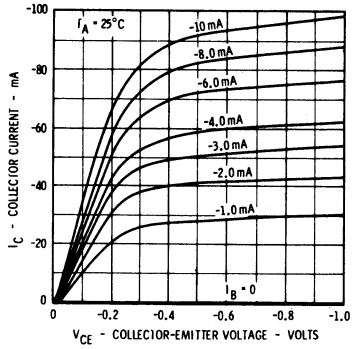


BASE-EMITTER ON VOLTAGE VERSUS COLLECTOR CURRENT

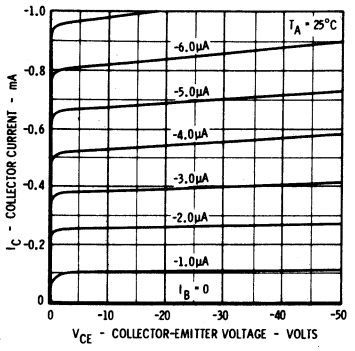


2N4889
TYPICAL ELECTRICAL CHARACTERISTICS

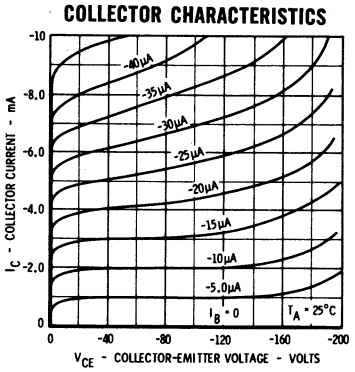
COLLECTOR CHARACTERISTICS



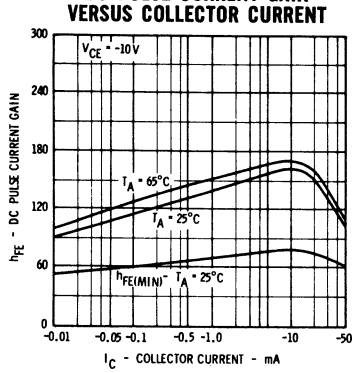
COLLECTOR CHARACTERISTICS



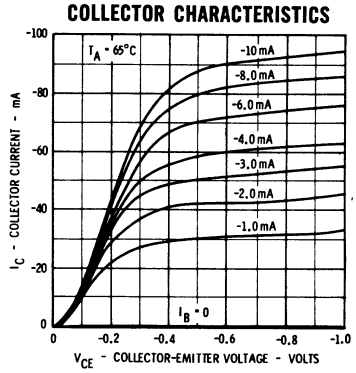
COLLECTOR CHARACTERISTICS



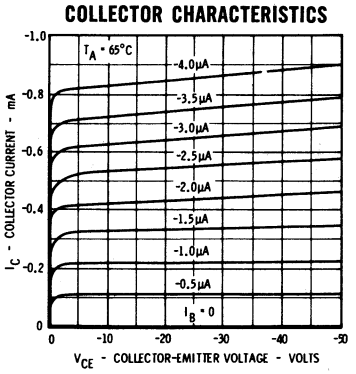
DC PULSE CURRENT GAIN VERSUS COLLECTOR CURRENT



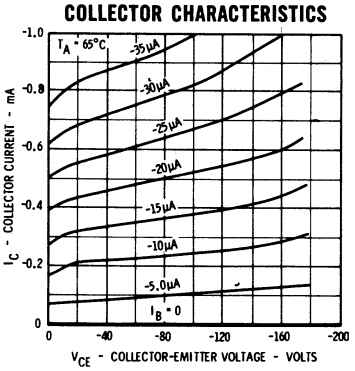
COLLECTOR CHARACTERISTICS



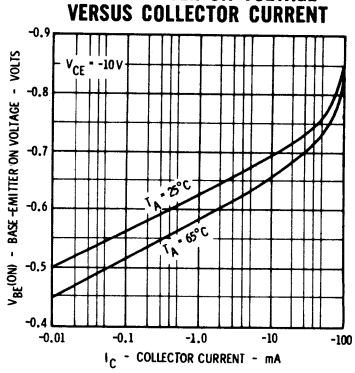
COLLECTOR CHARACTERISTICS



COLLECTOR CHARACTERISTICS



BASE-EMITTER ON VOLTAGE VERSUS COLLECTOR CURRENT



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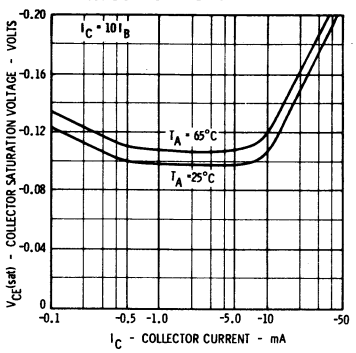
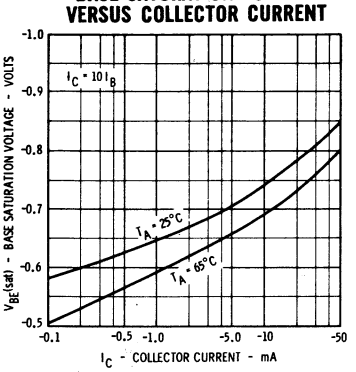
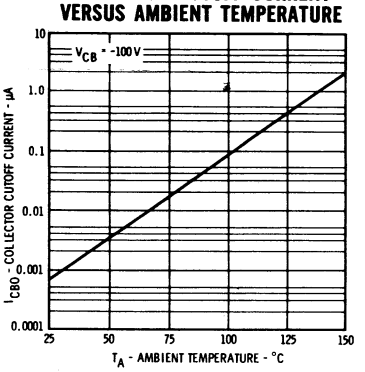
COLLECTOR SATURATION VOLTAGE VERSUS COLLECTOR CURRENT



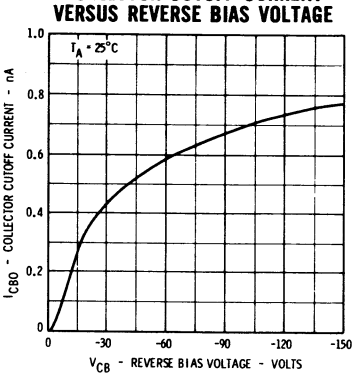
BASE SATURATION VOLTAGE VERSUS COLLECTOR CURRENT



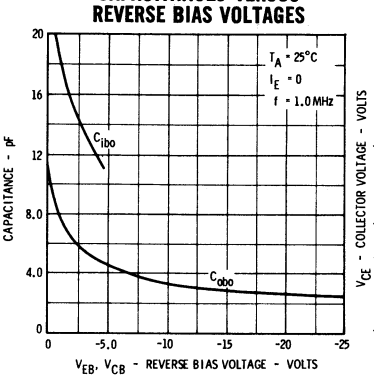
COLLECTOR CUTOFF CURRENT VERSUS AMBIENT TEMPERATURE



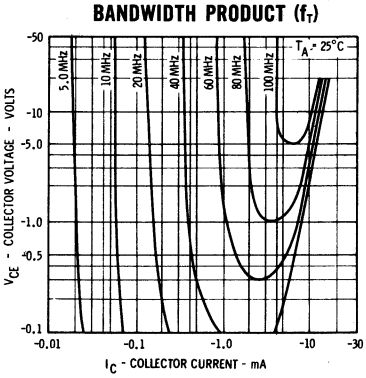
COLLECTOR CUTOFF CURRENT VERSUS REVERSE BIAS VOLTAGE



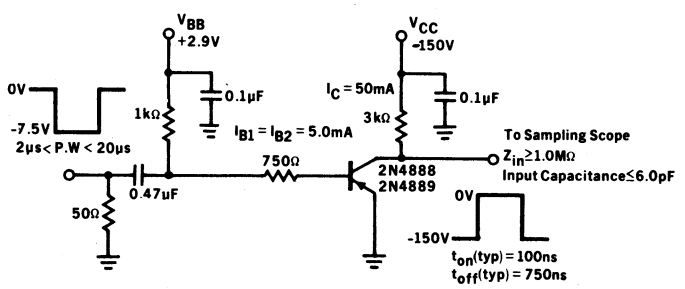
INPUT AND OUTPUT CAPACITANCES VERSUS REVERSE BIAS VOLTAGES



CONTOURS OF CONSTANT GAIN BANDWIDTH PRODUCT (f_T)

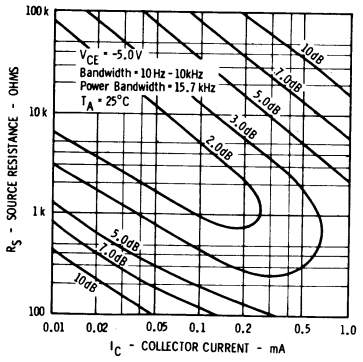


T_{on} – T_{off} SWITCHING CIRCUIT

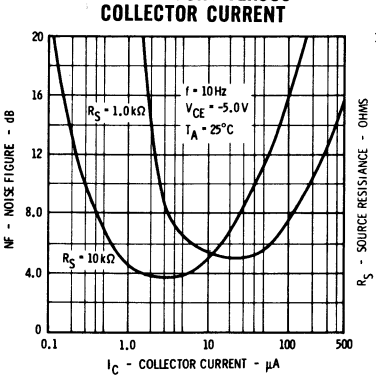


2N4889
TYPICAL ELECTRICAL CHARACTERISTICS

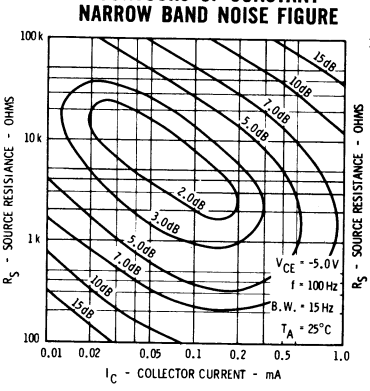
CONTOURS OF CONSTANT WIDE BAND NOISE FIGURE



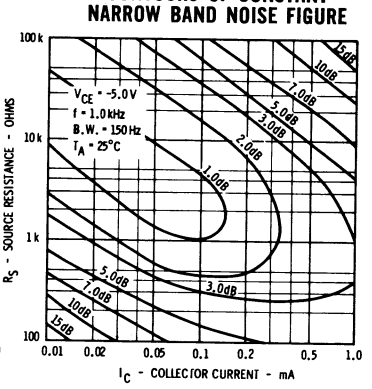
NOISE FIGURE VERSUS COLLECTOR CURRENT



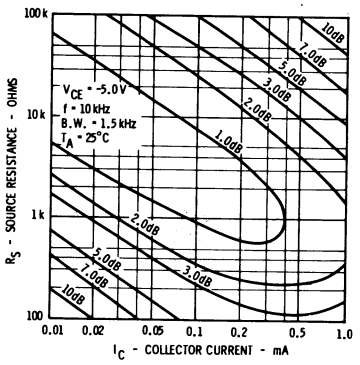
CONTOURS OF CONSTANT NARROW BAND NOISE FIGURE



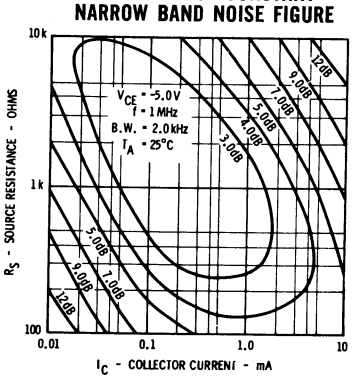
CONTOURS OF CONSTANT NARROW BAND NOISE FIGURE



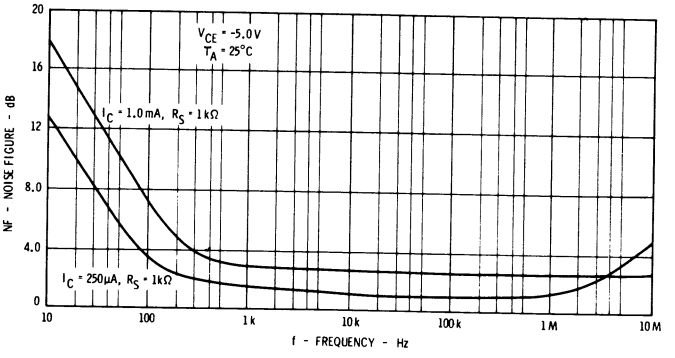
CONTOURS OF CONSTANT NARROW BAND NOISE FIGURE



CONTOURS OF CONSTANT NARROW BAND NOISE FIGURE



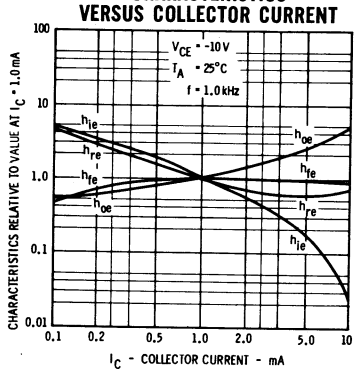
SPOT NOISE FIGURE VERSUS FREQUENCY



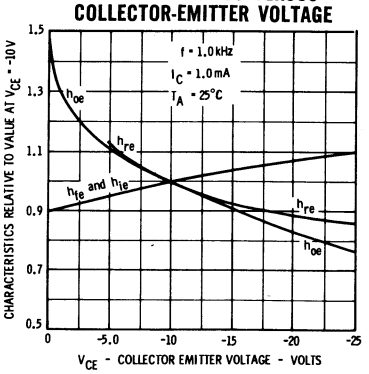
SMALL SIGNAL CHARACTERISTICS (f = 1.0 kHz)

SYMBOL	CHARACTERISTIC	2N4888 MIN.	2N4888 TYP.	2N4888 MAX.	2N4889 MIN.	2N4889 TYP.	2N4889 MAX.	UNITS	TEST CONDITIONS
h_{fe}	Small Signal Current Gain	30	40	500	65	150	400		I_C = 1.0 mA V_{CE} = −10 V
h_{ie}	Input Resistance	0.75	1.2	20	1.7	5.0	12	kΩ	I_C = 1.0 mA V_{CE} = −10 V
h_{oe}	Output Conductance	1.4	2.5	40	3.0	10	25	μmhos	I_C = 1.0 mA V_{CE} = −10 V
h_{re}	Voltage Feedback Ratio		1.0			2.5	5.0	$\times 10^{-4}$	I_C = 1.0 mA V_{CE} = −10 V

COMMON EMITTER CHARACTERISTICS VERSUS COLLECTOR CURRENT



COMMON EMITTER CHARACTERISTICS VERSUS COLLECTOR-EMITTER VOLTAGE



COMMON EMITTER CHARACTERISTICS VERSUS TEMPERATURE